Potable Water

Official Community Plan Focus Group

Policy Proposals
9 May 2007

Salt Spring Island
Official Community Plan Review
2006-2007

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Salt Spring Island Official Community Plan Review 2007 – 2008
Focus Group: Potable Water
Report to the Salt Spring Island Local Trust Committee

1.0 Background:

In February 2006 the Salt Spring Island Local Trust Committee initiated a review and update of the Salt Spring Island Official Community Plan (OCP). The Salt Spring Island OCP is an Islands Trust Bylaw that contains objectives and policies to guide the decisions of the Local Trust Committee with regard to community planning and land use issues on the island. This OCP Review will be focussed on specific sections of the community plan and may identify new policy issues. The review process and the adoption of the community plan amendments are scheduled for completion early in 2008. The process diagram for the Official Community Plan Review is shown below. It sets out the main steps to complete the review and the five planned opportunities for community consultation.

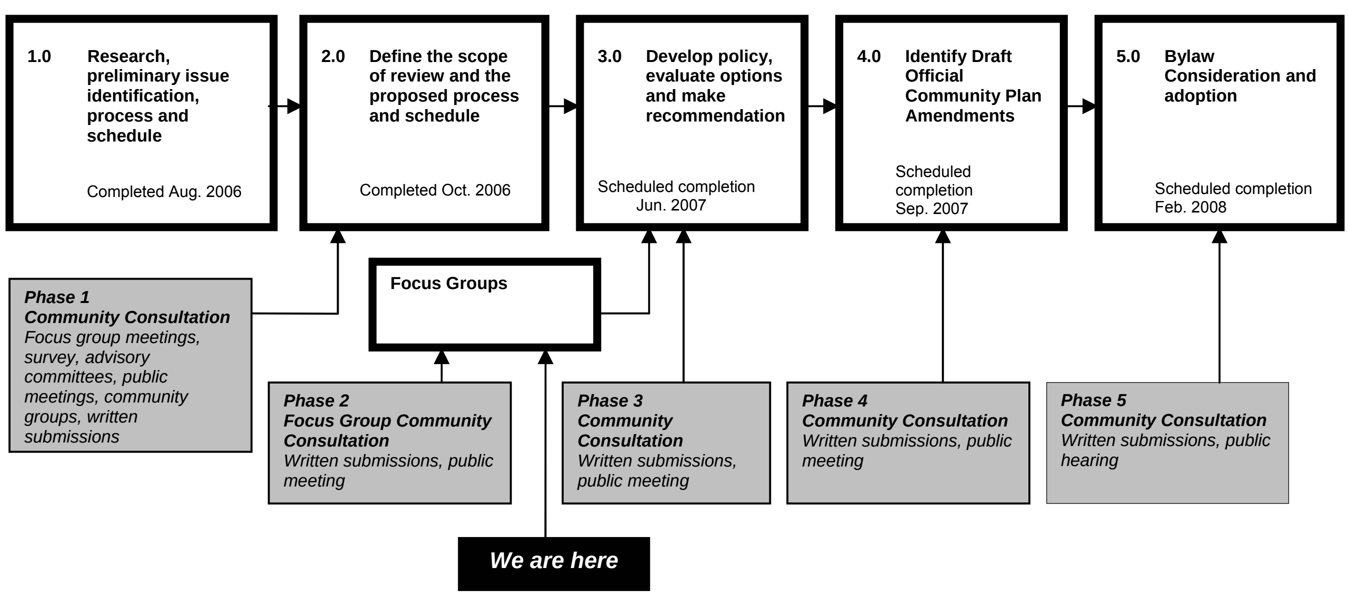
In response to community input, the Local Trust Committee established six Focus Groups to consider the primary subject areas of the OCP Review. After advertising in October 2006 for interested participants, the members of the focus groups were selected by the Trust Committee in consultation with the Advisory Planning Commission. The subject areas of the Focus Groups are:

- **Population, Housing and Settlement Patterns**
- **Economic Sustainability, Jobs and Tourism**
- **Environment**
- **Potable Water**
- **Ganges Village and Ganges Harbour**
- **Fulford Village**

The work of these focus groups will be supplemented by the independent and related work of the Area Farm Plan and the Community Energy Strategy groups. The focus groups were tasked to develop preliminary recommendations by the end of March 2007. In April 2007 community consultation meetings will be held *(phase 2 community consultation).* These meetings will give the focus groups an opportunity to hear from the community prior to finalizing their recommendations by the end of April.

Salt Spring Island Official Community Plan Review 2006 – 2007

Process Diagram



2.0 Focus Groups Membership and Contributors

2.1	**Chairperson:**	Tony Kennedy
	Vice-Chairperson:	Mike Larmour
2.2	**Members:**	Rick Gilleland Hugh Greenwood Ron Hawkins Deborah Miller Frank Moore Murray Reiss Bob Watson
2.3	**Islands Trust Staff Contributor:**	Leslie Clarke
2.4	**Trustee Contributors:**	Peter Lamb George Ehring
2.5	**Capital Regional District:**	Gary Holman

3.0 Summary of Recommendations

3.1 Apply the *Precautionary Principle* to the Planning, Utilization and Protection of Potable Water Resources on Salt Spring Island

The *precautionary* principle should be applied with regard to potable water supplies. Where the risk to the quality or quantity of potable water is considerable and long lasting, decision makers should act with caution, taking a highly conservative approach that comfortably offsets uncertainty of the impact of proposed actions that may impact on water supplies.

3.2 Coordinate Governance of Water Management Issues

As the governing body most affecting water demand by its actions and the only government body with protocol agreements with all other bodies concerned, the Islands Trust should include water management issues in existing protocol agreements with the CRD and all other bodies concerned.

3.3 Undertake a Comprehensive Water Management Plan for Salt Spring Island

Assess the potential magnitude of demand under present zoning and projections. Combine this information with other relevant information on supply, quality, conservation methods and costs to develop a comprehensive water management plan. Review the entire zoning framework of the island and make the changes necessary to secure reliable water resources for the future.

3.4 Control Growth in Areas Supplied by Surface water to Ensure Supply/Demand Balance.

The capacity to provide potable water from surface water sources is limited by hydrologic, economic, regulatory and environmental constraints. One water district will reach its legal limit to supply water before the build out projection in the current OCP is reached. Others are at or close to their licensed capacities. Revise planned development and settlement patterns in accord with the licensed and known capacities to provide high quality potable water at a reasonable cost.

3.5 Improve the Method of Proving the Adequacy of Groundwater Supplies

With the advice of a competent hydrologist, with local knowledge, the Trust should develop tests for proof of groundwater quantity and quality that are strict, well defined and cover conditions likely to apply through the year. Concerns of well interference, reliability under severe drought conditions, and overall sustainability at the permitted density and intensity of land use should be covered. The protocols thus established should serve as criteria guiding hydrologists acting for developers and for Approving Officers acting for the citizens of Salt Spring.

3.6 Place Every Community Watershed for Surface Water within a Development Permit Area

Place each watershed serving a community drinking water supply lake within a Development Permit Area. Define measures specific to each watershed with the objective of reducing sedimentation and nutrient loading in the lake it serves. Implement the Cusheon Watershed Management Plan. Prepare individual watershed management plans for other community drinking water lakes.

3.7 Require Minimum Lot Size in Areas Served by Groundwater

Establish minimum lot sizes to ensure sustainability of groundwater supply. This will require an area-by-area approach to the hydrology in order to establish reasonable local limits.

3.8 Require a Permit and a Development Plan for All Construction

All construction, whether a new subdivision, a house on an existing lot, or a renovation to an existing dwelling shall, in addition to a building permit, require the developer or owner to submit and have approved by the Islands Trust, a plan indicating how all water-related issues will be addressed.

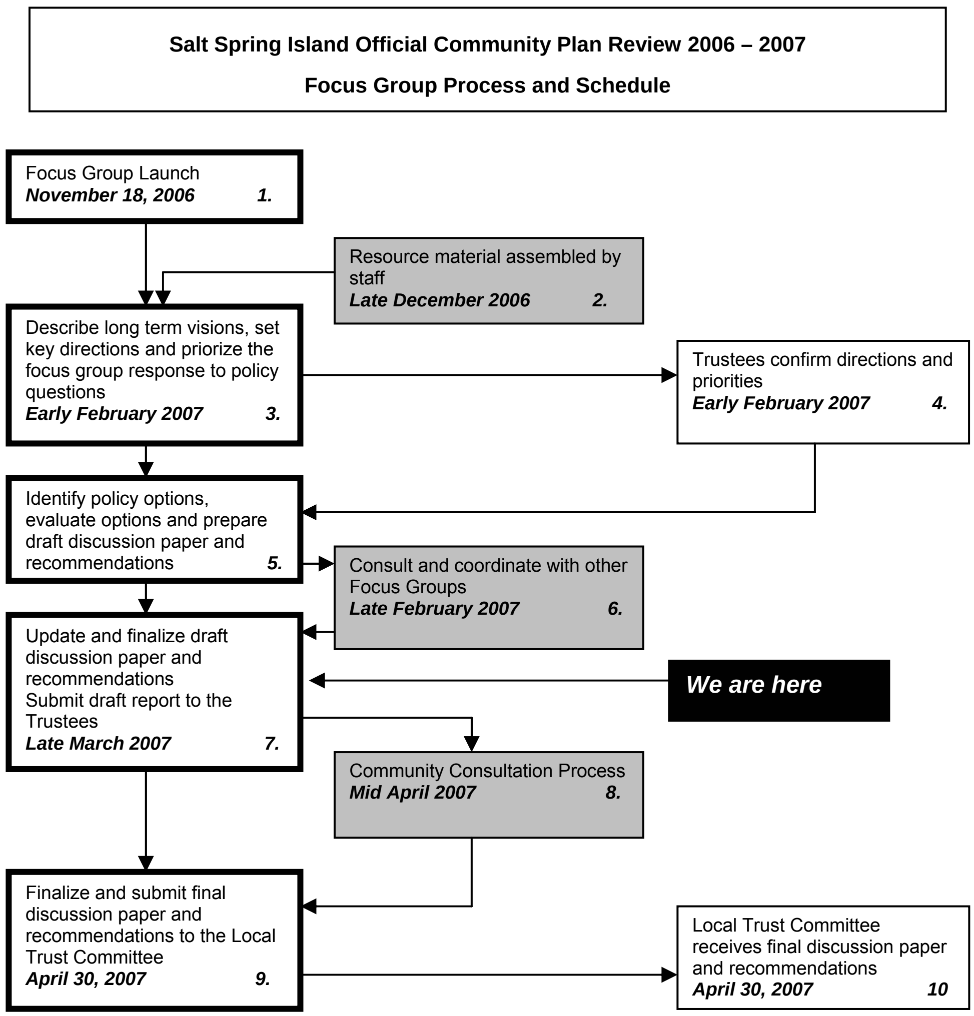
3.9 Establish a Water Conservation Policy

Develop an island-wide water conservation policy. In addition to education, a conservation policy should encourage imaginative development of demand management measures, incentives and disincentives including user pricing priorities and progressive rate structures.

4.0 The Focus Group Process:

4.1 The Process and Schedule

All OCP focus groups have been asked to undertake their work in accordance with the following process and schedule.



4.2 Consultation Outcomes:

In January, two members of the focus group met separately with the groups for Fulford and Ganges to exchange preliminary views on issues of common concern.

At the *Key Directions* workshop on 3 February, the focus group received written and oral comments on potable water.

A meeting attended by one member from each focus group was held on 7 March to enable a brief presentation and comments, and a further, similar meeting was held with the Ganges focus group on 22 March.

Following the 3 February meeting mentioned above, the Trust Committee subsequently suggested the following priority concerns for potable water:

1. Policy to keep permitted development levels within the sustainable water yield of the island
2. Policy concerning the protection of potable water quality by controlling land use in areas such as watersheds and groundwater recharge areas
3. Policy concerning alternative sources of potable water (eg, rainwater collection, desalination)
4. Policy concerning commercial (bulk) potable water sales on the island
5. Policy concerning potable water use and waste water disposal in home-based businesses
6. Policy concerning coordination among water supply agencies

5.0 General Comments

Vision:

Salt Spring Island will have a safe, assured supply of aesthetically pleasing high quality water that will serve the current and uncertain future needs of the island community at reasonable cost while honouring the natural beauty, environment and ecology of our island.

<u>Vision Principles:</u>

Water Quality
- To develop high quality potable water

Supply & Demand
- To reliably meet current and uncertain future needs
- To work in harmony with capacity of natural systems (respect, retain, restore)
- To make decisions based on good science
- To make no negative impact on supply systems (watersheds, groundwater sources, existing wells)
- To use precautionary approaches where good information is lacking
- To follow sustainable practices

Environment
- To meet ecological needs of communities
- To maintain aesthetics of natural systems

Governance
- To have collaborative management amongst jurisdictions
- To develop clear regulations, education & enforcement
- To encourage the idea that land and water use planning are inseparable and proactive.

6.0 The Policy Proposals

6.1 <u>Apply the *Precautionary Principle* to the Planning, Utilization and Protection of Potable Water Resources on Salt Spring Island</u>

6.1.1 What is the Problem?

The adequate supply and high quality of potable water are increasingly uncertain. In some areas they already appear inadequate as we proceed toward planned development levels.

Risks unknown at this juncture include, but are not limited to the impact of drought periods, the effect of climate change on water supplies and limited knowledge of the varying amounts of groundwater available in areas across the island. These risks suggest a conservative approach in setting aside water reserves in contrast to the full commitment of known or licensed supplies.

6.1.2 Does the Trust Policy Statement provide any guidance?

The preserve and protect mandate specifically includes the stewardship of resources and the careful management of the scale of development. Directive Policy 4.4.2 requires ensuring that neither the density nor intensity of land use is increased in areas which are known to have problems with the quality or quantity of freshwater.

6.1.3 What is the Policy Proposal?

The *precautionary principle* should be applied with regard to potable water supplies. Where the risk to the quality or quantity of potable water is considerable and long lasting, decision makers should act with caution, taking a highly conservative approach that comfortably offsets uncertainty of the impact of proposed actions that may impact on water supplies.

6.1.4 Are there alternative ideas to consider?

The concept of the utilizing the *precautionary principle* in planning contrasts with an alternative of going forward with poorly grounded optimism with regard to the quantity and quality of water. We must guard against the attendant possibility of drawing on water supplies beyond planned and licensed levels at high risk of damaging and possibly irreversible consequences.

6.1.5 Is this idea consistent with other policies?

The *precautionary principle* is fully consistent with the fundamental preserve and protect mandate of the Islands Trust.

6.1.6 How might the Policy be implemented?

The policy may be implemented through land use planning, and education of the public, commercial interests and developers. The water council and local governance bodies which share responsibilities for water should be concerned with monitoring the quality and quantity of surface and groundwater sources.

The other policy ideas in this paper have been developed with this principle in mind.

6.2 Coordinate Governance of Water Management Issues

6.2.1 What is the problem?

Governance over matters that affect water quantity and quality is distributed between local, provincial and federal government departments. In some cases there are conflicting priorities and in others no responsibility is accepted by any government. As a result it is difficult or impossible to manage our water resources or even to plan for their proper study or assessment. Insufficient research and monitoring prevents a thorough understanding of our water resources. The absence of this knowledge impedes informed decision making, which is difficult in any case in the absence of properly coordinated governance. This situation will be come more critical as we press the practical limits of our water supply. (Ref.: Appendix 6: Potable Water; Groundwater, Governance Issues, pp. 53-55.)

6.2.2 Does the Trust Policy Statement provide any guidance?

The Islands Trust Policy Statement Directive policies 4.4.2 and 4.4.3 indicate the concerns of the Trust Council regarding potable water. However these policies will not be effectively acted on without good governance and the necessary information and research that it provides.

6.2.3 What is the policy proposal?

As the governing body most affecting water demand by its actions and the only government body with protocol agreements with all other bodies concerned, the Islands Trust should include water management issues in existing protocol agreements with the CRD and all other bodies concerned.

6.2.4 Are there alternative ideas to consider?

The alternative is to do nothing and not have our water fully protected by the one governing body which knows all the concerns.

6.2.5 Is this idea consistent with other policies?

The policy proposal would assist in the strengthening and implementation of existing water policies.

6.2.6 How might the policy idea be implemented?

The policy proposal could be implemented by a directive statement in the OCP and through advocacy with the other bodies concerned. Establish one or more public advisory groups to identify issues provide information and make recommendations.

The Islands Trust should assume leadership in the coordination of water governance, research and monitoring, including supply, demand and quality issues. The Islands Trust should seek a mandate from all senior levels of government allowing the Trust to implement full management of island water resources.

6.3 Undertake a Comprehensive Water Management Plan for Salt Spring Island

6.3.1 What is the problem?

Considering island water resources as a whole the feasibility of providing sufficient water from our lakes or groundwater aquifers to deal with planned development has not been sufficiently studied. Neither has the effect of density transfers, affordable housing, institutional needs or other measures. Current zoning was established at a time when an increased population and water scarcity were not foreseen as problems. The present zoning patterns have resulted in the availability of land for subdivision in excess of the Island's natural capacity to provide water through present methods and licenses.

6.3.2 Does the Trust Policy Statement provide any guidance?

A primary objective of the Islands Trust is to *preserve and protect*. Part IV of the Islands Trust Policy Statement "Stewardship of Resources" provides guidance including the concern for self-sufficiency (4.4.1) and the directive to establish plans and regulatory bylaws that ensure neither density nor intensity of land use is increased in areas known to have a problem with quality or quantity of freshwater (4.4.2).

6.3.3 What is the policy proposal?

An island wide assessment of the potential magnitude of demand under present methods and licenses should be undertaken to provide a base for understanding the problem and seeking solutions. This information should be combined with other relevant information on supply, quality, conservation methods and costs to develop a comprehensive water management plan for Salt Spring Island. The entire zoning framework of the Island should be reviewed and changed with a view to securing reliable water resources for the future.

6.3.4 Are there alternative ideas to consider?

The alternative is to continue with unjustified optimism and the current zoning, attempting minor corrections to problems piecemeal as they arise. This will inevitably lead to problems, some of which may be irreversible and others may demand unusually expensive remedies. This alternative would not be consistent with the *preserve and protect* mandate or the *precautionary principle.*

6.3.5 Is this idea consistent with other policies?

This proposal is consistent with some OCP policies and in conflict with others

Consistent with:
- B.1.7 Finiteness of Resources (Conservation and Stewardship)
- B.8.1.1.1 Develop land use policies that protect water quality

Inconsistent with:
- B.8.1.2.2 Zones within designated watersheds will be allowed to continue uses allowed under current zoning

6.3.6 How might the policy idea be implemented?

This would be a directive policy for action by the Trust, undertaking a comprehensive water management plan and changing the zoning framework of Salt Spring Island. Broad consultation with the public would be required before changes could be implemented.

6.4 Control Growth in Areas Supplied by Surface Water to Ensure Potential Demand Does not Exceed Supply

6.4.1 What is the problem?

Water demand within the North Salt Spring Waterworks District (NSSWD) is projected to reach the limit of its present license well before the build-out projection in the OCP is met (ref. graph, appendix 1, p. 22). There are increasing constraints – regulatory, economic, hydrologic, environmental, legal, and in terms of water quality - that may preclude or limit further water demands being placed on the NSSWD.

The present OCP could allow the creation of approximately 700 new lots by subdivision within the NSSWD. Each new lot will add at a minimum the demand of one single family dwelling. At current consumption rates, the potential water demand from 700 lots is about 40 million gallons per year, which would lead to a total demand within the district at build-out exceeding both the district's current licenses and safe yield as given in the NSSWD annual consumption figures for 2005 (ref. explanatory note, p. 23).

Other areas supplied by surface water are at or near their licensed supply capacities. For some areas their source is fully licensed unless storage is created.

6.4.2 Does the Trust Policy Statement provide any guidance?

Islands Trust Policy Statement policy 4.4.3 supports this proposal.

6.4.3 What is the policy proposal?

Increased demand for surface water should not be permitted beyond committed levels in areas served by surface water unless appropriate withdrawal licenses are obtained first and arrangements made to have the full costs are borne by the new development.

As a matter of urgency for the NSSWD, a clear understanding and plan should be obtained from the relevant authorities on how to deal with the water supply situation – quantity, quality and cost - based on scientific knowledge and engineering principles before considering any increases in density.

To reduce potential future water demand within the NSSWD the OCP and the Land Use Bylaw may be amended to create a minimum lot size of 10 or 20 acres for new lots created by subdivision, with the exception of lots created by boundary adjustment for public service use or for lots subject to a covenant that they will not create a demand for water from the district.

The objective is to bring the potential water demand within the NSSWD more closely in line with the supply currently available under license, at levels of demand on Maxwell and St. Mary lakes that do not create excessive costs, hydrologic risks, environmental damage, or a negative effect on water quality. With the acquisition of a modest further license and strict control over land use, water should be available for limited low cost housing, public services and seniors accommodation as well as a reserve.

This policy proposal would not affect the land use of existing properties within the NSSWD.

6.4.4 Are there alternative ideas to consider? (These alternatives may be taken in various combinations to alleviate problems but are not regarded as sufficient in themselves. Some may produce undesirable side effects such as dam construction, flooding and impairment of water quality.)

- Rigorously encourage demand side management, including a heavily increased progressive rate structure, at levels that are likely to bring projected build-out demand and supply in balance.
- Set limits as a moratorium until a build-out supply/demand balance study is completed for other areas served by surface water and options on development plus alternative sources of supply and water reclamation can be evaluated.
- Use water treated by the Ganges sewage treatment plant for non-potable purposes.
- Work with other agencies on tax and other incentives to encourage the use of rainwater and efficient water fixtures and appliances.
- Allow increasing the capacity of St. Mary Lake by raising the dam, thereby flooding the shoreline and incurring costs and loss of fish habitat; by allowing excessive drawdown of the lake thereby incurring severe ecological and quality damage to the lake; by drawing on excess water from the Cusheon Lake watershed or by a combination of these measures with their attendant costs.
- Provide a desalination plant for stand-by purposes in case of a severe drought.

6.4.5 Is this idea consistent with other policies?

Sections B 1.5.1, C 3.1.1.3 and 3.1.2.9 in the OCP support this proposal.

6.4.6 How might the policy idea be implemented?

A directive statement leading to an amended Land Use Bylaw is appropriate.

6.5 Improve the Method of Proving the Adequacy of Groundwater Supplies

6.5.1 What is the problem?

The present test for the proof of an adequate supply of potable water, as required by the approving officer at the time of subdivision lacks a policy specifying exactly what constitutes satisfactory proof of water. There is thus no specific guidance to consulting hydrologists reporting on development proposals.

The adequacy of groundwater for further development is difficult to establish due to inadequate hydrologic information and variations in the situation from place to place on the island. In some areas, demand exceeds sustainable levels. (Ref.: Appendix 6: Potable Water; Groundwater, p. 48).The north end of the island has particular problems in this regard. The OCP allows levels of development that will exacerbate this situation. The option of providing surface water to all or an increased portion of the north end of the island does not appear practical, given the high demands already placed upon the lakes. The prospect of climate change makes it critical that new demands on groundwater be accurately assessed before development proceeds. (Ref.: Appendix 6: Potable Water; Groundwater, pp. 49-50).

6.5.2 Does the Trust Policy Statement provide any guidance?

Directive policy 4.4.2 of the Islands Trust Policy statement says in part that neither the density nor intensity of land use should be increased in areas which are known to have a problem with the quality or quantity of the supply of fresh water.

6.5.3 What is the policy proposal?

With the advice of a competent hydrologist, with local knowledge, the Trust should develop tests for proof of groundwater quantity and quality that are strict, well defined and cover conditions likely to apply through the year for all new development, new construction or major renovation. This policy should detail what requirements must be met, including pump tests, monitoring of neighbouring wells, the conduct of tests during the dry season to simulate drought conditions, and any other constraints thought necessary by the consulting hydrologist. Concerns of well interference, reliability under severe drought conditions, and overall sustainability at the permitted density and intensity of land use should be covered. The protocols thus established should serve as criteria guiding hydrologists acting for developers and for Approving Officers acting for the citizens of Salt Spring.

As requiring this “proof of water” may be beyond the jurisdiction of the Trust, coordination with other authorities, including the CRD and the Ministry of Transportation and Highways, will be necessary for this proposal. (Ref.: Appendix 6: Potable Water; Groundwater, p. 55, item 6).

6.5.4 Are there alternative ideas to consider?

The status quo proof of water is inadequate. In addition to addressing this problem, consider the following:

- Increase the minimum lot size permitted to reduce overall water demand and the amount of development at risk of water shortage. (Ref.: Appendix 6: Potable Water; Groundwater, Annual Water Balance, pp. 47-48.) Conditions vary across the island and so should minimum lot sizes.
- Carry out more detailed studies on groundwater availability and demand.
- Restrict development of groundwater to single-family dwellings on lots larger than 10 acres, with no future subdivision and development permitted.

6.5.5 Is this idea consistent with other policies?

OCP policy 3.2.2.3 speaks to the need for adequate proof of a potable water supply for each new lot created by subdivision. It is consistent with the principle of sustainability and with the precautionary principle inherent in the “preserve and protect” mandate of the Trust.

6.5.6 How might the policy idea be implemented?

The policy proposed is both a directive statement governing a decision of the local trust committee and an “encouragement statement” for the subdivision approving officer and the CRD building inspector.

6.6 Place Community Drinking Watersheds for Surface Water Within Development Permit Areas

6.6.1 What is the problem?

Current OCP land use provisions do not adequately protect water quality in Cusheon Lake, St. Mary Lake and Weston Lake. The OCP does not allow for the degree of control over detrimental land use such as logging, road construction, etc., that can be obtained through a wider use of development permits in community water supply watershed areas.

6.6.2 Does the Trust Policy Statement provide any guidance?

The trust policy statement section 4.4.2 says in part local trust committees shall in their official community plans and regulatory bylaws address measures that ensure water quality is maintained (a directive policy).

6.6.3 What is the policy proposal?

Place each watershed serving a community drinking water supply lake within a Development Permit Area. Define measures specific to each watershed area with the objective of reducing erosion and resulting phosphorus loading, algal blooms and turbidity, and of reducing other contaminants from entering the lake it serves. Implement the Cusheon Watershed Management Plan. Prepare individual watershed management plans for other community drinking water lakes. (Ref: Appendix 6 – Cusheon Lake Watershed Management Plan)

6.6.4 Are there alternative ideas to consider?

There are no feasible alternative ideas to reducing phosphorus loading on community surface water lakes from their watershed areas.

6.6.5 Is this idea consistent with other policies?

OCP objectives D 1.1.1.1 and D 1.1.1.2 support this proposal as does B 1.2.1

6.6.6 How might the policy idea be implemented?

- The policy should be implemented by an amendment to the OCP allowing watershed environmental DPAs.
- Individual restrictions should be written into each specific DPA.
- Restrictions should be developed and enforced to avoid the possibility of water use and waste disposal from home-based businesses negatively affecting community watersheds.
- Some residents in DPAs appear unaware of guidelines and restrictions within DPAs concerning important matters such as land clearance and diversion of creeks. Consider Road signs and other posting of DPA borders as well as other education initiatives.
- Apply the relevant recommendations of the Cusheon Watershed Management Plan to other DPAs established for community drinking watersheds for surface water.

6.7 Require Minimum Lot Size in Areas Served by Groundwater

6.7.1 What is the problem?

There are still over 1,000 lots that will be developed using ground water. It is not clear that this can happen without interference with existing wells or that there will be enough water found on all the lots currently planned. Without proper data, future development could be harmful to present usage and groundwater quality. Increased demands on groundwater may also result from extensive changes to existing dwellings through renovation for personal use, adding rental suites, home businesses, etc. If lots are subdivided according to current zoning, additional density may occur in areas least able to sustain growth. There are limits to the sizes of lots that will supply sustainable quantities of water. Increasing development will put increasing pressure on the overall aquifer even if pump testing proves sustainability for an individual lot. (Ref.: Appendix 6: Potable Water; Groundwater, p 37, #1;pp. 47-48; p. 50, #3; p. 54, #1).

6.7.2 Does the Trust Policy Statement provide any guidance?

Trust Policy 4.4 including all sub-paragraphs indicates that it is policy that the trust area be self-sufficient I the supply of freshwater and that the OCP and Land Use Bylaw should include measures to ensure it.

6.7.3 What is the policy proposal?

Establish minimum lot sizes to ensure sustainability of groundwater supply. This will require an area-by-area approach to the hydrology in order to establish reasonable local limits.

6.7.4 Are there alternative ideas to consider?

- Let growth continue according to zoning in all areas until problems occur. This will likely result in the implementation of controls too late to affect the outcome. Removal of development potential as problems occur will be more difficult to implement as development proceeds.
- Prove sustainable water supply with no interference with other wells. This solution requires the implementation of either DPA rules or building code modifications that address both quality and quantity.

6.7.5 Is this idea consistent with other policies?

The principle of sustainability is being applied. Other sources of water should be promoted more strongly, if not mandated to balance needs. In some areas location of wells, sharing of wells and cluster settlement patterns may need to be closely examined in view of water limitations. This proposal is not consistent with the current clustering policy which allows a minimum average lot size as well as a minimum lot size in any subdivision.

6.7.6 How might the policy idea be implemented?

- Put a moratorium on subdivision and/or rezone to larger lot sizes until hydrologic data is acquired.
- The current policy in the OCP, B1.3.3 and Bylaw 5.5.5 and 5.5.7 should be strengthened to reflect testing to an agreed standard which should be part of the OCP and Land Use Bylaw. The development of standards could be funded by the Islands Trust, employing an independent qualified P.Eng. Groundwater Hydrologist. The standards would then be reviewed by the development community and applied.
- This would be a directive policy and a Land Use Bylaw. It may need to be a recommendation at first, based on concerns and the need for more groundwater data.
- Until standards are developed the following minimum lot sizes should be applied: Residential-2 acres, Rural-5 acres, Rural Uplands-10 acres, Forestry-20 acres.
- Restrictions should be developed and enforced to avoid the possibility of water use by home-based businesses at levels detrimental to overall supply from the aquifer and waste disposal from home-based businesses negatively affecting the recharge area.
- Identify problem areas and improve groundwater data, then address and apply minimum lot sizes on a ranking of area risk. This is a long-term solution requiring the acquisition of data over significant areas of the island.

6.8 Require a Permit and a Development Plan for All Construction

6.8.1 What is the problem?

At present there is no requirement for a developer or owner to state how potential problems related to water supply and quality will be handled. Matters such as water supply and testing, water demand, water use expectation, tree cutting, road building, grading, drainage control, sewage control, well protection, and household metering are not commonly addressed in advance of development.

Without such oversight the ability to steer development in the right direction, or to manage potential problems on water supply and demand will be lost.

6.8.2 Does the Trust Policy Statement provide any guidance?

TP 4.4 including all sub-paragraphs indicates that it is policy that the trust area be self-sufficient in the supply of freshwater and that the OCP and Land Use Bylaw should include measures to ensure self-sufficiency.

6.8.3 What is the policy proposal?

All construction, whether a new subdivision, a house on an existing lot, a renovation to an existing dwelling, and for either new or existing home based businesses, shall in addition to a building permit, require the developer or owner to submit and have approved by the Islands Trust, a plan indicating how all water-related issues will be addressed.

6.8.4 Are there alternative ideas to consider?

- Arrange for the CRD building inspector to carry out this work on behalf of the Islands Trust.
- Examine the DPA framework to determine whether controls might be established under DPA rules.

6.8.5 Is this idea consistent with other policies?

There are inconsistencies. CRD has building permit authority, VIHA exercises monitoring and provision of the water end product (post treatment), lake water licences come through MOE, and Islands Trust attempts to manage primarily via land-use regulations.

The policy achieves proper oversight and improved development management. This is also consistent with other policy ideas or recommendations made to improve governance of development in general and of water issues in particular.

6.8.6 How might the policy idea be implemented?

This would be a directive policy for the OCP and Land Use Bylaw. A guideline for the plan to be submitted would have to be developed first and coordinated with other government organizations (building permits, additional DPA requirements, etc).

Existing home based businesses should be required to complete a survey based on the guidelines to determine if the policy is already being met, a plan is required, or rectification is needed.

This policy may be implemented through the Development Approval Information process by including this proposed water development plan as a requirement of meeting the DAI bylaw.

6.9 Establish a Water Conservation Policy

6.9.1 What is the problem?
Salt Spring faces a demanding, uncertain future with respect to both surface and groundwater supply. While we enjoy an abundance of precipitation, storage capacity through the dry season is seriously limited. (Ref.: Appendix 6: Potable Water; Groundwater, pp. 39-40). Some drinking water lakes are close to their capacity to meet both current demand and existing commitments for additional supply. The OCP (C.3.1.2.2) and recent supply-demand considerations (Appendices 1, 2 & 3) identify this concern with respect to the NSSWD. The capacity for supply from groundwater varies from place to place and requires technical assessment for each development. Difficulties with wells in the north end are increasing. As the summer of 2006 was relatively dry, trucked water sales, primarily in the north end, increased by 65%.

6.9.2 Does the Trust Policy Statement provide any guidance?
The Islands Trust Policy Statement (p.5) states "the Islands Trust has *responsibility for conservation* through land use planning and regulation for leadership in stewardship…". 'Conservation' is defined to include 'preservation of habitat' which includes watersheds and lakes. The guiding principles on page 6 state "the rate and scale of growth and development in the Trust Area must be carefully managed and may require limitation".

6.9.3 What is the policy proposal?
Develop an island-wide comprehensive water conservation policy. In addition to education, a conservation policy will require imaginative development of demand management measures, incentives and disincentives including user pricing priorities and progressive rate structures. As future demand rises and climate change uncertainties confront us, the surest means of improving our supply situation are conservation and rainwater catchment.

6.9.4 Are there alternative ideas to consider?
There is no cheaper, sustainable water supply opportunity.

6.9.5 Is this idea consistent with other policies?
OCP Section 3.3.3 encourages careful management of freshwater bodies. Section 4.4.1 commits Trust Council to self-sufficiency in the supply of fresh water. Section 4.4.4 encourages conservation practices with the use of fresh water.

6.9.6 How might the policy idea be implemented?
Through discussion in the Water Council, water districts, the CRD and MOE with particular attention to the NSSWD.

In addition to education, continuing encouragement and incentives should be given for water efficient appliances. Rainwater catchment, grey water recovery, package treatment plants and composting toilets could be important elements of the policy.

Establish a water conservation strategy for Salt Spring, elements of which include:

- Universal metering, public education and rebate programs.
- Land Use Bylaw provisions like those in the Scott Point Water District which enables cutting off extreme consumers after due warning.
- Designers, builders and the CRD building inspector making clients aware of the cost-effectiveness of designing for some degree of rainwater catchment.
- Several pilot demonstration projects.
- Low water demand landscaping.
- Active education program for individual well owners.
- The volume of water used in home based businesses should have a negligible impact on groundwater and community surface water lakes. Their waste should have no negative impact on aquifer recharge areas.

7.0 Other Proposals

7.1 Require/Encourage Further Measures for the Protection and Improvement of Groundwater Quality

A program for well protection and groundwater stewardship should be developed. Septic systems should be monitored and proof of maintenance required and enforced. Alternative sewage treatment systems such as package plants should be considered to replace septic systems for new construction and remediation of failed septic systems.

7.2 Ensure Costs Are Paid By Those Who Cause Them

It is important not only to plan for future development, but to determine the cost of that development and how it will be funded. Before approving an increase in density in a water district, the Islands Trust should consider the impact of that new density on the supply of potable water. If approval requires new water supply solutions, their cost should be fully born by the new development, not spread across the water district as a whole or the island as a whole. This includes any requirement for more sophisticated water treatment as a result of the impact of increased demand on water supply. For example, if a proposed development cannot demonstrate that sufficient water can be supplied by known suppliers or proven groundwater, the developer must assume the cost of providing alternate solutions such as desalination, rainwater collection and storage, and distribute that cost among the users of that development alone.

8.0 Proposed Encouragement Statements

In addition to those actions recommended earlier in this report which require Islands Trust advocacy and encouragement and collaboration with other agencies, the following do not fall within the authority of the Islands Trust but are recommended for pursuit by the Islands Trust with the agencies noted.

8.1 CRD: Develop practical guidelines and specifications to assist homeowners in the proper installation of rainwater, grey water and black water collection systems, and in the installation of composting toilets.

8.2 CRD: In collaboration with water districts and CRD develop and annually update island-wide water supply/demand projections which respect the capacity of natural systems to supply water.

8.3 CRD: Establish a requirement for mandatory inspection and more frequent monitoring, education and enforcement of septic systems everywhere, but particularly in community water supply watersheds and groundwater recharge areas serving community systems.

8.4 CRD & MOE: Encourage phosphate free fertilizers, detergents and soaps in drinking watersheds.

8.5 CRD, VIHA & MOE: Regarding the commercial sale of potable, non-potable, groundwater and surface water, establish requirements for licensing, monitoring and reporting to establish water quantity trends, including customer locations.

8.6 CRD and other water purveyors: Ensure water treatment systems effectively address algal toxins.

8.7 Transport Canada: Keep airplanes and all gasoline-powered engines out of drinking water lakes, including safety boats for rowing or other recreational clubs.

8.8 Health Canada: Create standards for short term exposure to all relevant algal toxins.

9.0 Comments on Priorities:

The adequate, healthy supply of potable water on Salt Spring Island is at risk as we move forward with further development. In some groundwater areas and in at least one surface water district, planned development appears to exceed known or licensed supplies in a manner that threatens a significant impact on the quality and cost of living of those affected. In response, the priorities for consideration by the Local Trust Committee include:

1. Apply the *precautionary principle* to offset unforeseen problems in quality and quantity of potable water for projected development.

2. Coordinate governance of water management issues now spread across various governmental agencies.

3. Develop a comprehensive water management plan for the island as a whole.

4. Control growth in areas supplied by surface water to ensure supply/demand balance.

5. Improve the method of proving adequate water supply in areas to be served by groundwater.

6. Establish Development Permit Area restrictions in every watershed serving a community drinking water supply lake.

7. Establish minimum lot sizes for areas served by groundwater in a manner that takes account of varying conditions across the island.

8. Approve construction in a manner that ensures avoiding negative impact on the supply and quality of potable water.

9. Develop an island-wide water conservation policy.

Current and future technological developments may enable lowering per capita water consumption or ensuring adequate water quality in ways permitting growth at levels above currently foreseen limits. These measures may include re-use of treated sewage water and grey water. Such measures should only be considered where the cost will be fully offset by the additional development they permit rather than distributed to all the water district's customers or the island as a whole.

10.0 Appendices

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10.1 Appendix 1

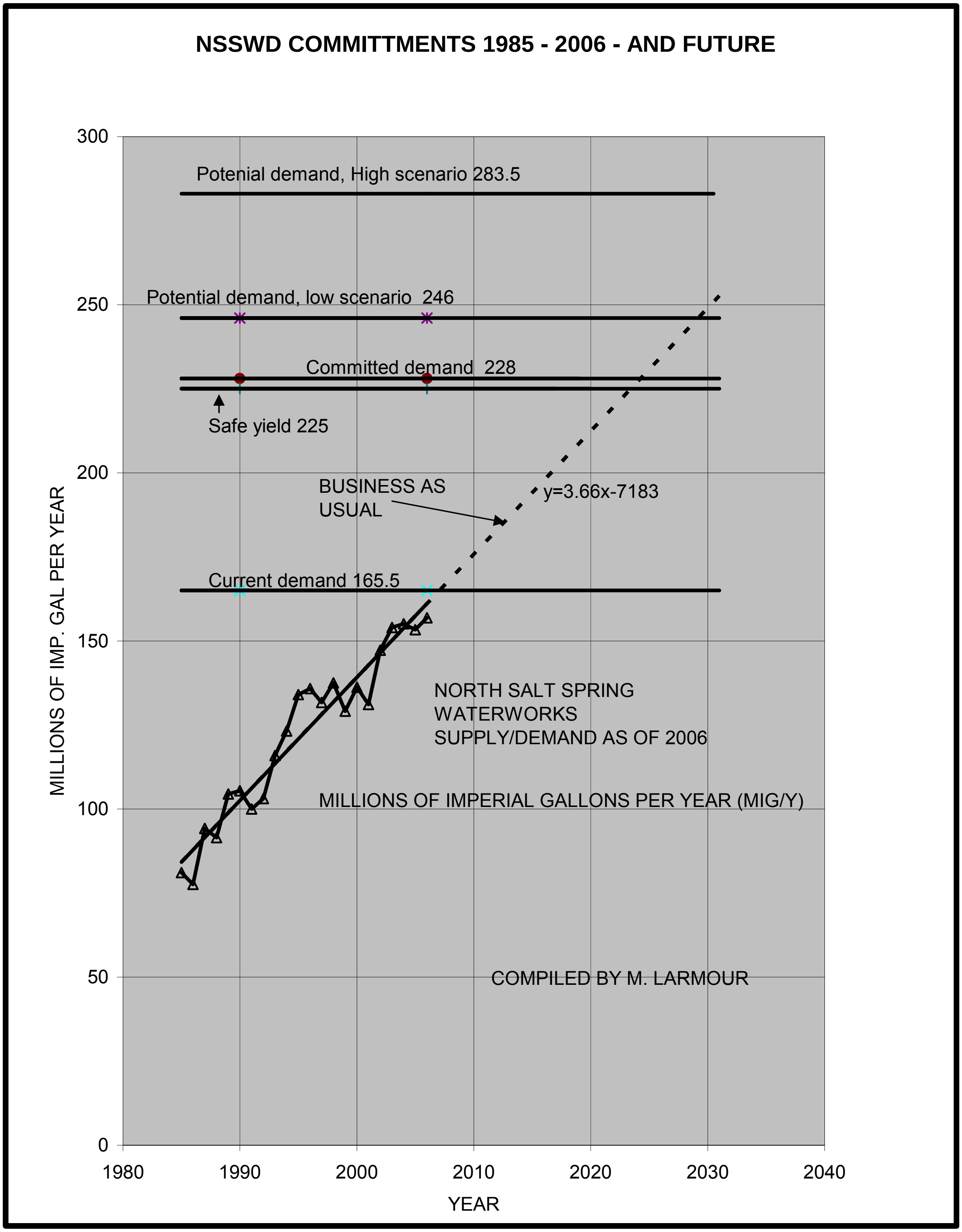
10.2 Appendix 2

10.3 Appendix 3

10.4 Appendix 4

10.5 Appendix 5

10.1 Appendix 1: North Salt Spring Water Works District, Supply-Demand Graph



Explanatory Notes to Graph of North Salt Spring Waterworks Supply-Demand

1. Year 2000-2005 water use based on NSSWD reported annual water use.

2. Year 2006-2020 water use projection based on an annual increase of 3.66 million gallons per year, i.e. the recent average annual increase.

3. Current Demand (2006): 165,493,990 gallons/year.

4. Safe Yield of Lake: 225,000,000 gallons per year for NSSWD drawing from both Maxwell & St. Mary Lakes, under current licenses. (Ref. Table 2. North Salt Spring Waterworks District Annual Consumption Figures for the year 2005.)

5. Committed Demand: Total of Channel Ridge development, empty subdivision lots (single family dwellings) and build out potential of property within the district and currently zoned for commercial, institutional, industrial and multiple family use – 228,000,000 gallons/year.

   Estimates of future demand are derived from the Islands Trust build out study for the NSSWD. This projection considered single and multiple family dwellings, commercial, institutional and industrial development but did not include increased development due to amenity zoning, density transfers, or rezoning. No change was assumed in the average water demand per dwelling unit or per square metre of commercial and institutional use.

6. Potential Demand – Low Scenario: Estimated total water demand from development permitted under current zoning (2005). The additional increment of demand over committed demand is primarily through subdivision. The District is not obligated to serve subdivisions if it does not have sufficient source capacity.

7. Potential Demand – High Scenario: Same as low scenario but with a 15% safety factor added in consideration of many unknown or uncontrollable factors that could increase future water demand above that projected in the low scenario.

10.2 Appendix 2:

North Salt Spring Water Works District
Supply & Demand
Denis Russell & Bob Watson
January 23, 2007

EXECUTIVE SUMMARY

North Salt Spring Waterworks District obtains its water supply from two lakes – Lake Maxwell and St Mary Lake. NSSWD is the only user of the water from Lake Maxwell, but there are other users of St Mary Lake water.

Estimates of the supply and demand for water are based on data from measurements and are subject to considerable uncertainty from shortage of data, and uncertainties about future development and the effects of climate change. However, now there are structures at the outlets of both lakes that will allow accurate measurement of runoff. This combined with ongoing recording of precipitation, air temperature, and water demand will provide a firmer base for future planning.

Salt Spring Island is relatively dry compared to adjacent areas on Vancouver Island and this means that runoff is much more variable on Salt Spring than on Vancouver Island. For example, the average annual runoff to the Cowichan River is 2.1 MG/acre (million imperial gallons per acre), while it is only about 0.35 MG/acre on Salt Spring. In a severe drought, such as the 1 in 50 year, 5 year long sequence of dry years, the average runoff on Salt Spring falls to 0.15 MG/acre (only about 40% of the long term average), compared to 1.6 MG/acre (75% of the long term average flow) in the Cowichan River.

Storage is critical to meeting the demand of NSSWD and others for water, even in average years, because of the natural seasonal pattern of high runoff in winter and low, if any, runoff in summer. But the storage in the two lakes is especially important for meeting the demands for water during extended droughts. In some ways the most important question is not "Do we have enough water to meet foreseeable demands?" but "Do we have enough storage?"

The present total demand for water from both lakes is about 300 million gallons per year (MG/year). This can easily be met during average years, as the total average annual runoff is about 700 MG. Even during a 1 in 50 year, 5 year long drought, when the total annual runoff from both lakes would fall to about 300 MG/year, present needs for water could be met.

The total demand from both lakes at "build-out" is estimated at about 450 MG/year. This could readily be met in a year with average or above average precipitation. But should there be a severe drought near or after build-out, it would be necessary to withdraw millions of gallons of water from storage to supplement the supply from runoff. That would involve drawing down the lakes, particularly St Mary Lake. In the extreme, during the 1 in 50 year, 5 year long drought, it might be necessary to withdraw up to 900 MG from St Mary Lake, resulting in a maximum drawdown of about 3.0 m (10 feet) by the end of the drought. This is based on the "high" estimate of demand and the "best" estimate of runoff. The large drawdown would be "temporary", as the lake would fill again, as precipitation returned to normal in subsequent years – with average yearly runoff, it would take 5 years for St Mary Lake to refill. With the extreme 1 in 50 year, single year drought, it could be necessary to draw down St Mary Lake about 2.1 m. The lake would refill when runoff returned to normal, within about 3 years. In practice, should there be such unusually severe droughts; strong conservation measures to reduce the impacts would almost certainly be implemented.

Alternative measures that could help reduce the impact of a very severe drought on St Mary Lake include diverting 2 small creeks, Andrea and Gossett, into Lake Maxwell, raising the dam at the outlet from Lake Maxwell and diverting part of the winter flow from Cusheon Lake. With these measures, the St Mary Lake drawdown during droughts and refill time after droughts could be greatly reduced.

Although there seems to be no supply-demand "problem" now, the demand is likely to build up over the years. It will be important to study the various alternatives that could reduce the impact of a long severe drought on St Mary Lake, develop plans, obtain approvals from the Ministry of Environment and implement the selected measures in good time – hopefully, long before they are needed. It will also be important to install flow measuring systems at the outlets from Maxwell and St Mary lakes as soon as possible, to help provide a firm base for future planning.

INTRODUCTION

The water supply for North Salt Spring Waterworks District (NSSWD) comes from two sources – Lake Maxwell and St Mary Lake. This short report looks at the present supply and demand for water and projections for the next 20 to 30 years – until "build out" – the level of development on Salt Spring allowed under the current land use Land Use Bylaw.

BACKGROUND

Estimates of the supply and demand for water have to be based on present day and past measurements that provide information not only on the present supply and demand for water, but also on their variability from year to year and long term trends. Water supply estimates are based on measurements of precipitation, air temperature, evaporation and stream flow. Estimates of demand are based on measurements of actual consumption. The way in which the measurements are made and some of the difficulties in making and assessing them are discussed below, to give some idea of the reliability of the estimates and projections.

Precipitation and air temperature Rainfall is measured by collecting the rainfall in a rainfall gauge and each day measuring and recording the amount that fell since the previous measurement, usually at the same time, the day before. If there is snowfall, it is also measured and converted to the equivalent amount of water. Rain gauges are cheap and relatively simple. Air temperatures are usually measured at the same locations. There are several precipitation/air temperature stations on Salt Spring, including one at Lake Maxwell and one at St Mary Lake.

Evaporation Evaporation is measured in an evaporation pan. It measures "potential evaporation", the evaporation that occurs when there is no limit on the amount of water available. An evaporation pan is a specialised piece of equipment and the nearest one was at the recently discontinued Agricultural Research Station in Saanich. It was the only one on Vancouver Island. There are none yet on Salt Spring, although NSSWD is planning to install one at Lake Maxwell. Lake evaporation depends on many variables including lake surface water temperature, air temperature, wind, and humidity. It is estimated from evaporation pan readings, but there is obviously considerable uncertainty about estimates of the evaporation from Salt Spring lakes based on evaporation pan data from Saanich.

Evapo-transpiration Some water is "lost" to evaporation from water surfaces such as the lakes, some from damp ground, and some through plant transpiration. The total is often referred to as "evapo-transpiration" or "ET". Immediately after a rainstorm, the ET from a catchment equals the potential evaporation (PE), but then, as the land and vegetation dry out, the ET falls below the PE, eventually reaching a very low value after a long dry spell. In practice, information on average ET over whole catchments is needed and has to be estimated with the help of empirical formulae. These are formulae developed from actual data – but the data may not be very representative of local catchments, thus ET estimates are very uncertain.

Measuring stream flow The flow in a river, the "runoff", can be measured directly by a "stream gauge". This involves measuring the water level on a daily or on a continuous basis, looking up the corresponding flows from a "rating curve", and adding the results to obtain totals over any desired period. For comparing supply and demand, the annual totals are of most interest. The rating curve for a particular site shows the relationship between the water level and the flow. It is obtained by taking about 3 flow measurements a year, near the water level gauge, and plotting them against their corresponding water levels. Once a rating curve has been established, the water level can be measured and then the corresponding flow can be looked up from the curve. Establishing and maintaining a stream gauge requires skill and experience and, in Canada, it is usually done by the Water Survey of Canada.

Stream flow data Some runoff flows were measured at the outlet to St Mary Lake in the 80's, but only during part of the year, so they are of little use for estimating total annual flows, which are the values needed for planning. Flows throughout the year were measured at the outlet from Cusheon Lake from 1977 to 1998 and these can be used for estimating flow rates on Salt Spring. The nearest stream gauges with long term flow records, which are needed for establishing trends, are on the Cowichan River, the Koksilah River near Cowichan, and the Chemainus River, all on Vancouver Island. Stream flows at a point are the total runoff from the whole catchment upstream of that point and thus they provide "integrated" information on the whole catchment. In contrast, precipitation and evaporation measurements only provide information at point locations. As a result, when estimating flows, hydrologists tend to rely more on stream flow data than on precipitation and evaporation data. In practice they usually have to make the most of whatever they can get.

Estimating flows The flows into and out of lakes such as Maxwell and St Mary can be estimated from precipitation and evaporation data by using suitable formulae and/or from stream gauge information. Since these flows have not been measured, they have to be estimated from the available information. However, a small dam has now been built at the outlet from Lake Maxwell and a weir has just been built at the outlet from St Mary Lake. The flow over a dam or weir can be computed given the water level upstream. Water level records can be kept for both lakes and from these records it will be possible to accurately compute the outflows from the lakes. These data will provide a firmer base for future planning than has been available to date.

Water demand Water "demand" (consumption) is measured by meters in the water mains that leave Maxwell and St Mary lakes and also by a meter at each individual home or other "customer". From time to time leaks develop in the piping systems, and are repaired when they are located. Water is allowed to overflow from the storage tanks on Fulford-Ganges Road during periods of the day when demand is low, in order to maintain the required levels of chlorine in the water. However, improvements are being made and it will soon no longer be necessary to have water overflowing from these tanks. At St Mary Lake, there is filter backwash that is not measured. Meters wear and tend to under-read, may become inaccurate, and need to be replaced from time to time. There are thus some inaccuracies in the flow metering, but these are relatively small – probably on the order of 5%. Present and past water consumption are thus known fairly accurately. The main uncertainty is water main leakage, which has varied from negligible to about 15% of total demand in the St Mary distribution system during the past few years. There are some old asbestos-cement water mains in the distribution system and these will need to be replaced over time to minimise leakage.

Future supply Normally one would expect that the supply of water would not change over time. However, it could change if the climate changes. It is generally recognised that global warming is taking place and local records show that average air temperatures have been increasing. This is likely to increase the ET – evapo-transpiration, but an analysis of the total annual evaporation at Saanichton over the period of record from 1970 to 1998 did not show any trend. This does not mean that there is not a trend, just that the available data, which has some gaps in it, does not show one. There is also evidence that precipitation is increasing and the two trends could cancel one another out.

Looking at the nearest long term stream flow gauges on Vancouver Island and on the Fraser River at Hope – the gauge with the longest record in B.C., it looks as if flows may actually be increasing slightly – if one looks at the whole period of record. Shorter periods are suspect as they could be selected to show any trend that one wishes. Annual flows on the Cowichan River show little evidence of a trend even though air temperature began to rise a few decades ago.

However, there are many uncertainties and at this stage, it is just not possible to make any definitive statements about the effects of climate change on the local water supply. As an example of the many uncertainties, it has only recently been realised that there are rainfall cycles and hence runoff cycles associated with climatic events such as the El Nino cycles.

Future demand Water consumption to date is reasonably well known from records of the metered flows, but future demand can only be estimated. Future demand will depend on many things, but especially on the amount of development. However, assuming that the amount of development allowed under the current land use Land Use Bylaw eventually takes place, an upper limit to the demand can be estimated. There will be uncertainties such as the extent of supply replacement, irrigation and other needs to meet community goals, and these have to be allowed for.

LONG TERM AVERAGE YEAR WATER SUPPLY

For planning purposes, it is important to consider both the average year runoff and the runoff during years with less than average precipitation – droughts. There is over-year storage at both Maxwell and St Mary lakes that could help "tide us over" short term low runoffs, such as extreme single year droughts or major extended droughts. Estimates were prepared for both the long-term average year water supply and for droughts, using available precipitation, evaporation and stream flow data.

Estimates based on precipitation and evaporation The amount of runoff at both lakes during an average year was estimated on the basis of precipitation and ET – evapo-transpiration. This estimate relied heavily on the work and reports of Roy Hamilton, a hydrology consultant to the NSSWD in the 90's. The results in terms of million imperial gallons per year (MGY) were 171 MGY for Lake Maxwell and 527 MGY for St Mary, for a total of about 700 MGY.

Estimates based on flow measurements Annual flows were measured at the Cusheon Lake outlet for the years 1977 to 1982 and from 1985 to 1998. Cowichan River flows during this period of record were compared with its long-term average flows – flows during the period of record were 95% of the long-term average. Correcting for this and the large difference in runoff per acre between Cusheon and Cowichan gives an estimate of the long-term average runoff at Cusheon of about 0.35 MG/acre/year. This translates to 170 MGY for Lake Maxwell and 620 MGY for St Mary Lake.

The small dam at the outlet to Lake Maxwell was raised in 2000 and the reservoir did not fill and overflow in 2001. As a result, it was possible to calculate the runoff at Lake Maxwell that year from the metered outflow and the change in lake storage resulting from the change in water level during the year – 117 MG. However, 2001 was an unusually dry year. When corrected for this, using the long term pattern of runoff at the nearest Vancouver Island gauges, gives 174 MG as the average annual runoff at Lake Maxwell using the Cowichan River data, 184 using the Koksilah River data and 211 using the Chemainus River data.

Best estimate for average year water supply About 171 MGY from Lake Maxwell and 527 MGY from St Mary Lake are the best "working" estimates of the average annual runoff available from these two lakes; and these total 698 MGY. Thus, without utilising over-year lake storage, present average year supply is about 698 MGY.

WATER SUPPLY DURING DROUGHTS

Supply reliability is needed during droughts. Both Maxwell and St Mary lakes have a large amount of over-year storage (stored water that can be carried over from one year to the next). Estimates were made for the 1 in 10 year 5-year average runoff, the 1 in 50 year 5-year average runoff and the 1 in 50 year single year runoff. The 1 in 50 year single year runoff is defined as the total annual runoff that, on average, is exceeded in every year but one, during a 50 year time period. Similarly the 1 in 50 year 5-year average runoff is defined as the annual runoff averaged over 5 years that on an annual moving average basis, is exceeded in every year but one, during a 50 year time period. Flow data from the same nearby rivers on Vancouver Island as before – the Cowichan, Chemainus and Koksilah rivers, were used for reference. Also precipitation data from Maxwell and St Mary lakes were used for the 1 in 10 runoff estimates.

The Cowichan Lake outlet stream flow data is very helpful as it includes a lake with a surface area that is 10% of the watershed, includes the 1940-45 extended major drought, includes 3 of the 4 major single year droughts since 1914-15, and has no data gaps.

Precipitation and runoff on Salt Spring Island are much lower than that on Vancouver Island. The average annual runoff in the Cowichan River is 2.1 MG/acre (million gallons per acre), while it is only about 0.35 MG/acre on Salt Spring. The 1 in 50 year 5-year average runoff in the Cowichan River is 76% of the long-term average. This corresponds to average annual precipitation, during the 5 low years, that is 80% of the long-term average (assuming an average ET of 0.5 MG/acre/year). Using the same percentage (80%) for the average precipitation on Salt Spring during the low runoff period gives the runoff from Maxwell and St Mary lakes as only 44% of the long-term average. Drier areas, such as Salt Spring are thus much more vulnerable to long periods of low precipitation than are wetter areas, such as Vancouver Island.

Figure 1 below shows a 5 year moving average of the precipitation at Lake Maxwell. It was developed from Maxwell and other local weather stations. The 1896-1916 data are in calendar years, but the rest are in water years (Oct-Sept), as these are more useful than calendar years for dealing with questions of water supply and lake storage. The chart illustrates the variability of the precipitation over long periods and the severity of droughts. For example, the average yearly precipitation in the 5 year periods 1925-30 and 1940-45 was only about 80% of the long term average, which is the same as the percentage given in the previous paragraph; and as described above, this results in a 5 year average runoff that is only about 44% of the long term average runoff.

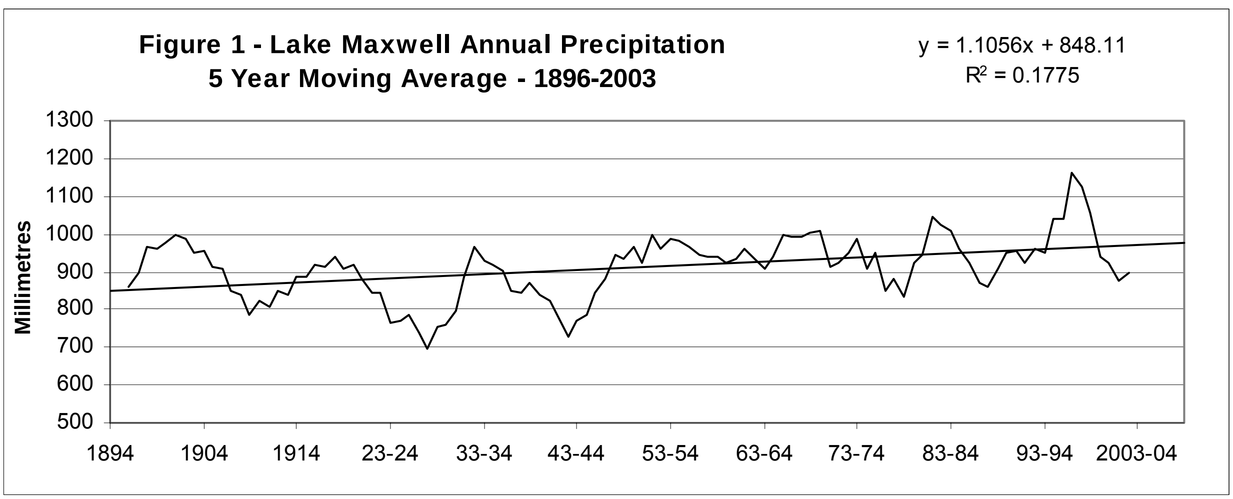


Figure 1 shows that precipitation during the 1925-30 and 1940-45 droughts would on average over a 5-year period have been about 180 mm/yr less during these droughts than during an average year. With increasing average year precipitation, a current extended drought of similar severity would result from about 790 mm/yr precipitation. Future droughts of this extent and severity appear to be one of the types of events that need to be planned for.

Figure 2 below shows the same data as Figure 1, but on a single year basis.

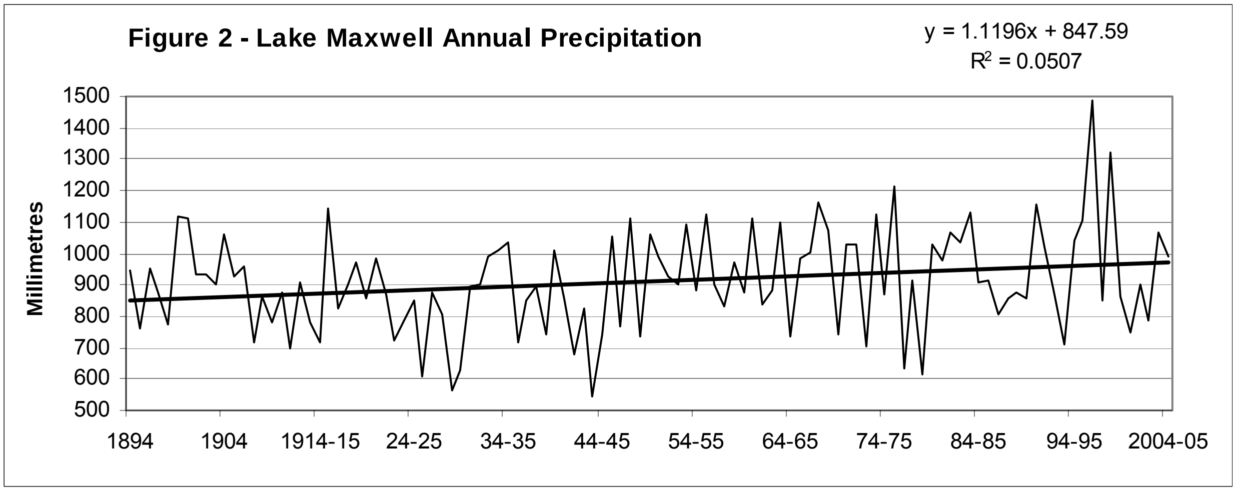


Figure 2 shows 4 single-year droughts since 1914-15 when precipitation has been 300-350 mm less than during an average year (during 1928-29, 1943-44, 1976-77, and 1778-79). These major single-year droughts are also events that need to be planned for.

Precipitation at Lake Maxwell and St Mary Lake has been similar during the period of on-site records, except possibly during some droughts. St Mary Lake is only 40.7 m above sea level compared to 314.5 m for Lake Maxwell, so there may be a difference in drought precipitation.

Table 1 shows the best estimate of annual (water year) drought total runoff from each lake. The calculations are shown in Appendix 1. Several approaches were used and the results were combined to try and minimize errors and uncertainty. However, the Total estimates of total runoff during major droughts (which are critical for planning) are probably only accurate to within plus or minus 50 MGY of the true values.

***Table 1 – Best estimate of average annual drought total runoff from* Maxwell and St Mary lakes (all in MGY)**

Drought Severity	Lake Maxwell	St Mary Lake	Total
1 in 10 year 5-year average	117	326	443
1 in 50 year 5-year average	87	218	305
1 in 50 year single year	16	-45	-29

DEMAND

Present NSSWD water demand from the Maxwell and St Mary distribution systems combined during a dry summer year is estimated at 171 MGY. “Present” is based on year 2003, a dry summer year typical of expected future summers with climate change, customer meters with a 5% meter wear allowance, and a 15% loss allowance. NSSWD demand at “build-out” is estimated at 277 MGY – about a 60% increase from the present demand. NSSWD build-out is based on the Islands Trust June 30, 2006 Staff Report build-out projection for currently permitted (zoned) development within NSSWD. The proportion of multi-family to single family residences in Channel Ridge Village shown in the Islands Trust report was adjusted to match present Channel Ridge Village plans. Estimates of present demand are reasonably certain, since they are based on actual meter readings, but because of losses from periodic water main leaks are probably only accurate to within plus or minus 10% of the true values.

Present “other” demands on St Mary Lake are for fisheries maintenance in Duck Creek, irrigation of land, water supply for the Capital Regional District’s (CRD’s) Fernwood and Highland waterworks, and supply for lakeshore properties not served by either the NSSWD or CRD waterworks. Fisheries plus present “other” St Mary Lake demands at licensed limits total about 120 MGY. Fisheries demand is not expected to change. There may be an increase in irrigation needs for both agricultural areas and residential areas, as a result of the drier, warmer summers likely to result from climate change. The CRD’s North Beach area is not yet serviced, but it is licensed, and thus is included in the present demand estimate. None of the CRD service areas are expected to require more water at build-out than that included in the present demand estimate. However, many areas in the northern portion of Salt Spring Island that rely on ground water are experiencing increasingly severe water supply problems. Extensions from CRD or NSSWD’s distribution systems may eventually be needed to augment or replace some of these supplies. Water may be needed to meet community amenities and to deal with issues such as low-cost housing. Allowing for such possible changes, the total annual “other demand” at “build-out” is estimated at 170 MGY +/- 10%.

In summary, the total annual water demand from both lakes at “build-out”, in million gallons is estimated as follows:

NSSWD present annual demand	Best estimate	171
Total present annual demand	Best estimate	291
NSSWD annual demand at build-out	Low estimate	249
	Best estimate	277
	High estimate	305
Total annual demand at build-out	Low estimate	402
	Best estimate	447
	High estimate	492

SUPPLY AND DEMAND IN AVERAGE YEARS

In an average year, the total available supply of water from runoff from Maxwell and St Mary lakes and the total demand, in million gallons, at present and at “build-out” are as follows:

Average annual supply from runoff	Best estimate	698
Total present annual demand	Best estimate	291
Total annual demand at build-out	Low estimate	402
	Best estimate	447
	High estimate	492

Comparing the above estimates of the total demand for water from both lakes, under both present day conditions and at build-out with the estimated average annual supply, it can be seen that all of the estimated demands – present day and low, best or high estimates of the demand at build-out could easily be met during average year supply from runoff.

SUPPLY AND DEMAND BALANCE DURING MAJOR DROUGHTS

During an average year, inflows to the lakes are greater than the demand in winter and the lakes fill in winter. Then, in summer, when the demand exceeds the inflow the difference is made up from storage and lake levels fall. During very dry periods, it is necessary to use "over-year storage" to continue meeting the demand. Over-year storage is the storage in a lake that is over and above the normal amount of "seasonal" storage. During major droughts, the total annual demand may exceed the total annual runoff in that year. The difference has to be met from over-year storage in the lakes. Table 2 shows the total amounts of over-year storage that would be needed to supplement runoff to meet demand during drought periods. The estimates assume a demand range of the best estimate +/-10% and the best estimate of runoff.

Table 2 – Amounts of over-year storage needed to maintain supply during droughts
(Million imperial gallons)

	Low Estimate	**Best Estimate**	**High Estimate**
Total demand at "build-out"	402	447	492
Supply needed from over-year storage			
1 in 10 year 5-year drought	0	20	245
1 in 50 year 5-year drought	485	710	935
1 in 50 year single year drought	431	476	531

Using over-year lake storage for droughts. At build-out there would be about 90 MG of storage available in Lake Maxwell, over and above the normal need to store winter flows for use during the following summer. However, the resulting lake drawdown could result in algae blooms. Normal seasonal drawdown with a dry summer is currently about 1.0 m. Total drawdown should probably be limited to about half the allowed 2.8 m to prevent algae problems. A 1.4 m lake drawdown limit would limit the over-year storage in Lake Maxwell to about 20 MG.

If the usable over-year storage in Lake Maxwell is only about 20 MB, this would mean that almost all the over-year storage needed to supplement runoff during drought years would have to come from St. Mary Lake.

Extended droughts There is ample storage in St. Mary Lake, but under the worst of the conditions in Table 2 – with the severe 5 year drought, at build-out just over 900 MG of over-year storage would have to be withdrawn from St. Mary Lake over the 5 year period. This would produce a drawdown by the last summer of the drought of about 2.1 m. which, on top of the normal seasonal drawdown, would result in a total drawdown of about 3.0 m. (about 10 feet). The drawdown estimate is based on the "high" estimate of demand and the "best" estimate of runoff.

The large drawdown would be "temporary", as the lake would fill again as precipitation returned to normal in subsequent years. With average year runoff, "best" estimates of runoff and total demand, and full Utilization of Lake Maxwell, it would take 5 years to refill. St. Mary Lake holds about 3,600 MB of water when full. If the "low" estimate of extended major drought runoff were used instead of the "best" estimate, the lake would still be 2/3 full, but it would be drawn down further, and it would take longer to refill. In practice, should there be such an unusually severe drought, strong conservation measures to reduce the impacts would almost certainly be implemented.

Single year droughts During a severe single year drought, at build-out about 500 MG of over-year storage would have to be withdrawn from St. Mary Lake. This would produce a drawdown of about 1.2 m. which, on top of the normal seasonal drawdown, would result inn a total drawdown of about 2.1 m. (about 7 feet). The drawdown estimate is again based on the "high" estimate of demand and the "best" estimate of runoff.

The lake would fill again as precipitation returned to normal in subsequent years. With average year runoff, "best" estimates of runoff and total demand, and full utilization of Lake Maxwell, it would take 3 years to refill. Again, in practice, strong conservation measures to reduce the drought impacts would almost certainly be implemented.

ALTERNATIVES TO INCREASE SUPPLY AND/OR STORAGE

Two creeks adjacent to the Lake Maxwell watershed (with suggested names Andrea and Gossett creeks) could be diverted into the lake. These diversions would provide low phosphorus water to the lake, which would reduce the risk of algae blooms and allow full use of the licensed 2.8m of lake draw-down, thereby providing an additional 70 MG of storage, without the need for lake aeration or water filtration facilities at Lake Maxwell. Thus, during the severe 5 year drought, these two small diversions would provide about 41 MGY of additional Lake Maxwell supply from the combination of additional runoff plus increased usable storage. This would reduce St Mary Lake drawdown during both extended and single year droughts.

It would also be relatively easy to increase the storage in Lake Maxwell, by raising the small dam at the outlet and/or increasing the allowable drawdown, although for these, it would be necessary to make sure that the water quality was not compromised. This would reduce St Mary Lake drawdown particularly during single year droughts.

The need for water from storage, and hence drawdown and lengthy refill in St Mary Lake during a severe extended drought could be greatly reduced by diverting water from Cusheon Lake during winter. Preliminary studies have shown that it should be possible to divert at least 150 MGY from Cusheon Lake to St Mary Lake in winter during a 1 in 50 year 5-year drought without adversely affecting Cusheon Lake or potential future needs of others in the Cusheon Lake watershed, since this water would otherwise just be flowing to the sea. Cusheon diversion might not reduce St Mary drawdown during a severe single year drought, because of low runoff, but it would greatly reduce refill time following the drought.

It would also be possible to increase the maximum water level in St Mary Lake, by raising the outlet weir crest level by 0.3 m to elevation 41.0 m, as permitted under the present water license.

Although there is no immediate need for any of these measures, it would be wise to begin developing a long range plan so that the necessary studies, consultations, comparisons, approvals and, eventually, structures could be ready in good time and fully functional by the time they are needed.

CONCLUSIONS

There are uncertainties about the supply of water, especially during severe droughts. There are uncertainties about future demands and climate change. However, the supply of water from Lake Maxwell and St Mary Lake appears to be sufficient for present needs of NSSWD and other users, even during the most severe droughts that have occurred during the past century.

At "build-out", the supply of water appears adequate to meet estimated demands during years with average precipitation. But, should a severe drought occur at close to or after build-out, it would be necessary to withdraw water from over-year storage, mainly from St Mary Lake, to supplement the runoff and meet the demands for water. Average year drawdown at St Mary Lake at build-out would be about 0.9 m. In the extreme, with the "high" estimate of demand, "best" estimate of runoff, and a 1 in 50 year, 5-year long drought, it may be necessary to withdraw about 900 MG from St Mary Lake, causing a drawdown of about 3.0 m by the last summer of the drought. The demand could still be met and the lake would refill when precipitation returned to normal, likely over about 5 years. The other extreme is a 1 in 50 years, single year drought. It may be necessary during this type of drought to withdraw about 500 MG from St Mary Lake, causing a drawdown of about 2.1 m. The lake would refill when precipitation returned to normal, likely over about 3 years. In practice, conservation measures would almost certainly be implemented to reduce demand and thus reduce lake drawdown during severe droughts.

There are alternative measures that could increase the supply and/or storage in the system; and these could greatly reduce the need for storage withdrawal and drawdown of St Mary Lake. These include diversion of Andrea and Gossett Creeks into Lake Maxwell, raising the maximum and lowering the minimum water levels in Lake Maxwell, diverting part of winter runoff from Cusheon Lake into St Mary Lake and increasing the maximum water level in St Mary Lake. These should be investigated, discussed with the Ministry of Environment, compared, and the most desirable selected and implemented in good time.

RECOMMENDATIONS

It is recommended that NSSWD:

1. Review the NSSWD water supply-demand situation with Ministry of Environment Water Management staff and begin the planning process to identify the best alternatives for matching supply and demand, providing security of supply and minimizing lake drawdown during severe droughts.
2. Review the weather station and flow monitoring facilities, record keeping and data analysis and ensure that there is an effective system in place for measuring and recording water diversion and runoff.
3. **Update this supply and demand assessment every few years, using the latest information on the hydrology of the lakes and their catchment areas, on anticipated "water consuming" developments in the District, and in the light of any changes to the OCP, land use zoning, Salt Spring governance structure, and the impact of climate change.**

Prepared by:

Bob Watson, MS, P.Eng   Denis Russell, PhD, P.Eng

Appendix 1 to NSSWD Supply & Demand Report

Calculation of Runoff from Lake Maxwell and St Mary Lake

	Long Term Average Year		1 in 10 Year 5 Year Low Flows		1 in 50 Year 5 Year Low Flows		1 in 50 Year 1 Year Low Flows	
	Maxwell	**St Mary**	**Maxwell**	**St Mary**	**Maxwell**	**St Mary**	**Maxwell**	**St Mary**
Lake Area (ac)	74	460	74	460	74	460	74	460
Catchment Area (ac)	411	1330	411	1330	411	1330	411	1330
Precipitation (mm/yr)	970	970	844	844	776	776	611	611
Lake Evap (mm/yr)	632	762	632	762	632	762	632	762
Catchment Area ET (mm/yr)	563	597	563	597	563	597	563	597
Lake Runoff (mm/yr)	338	208	212	82	144	14	-21	-151
Catchment Area Runoff (mm/yr)	407	373	281	247	213	179	48	14
Catchment Area Runoff Factor	0.420	0.385	0.333	0.293	0.274	0.231	0.079	0.023
Lake Runoff (MGY)	22	85	14	34	9	6	-1	-62
Catchment Area Runoff (MGY)	149	442	103	292	78	212	18	17
Total Runoff (MGY)	**171**	**527**	**117**	**326**	**87**	**218**	**16**	**-45**

10.3 Appendix 3: Review of the North Salt Spring Water Works District Supply & Demand Report, Michael Larmour, March 2007. ("In Response", The Driftwood, March 7, 2007)

The article entitled Report Debunks Water shortage Myth in the Driftwood, February 25, 2007, presented a cursory examination of a report by two North Salt Spring Waterworks District (NSSWD) trustees on future water supply within the District.

The report by Bob Watson and Denis Russell proposed obtaining more water from St. Mary Lake by significantly reducing normal lake levels, thus providing more storage to accommodate excess water during wet years.

A closer examination of the report would have revealed that it had serious flaws: it did not consider the B.C. Ministry of Environment policies on water allocation, it did not indicate costs involved and who is expected to pay them, and it did not examine the impact on water quality and the environment of Maxwell Lake and St. Mary Lake.

For the record, the Ministry of Environment would not approve this proposal. It is clearly in contravention of the Water Allocation Plan because it relies on deliberately pulling the normal level of St. Mary Lake well below the outlet creek elevation. In a series of dry years, the lake level would drop to as much as ten feet (3 metres) below the outlet level and would take several years to recover.

The report suggested pumping water from Cusheon Lake to St. Mary Lake to supplement St. Mary Lake in drought periods. My estimate of the capital costs, based on 18 inch and 20 inch DR18 PVC pipe, 2000 gallon per minute pumping capacity, surveys, a possible dam on Cusheon Creek and a 30% allowance for engineering and contingencies is 8 million dollars. Amortized over 20 years at 6%, this would result in a total cost of about 13.5 million dollars. This is simply not affordable, especially when viewed in the context of other large costs the District faces in the future.

The water quality impact of greatly reduced water levels in St. Mary Lake has been examined by two limnologists. We can expect an increase in nutrient loading, which of course is the very thing we are trying to avoid. Turbidity would also increase due to wave action on the exposed mud.

Most of the fish-spawning and rearing habitat in St. Mary Lake occurs in relatively shallow shoal areas, at a depth of 3 to 9 feet (1 to 3 metres) and this area would be dry at times doe to more extreme lake level fluctuations and drawdown.

Both recreational use of the lake and tourism would be negatively affected and certainly the aesthetics would not be improved by the exposure of mud flats and dying vegetation.

The impact of climate change is a major concern, especially for St. Mary Lake. But here again, the report is silent and does not provide a clear safety factor for unpredictable risks in the future.

Perhaps the single largest failing of the North Salt Spring Waterworks District report is that it assumes that development in the area served by the District must grow to the limit allowed by the Official Community Plan irrespective of cost, environment damage to the lakes, risks of water shortage and policies of the Ministry of Environment.

A more reasonable approach to community planning would be to assess the amount of water available to the North Salt Spring Waterworks District without excessive costs, environmental damage or risk of water shortage, and at levels acceptable to t he Ministry of Environment, and plan for development not greater than that level.

The writer is the retired manager of the NSSWD.

March 4, 2007, Michael Larmour, 765 Beddis Road, Salt Spring Island, B.C. V8K 2E

10.4 Appendix 4

GROUNDWATER
POTABLE WATER FOCUS GROUP
H.J. GREENWOOD, P.Eng (ret.) & R.J. GILLELAND, P.Eng
March 13, 2007

EXECUTIVE SUMMARY

The adequacy of the Salt Spring groundwater resource is difficult to evaluate with precision, but we can be reasonably confident of certain facts and of actions that should be followed because of these facts. Some of the actions are within the authority of the Islands Trust and others, no less important, can only be implemented with the help of more senior levels of government.

Below we summarize the controlling facts and the actions which we consider to be imperative.

Factual Background

1. Groundwater on Salt Spring Island is contained mainly in fractures both in the sedimentary rocks of the Nanaimo Group and the metamorphic igneous rocks of the Sicker Group at the south end. The effective porosity or capacity to contain water is very low, approximately 0.01% percent of the rock volume, but a reliable quantitative estimate is impossible without an extensive field study of the hydrology by means of well pumping and monitoring.

2. All the fresh water on the island arrives in the form of precipitation, most of which either runs off into the sea or evaporates. The water that eventually enters the groundwater system represents, out of the annual precipitation of about 900 millimetres, somewhere between 150 millimetres and 25 millimetres. It appears that this is enough to annually recharge the groundwater system in some places but not in others. Once the fractures are filled any further precipitation leaves as runoff.

3. Groundwater systems that are dominantly based on fractures are more vulnerable to contamination than those that are based on homogenous porous media such as sand.

4. Groundwater is a community resource and must be shared and conserved. Individual property owners and users must realize that although they have the right use the groundwater under their property they do not have the right to exploit it at the expense of neighbouring users of the same aquifer. (*Water Act- RSBC 1996, Chapter 483 Part 5- Wells and Ground Water protection, Well Operation page 41.)* They have instead an obligation to use it wisely, conservatively, and to refrain from depleting it at the expense of others.

5. The amount of rainfall that can annually reach the water table is not great and consequently the area from which each well draws must be large enough to capture the required amount of water. This implies that a minimum average lot size should be established where the water is derived from wells.

6. Global climate change presents a challenge to water-planners in that precipitation and drought events must be considered. The annual precipitation may well increase but it will occur mainly during the winter, and as the aquifer appears to be already recharged by existing rainfall, any excess will only add to runoff. Further, extreme weather events such as droughts are likely to become twice as frequent with the result that drought events that are now considered to occur only once every 50 years could recur as often as every 25 years. Any planning for future water management must adopt a stance that will deal with this 'worst scenario' which is ever more likely to occur.

7. Some of our groundwater areas are already stressed beyond their capability to supply current demand

8. The foregoing indicates we must adopt management strategies that will protect our groundwater resource and that we can no longer allow access to it without applying constraints to development, subdivision, well-drilling, and rates of water withdrawal. Some of these constraints may be applied by the Islands Trust but others will need outside cooperation and cooperation by all our users.

Recommendations that may be acted on by the Island Trust

1. We recommend that the average lot size in any area be kept large enough to prevent over-extraction from the water table. Two acres should be the minimum and 5 acres would be better in view of the threat of global climate change. Optimum lot size may depend on location and it may be that the Trust should opt for the larger minimum as a conservative approach.

2. We recommend that wherever possible recognized water well-recharge zones, watershed areas, and new subdivisions be identified and placed in Development Permit Areas. This will allow imposition of controls on siting, extraction rates, sewage handling, and installation of water-conservative appliances.

3. We recommend that the Trust encourage vigorous inspection of both old and new septic systems on a regular and rotating basis. Proof of proper maintenance should be required in view of the susceptibility to contamination of fracture-based aquifers

4. We recommend that the regulations that can be imposed in Development Permit Areas be strengthened to facilitate control over water quality in matters such as tree cutting, road building, subdivision development, and sewage handling, including metering of all community groundwater-based systems.

5. Proof of water quantity testing must be strengthened for any sub-division, new construction and significant renovation. Proof of a sustainable water supply with no adverse impact on adjacent or affected properties is mandatory. This can best be implemented by performing pump tests combined with monitoring of adjacent wells either in existence or specially drilled for the proof-test.

6. We recommend that the LTC engage consultants in hydrology to formulate in detail the criteria for approving any access to groundwater from new or renovated construction. These criteria should include the details of what pumping and monitoring tests should be considered adequate to ensure that the new work can expect to have sufficient water of acceptable quality and to ensure that use of the groundwater will not have any negative effect on the groundwater capability of surrounding properties. (Note the excerpt below from the Water Act, Ch 483 which makes it illegal to operate a well in a manner that negatively impacts an existing well)

   Any new proposal should be accompanied by the report of a professional groundwater hydrologist, which report should document the results of having performed the tests detailed in the policy above. Lack of such a report or the submission of an inadequate report should be grounds for refusing a permit to proceed with the work.

   Water Act- RSBC 1996, Chapter 483 Part 5- Wells and Ground Water protection, Well Operation page 41.

   78(2) A person must not operate a well in a manner that causes or is likely to cause
   (b)- a significant adverse impact on:
   (i) the quality of the groundwater

(ii) The existing uses made of the groundwater from any well that drains from that aquifer.

7. We recommend that the Trust undertake a program of information and education to encourage all users, both private and public, to adopt a seriously conservative approach to fresh water, with suggestions and incentives as to how to proceed.

Recommendations of Importance but Beyond Direct Control of the Islands Trust

1. We suggest that is necessary to clarify where the authority lies in connection with water purity, water allocation, well registry, and control of groundwater. . As it is, the Trust is unable to force developers and other citizens to behave responsibly with respect to limited water resources. The Trust, CRD, MOE, and Health must find ways to make clear exactly where authority lies and how control may be exerted.

2. We urge the Trust to pursue actively funding from senior government for a comprehensive study of both the hydrology and its management. A new water allocation plan may be needed.

3. We recommend that the Trust pursue senior levels of government to establish building code criteria that will include sustainable water harvesting and utilization by private and community users of water in the Gulf Islands.

4. We recommend the implementation of ground water regulation that includes the licensing of private wells as well as community systems with authority to limit water extraction depending on local conditions.

5. We recommend the review of all new construction to require the use of water-conserving fixtures and appliances. Tax incentives might encourage the installation of such appliances during renovation.

6. We recommend introduction of Land Use Bylaws restricting outdoor water use in the dry seasons.

7. We recommend that a program for well protection and ground water stewardship be initiated to have all private and community system well owners participate in a survey of well condition and statistics, and implement program of well protection measures

8. We recommend that water use and stewardship issues, regulations and constraints be made part of the documentation on the sale of property.

INTRODUCTION

The paper is intended to help the examination of both the availability of, and demand for, groundwater on Salt Spring Island. It is also intended to highlight certain benchmarks and associated information such as island demographics to help narrow the limits on water availability and use. The writers have attempted to examine as much research material and associated information as possible in the time available. An initial look at data clearly indicates that an exact calculation of water balance is not possible at this time, but some estimates can place limits on what is possible and what we may reasonably expect in the future.

The Task

The Focus Group for Potable Water has been asked to determine if it is necessary to control land use so as to conserve our water resources, and to make recommendations to the Local Trust Committee. This position paper deals with the groundwater portion of that task.

The Approach

We approach the problem of supply and demand in two ways. First, we examine data related to inputs (precipitation), losses (runoff and evapotranspiration), storage capacity of the rocks, and the expected demands put upon the resource. Second, we examine as much as possible the history of well production in specific areas of the island to assess how well our groundwater resource is functioning. Finally we make recommendations on the basis of the foregoing examination.

SUPPLY & DEMAND FROM PRECIPITATION & RUNOFF

Aquifer properties

The rocks of Salt Spring Island are sandstones, shales, and conglomerates of the Nanaimo Group of sediments, and the older, metamorphosed igneous rocks of the Sicker Group. The Nanaimo Group sedimentary rocks occur north of a line roughly through Peter Arnell Park and Lake Maxwell, and the Sicker Group rocks occur south of that line. The sediments are cemented with calcite and dolomite and some zeolitic minerals and have very low primary porosity. In the sediments the main storage capacity is in the fractures but there may be some available pores as the net effective fracture porosity is very low, approaching 0.01% of the rock volume. The Sicker rocks are generally massive and fractured and have limited primary porosity. The principal storage capacity is in the fractures. Some of the features important to hydrology are summarized below.

Sicker Group
These rocks are a mixture of granitic and volcanic rocks, with minor sediments. All are much older than the Nanaimo rocks and are variably fractured from place to place. Fracturing is most intense near recognizable fault zones.

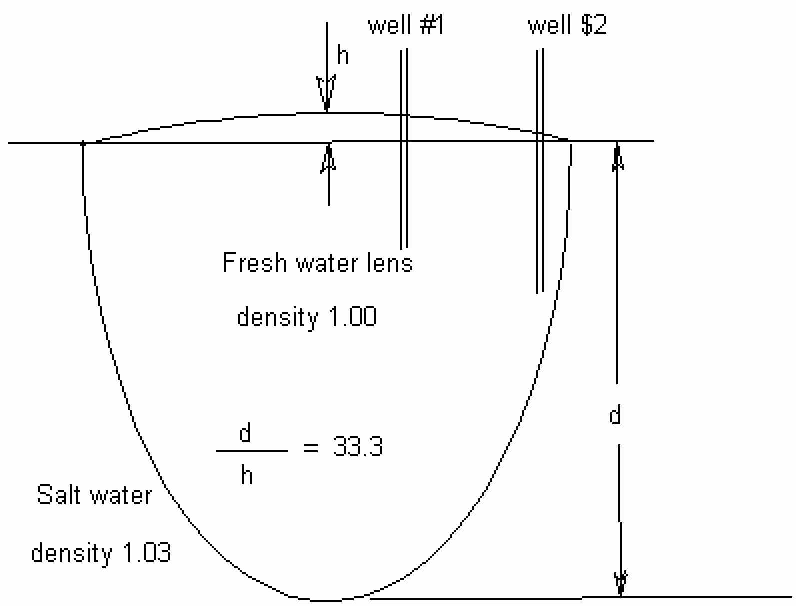
Nanaimo Group
Mackie, Allen, & Mustard (2001) have made a study of fracturing in these rocks on Gabriola, Valdez, Galiano, Mayne, and Saturna islands. 6000 measurements were made and correlated with rock types and regional structures. They conclude:

- The most abundant fractures are perpendicular to bedding planes
- The next most abundant are near shear zones and faults
- The intensity of fracturing is ten times higher near major lineaments, faults
- The increase in fractures near faults is more intense in sandstone than shale
- Sedimentary layers with mixed sandstone and shale as interbedded units have the most fractures

<u>The role of total porosity and storage potential</u>

We would like to be able to estimate the amount of water that can be stored in the rocks and relate that to the amount of precipitation that gets into the groundwater and to the expected demands of an average single family dwelling. This turns out to be difficult due to the uncertainties in the critical numbers.

It may be worth noting that an island aquifer occurs as a lens of fresh water ‘floating’ in a porous medium on a surrounding of more dense salt water. The height of the water table above sea level is mirrored below sea level to a depth dictated by the relative densities of fresh and salt water. The depth below sea level is about 33 times the height of the water table above sea level. Wells near the shore (well #2 below) will encounter salt water at a shallower depth than wells farther from the shore (well #1 below). Over-pumping of a near-shore well will cause salt-water intrusion and may permanently damage the aquifer. Withdrawal of water from near the top of the water table will cause the base of the fresh lens to move upward by 33 meters for every meter of lowering of the water table. This behaviour depends on the degree to which the fracture porosity is interconnected and in communication with the surrounding sea. Due to the irregular distribution of fractures, the actual shape of the lens will be irregular and jagged rather than the smooth idealized shape illustrated. Due to uncertainty about this inter-connectivity it is difficult to evaluate with any precision the actual capacity of the overall island aquifer system. Consequently a very conservative approach should be adopted.



Saltwater Intrusion

The possibility of a water well encountering salty water is greater in near-shore regions than in inland regions. Continued extraction of salty water by a well owner can exacerbate the problem, posing a threat to nearby well owners. Areas that have low topography are more at risk for saltwater intrusion and the number of wells in such areas should be limited.

Allen and others (2001, 2003) have studied the aquifer properties on Saturna Island by doing pump tests and geophysical measurements. This was supplemented (Allen et al. (2002) by a broad study of available pumping test data from BC Ministry of Environment records to derive some fundamental properties of the potential reservoirs. No estimates from the Sicker Group were available, and only a few of the Nanaimo Group formations are represented. These properties are transmissivity (T), the ability of rocks to allow the flow of water through them, and storativity (S), the capacity of rocks to store water. Most of the wells tested were situated nearby fault zones, likely biasing the results to higher values. Thus, the study concluded that because the test data reflect the dominant presence of fracture zones, the average values are probably a poor reflection of representative values for the formations. Rather, it was proposed that ***the minimum values be used to represent the relatively unfractured aquifer and the maximum values or averages used to represent the fractured aquifer near faults and fracture zones***. The authors noted that it is important to note that the fractures themselves will probably have at least one or two orders of magnitude higher T values than the fractured aquifer surrounding them.

Table 1: Average T Values for the various formations from Thetis (data from Allen et al., 2002) (2001,2003?)

	Sandstone-dominant				***Mudstone-dominant***	
Formation	***Gabriola***	***Geoffrey***	***Protection***	***de Courcy***	***Spray***	***Cedar District***
# of tests	**73**	**16**	**1**	**1**	**8**	**2**
Average	1.02E-5	2.40E-5	1.08E-5	5.21E-5	8.56E-6	2.89E-5
Max	5.42E-2	8.13E-4	3.58E-5	7.50E-5	5.31E-5	5.95E-5
Min	3.38E-7	1.22E-6	2.80E-6	3.88E-5	7.55E-7	1.40E-5

Standard dev	.35	.50	.35	

Table 2: Average S Values for the various formations from Thetis (data from Allen et al., 2002)(2001,2003?)

	Sandstone-dominant				***Mudstone-dominant***	
Formation	***Gabriola***	***Geoffrey***	***Protection***	***de Courcy***		
# of tests	**9**	**5**	**2**	**3**	**0**	**0**
Average	6.97E-4	1.45E-4	1.82E-4	3.69E-4		
Max	3.67E-2	4.32E-4	7.17E-4	5.58E-4		
Min	2.41E-7	4.44E-5	4.62E-5	2.84E-4		
Standarddev	4.55	3.29				

Summary of Aquifer Properties

Based on the above results, the transmissivity and storativity values computed for the sandstone-dominant and mudstone-dominant units are as follows:

Sandstone-dominant

Transmissivity between 3E-7 and 5E-3 m^2/s **(ave. 1E-5 m^2/s)**

Storativity between 2E-7 and 4E-2 **(ave. 1E-4)**

Mudstone-dominant

Transmissivity between 8E-7 and 6E-5 m^2/s **(ave. 1E-5 m^2/s)**

Storativity between no data available

Note: 0.0002 = 2E-4

Subsequent work by Surrette (2006) has used the actual fracture measurements to model the permeability and, thus, transmissivity of the rocks. Results indicate that fracture-based estimates of T are generally consistent with values obtained from pumping tests and furthermore increase with proximity to the hinge line of a regional northwest-trending asymmetric fault propagation fold structure, and with proximity to superimposed high-angle north and northeast-trending brittle faults.

In general it seems that massive shale and mudstone have much lower transmissivity than sandstone or interbedded sandstone and shale.

Storativity estimates are similarly variable; however, no values are available for mudstone-dominant formations. Fracture intensity is greatest near major cross-cutting lineaments and faults and thus may lead to greater storativity near faults and lineaments. Quantitatively we conclude that storativity can be anywhere from 2E-7 to 4E-2, with an average of roughly 1E-4 (or 0.0001). This implies that on average one cubic meter of rock could contain approximately 100 milliliters of water.

Other estimates of porosity include those by Potter (2001): between 0.001 and 0.0001. Hodge (1977) assumed porosity to be 0.0001

Inputs and Losses

Precipitation

There exist several summaries of annual precipitation in the Gulf Islands and especially Salt Spring Island. These can be summarized as follows:

Hodge (1977)	840 to 1029 mm/yr
Hodge (1995)	902 average, 1215 wet yr, 566 dry yr
Hamilton (1998)	960 average, 1030 maximum, 616 minimum
Aquion Report	900
Watson & Russell (2007)	974, increasing 1.1 mm/yr with fluctuations of 200 mm

Summary of precipitation average 900 mm/yr, maximum 1050, minimum 566

Table 3 – Historic Annual Precipitation, Lake Evaporation, and Watershed Runoff

Units – mm/year unless otherwise noted	Lake Maxwell			St Mary Lake				Cusheon Lake
	Long Term (1914-1993)	**Recent Term** (1976-1993)	**Recent Term** (1978-2005)	**Long Term** (1914-1993)	**Recent Term** (1976-1993)	**Recent Term** (1979-1996)	**Recent Term** (1978-2005)	**Recent Term** (1976-1993)
Precipitation								
Average Year	902[1]	921[2]	962[14]		935[2]	981[13]	982[14]	964[2]
Dry Years (<810mm)			771[14]				732[14]	
1:50 Dry Year – using Saanichton CDA	566[2, 3]			574[2]				592[2]
1:50 Dry Year – using Victoria Airport		613[2]			623[2]			642[2]
1926-30 Multi-Year Drought	731[7]							
1940-45 Multi-Year Drought	716[7]							
Lake Evaporation								
Average Year	660[5]	673[10]	585[14]			658[11]	713[14]	
1:50 Dry Year	655[6]							
1926-30 Multi-Year Drought	648[7]							
1940-45 Multi-Year Drought	657[7]							
Net Lake Precipitation (calculated)								
Average Year	242							
1:50 Dry Year	- 89							
1926-30 Multi-Year Drought	83							
1940-45 Multi-Year Drought	59							
Runoff Factors (unitless)								
Average Year	0.398[5]	0.408[4]				0.475[12]		0.478[4]
1:50 Dry Year	0.256[8]			0.258[13]				
1926-30 Multi-Year Drought	0.37, 0.44, 0.29, 0.29, 0.31[9]							1.17 x Maxwell [9]
1940-45 Multi-Year Drought	0.28, 0.28, 0.38,							1.17 x Maxwell [9]

	0.27, 0.30[9]							
Net Watershed Runoff (calculated)								
Average Year	359					466, 479[12]		
1:50 Dry Year	133							
1926-30 Multi-Year Drought	219							
1940-45 Multi-Year Drought	200							

Information Sources: Roy Hamilton's Jan 1995 report *Hydrology of Maxwell Lake Water Supply*: 1– Sect 3.1.3; 2 – Table D; 3 – Sect 3.1.2; 4 – Table 2; 5 – Table 3; 6 – Table 13; 7 – Table 13; 8 – Sect 3.3.3 and Table 12; 10 – Table 1A;
Roy Hamilton's Nov 1998 report *Maxwell Lake Hydrology of Dry Years*: 7 – Tables 2 and 3; 9 – Sect 5.3
Roy Hamilton's Feb 1998 report *Hydrology of St Mary Lake*: 11 – Appendix C; 12 – Sect 5.3; 13 – Appendix F
Item 14 – see this report Appendix 1 and 2 and Table 1 and 4

<u>Runoff</u>

Runoff factor is the proportion of the rainfall that runs off to the sea.
Several estimates have been made by measuring flow rates at streams and using the rainfall measured in the capture area of the stream. Summarizing these estimates of runoff factor:

Hamilton (1998 1995)

	Cusheon Creek	Maxwell
Average	.387	.331
Maximum	.52	.44
Minimum	.32	.27

Larmour (May 2006, critique of Aquion) St Mary Lake

1990-91 (wet)	.531
1989-90 (medium)	.384
1987-88 (dry)	.291

Runoff summary

Average	0.38	
Maximum	0.52	
Minimum	0.30	(may be less in severe drought)

Note that the runoff factor will increase as development and growth of impervious surfaces such as roads, roofs, and driveways increases.

From Appendix 1 of **"North Salt Spring Waterworks District Supply and Demand"** by Russell and Watson, January 23, 2007.

Maxwell runoff:	Average Year	0.420	
	1:10 Year 5-year Drought		0.333
	1:50 Year 1-year Drought		0.079
	1:50 Year 5-year Drought		0.274
St Mary runoff:	Average Year	0.385	
	1:10 Year 5-year Drought		0.293

1:50 Year 1-year Drought	0.023
1:50 Year 5-year Drought	0.231

Evapotranspiration

Losses due to evapotranspiration depend on the relative areas of lakes, land, vegetation, the kinds of vegetation, average humidity, amount of wind, and hours of sunshine. Several estimates have been made by different methods, which may be summarized as:

Hamilton (1998 1995)(Lake Maxwell)		650 mm/yr – lake evap
Hodge (1977)		406 mm/yr
Larmour	L. Maxwell	688 mm/yr – lake evap
	St. Mary	650 mm/yr - lake evap
Lindroth et al (spruce, Sweden)		392 mm/yr (transpiration only)
Allen (pers. Comm., SFU)		435 mm/yr (ave. annual/treed)

Summary, evapotranspiration

Average	550 mm/yr
Maximum	700 mm/yr
Minimum	400 mm/yr

From Appendix 1 of **"North Salt Spring Waterworks District Supply and Demand"** by Russell and Watson, January 23, 2007.

Maxwell ET:	all years	563 mm/yr
St Mary ET:	all years	597 mm/yr

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With the foregoing summaries we may make an attempt to evaluate how much water may be taken up by groundwater, considering precipitation, runoff, evapotranspiration, and storage capacity. It will be seen that the results are rather uncertain but not encouraging in our attempt to distinguish between shortfall and excess.

In summary we note the following ranges of the critical values.

	Average	Maximum	Minimum
Precipitation mm/yr	900	1050	566
Runoff factor	.38	.52	.30
Evapotranspiration mm/yr	550	700	400
Storativity	0.0001	0.04	0.0000002

Storage = Precip - (Runoff + Evap)
Total runoff is calculated by multiplying the total precipitation by the runoff factor.

Testing several scenarios we can see a wide range in the estimated water that arrives at the water table (equiv. mm's of precip)

Precip	900	900	1050	1050	1050	1050	1050	1050
Runoff	0.38	0.30	0.38	0.38	0.52	0.30	0.30	0.30
Evap	400	400	650	400	400	650	700	400
To G/W	158	230	1	251	104	85	35	335

Below is a personal communication, Dr. Diana Allen, Dec 2007:

"We have done modeling of recharge on the Gulf Islands for current and future climate change conditions. We know that our model is underestimating runoff, but given your numbers above for runoff factors, I can make an adjustment to our runoff values (use 0.35) to obtain the following results for the entire Gulf Islands region (average annual). The results were highly spatially variable depending on geology, soil, slope, water table depth, etc. But, our values appear to be consistent with your first column of numbers."

Parameters (mm)	Historical
PRECIPITATION	880.48
RUNOFF	308.17*
EVAPOTRANSP.	435.24
RECHARGE	137.07

- value adjusted to incorporate runoff factor of 0.35

An independent estimate of the proportion of annual rainfall that can be expected to find its way into the groundwater was made by Foweraker(1974) for the southern Gulf islands. Foweraker arrives at a value of approximately 3% of the annual rainfall, which amounts to about 25 mm/yr. (Considered to be a very low estimate; pers. comm. D. Allen)

Based on these results, and using the most representative values for precipitation, runoff, and evapotranspiration, the average annual groundwater recharge is likely on the order of 140 mm/year or 16% of the annual precipitation. Of course, depending on a number of factors, the amount will vary considerably in different parts of the island. Some areas may be prone to more runoff due to soil type and vegetation. Likewise, areas underlain by fracture zones are expected to have higher annual recharge. (See comment by Prof. Allen, above, on spatial variability).

Summarizing the above estimates it is clear that calculating the amount of precipitation that is able to enter the groundwater system is rather uncertain and critically dependent on the values chosen for evapotranspiration and runoff, both of which will depend on the incident rainfall. Especially critical is the fact that the figures are for a complete year but the process of evapotranspiration occurs in the dry months and runoff in the wet months, and once the aquifer is full the runoff becomes much larger. Further, as withdrawal will continue while recharge is taking place, the aquifer will have a larger capacity than indicated by a simple calculation.

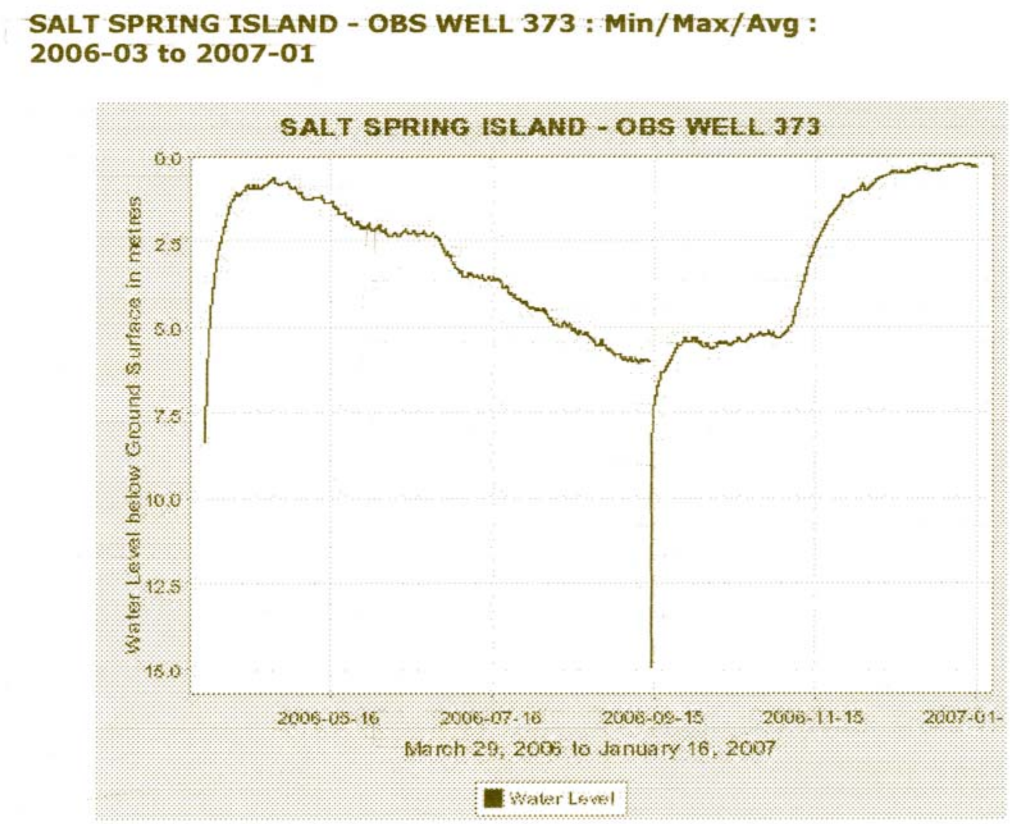
Without knowing the details of an aquifer capacity it is still possible to assess whether or not the aquifer is being recharged. Below is a plot of a Salt Spring Island observation well which shows that the level of water in the well reaches the same value each rainy season. This indicates that full recharge does occur at some localities, whatever the values of runoff and evapotranspiration may be. What remains unknown is the actual capacity of the aquifer or how representative this may be of other parts of the island.

Summary

Estimates of the amount of water that recharges the groundwater reserve annually are uncertain, but the amount is generally small, probably not more than 140 mm/yr. Estimates of storage capacity are likewise uncertain but it seems clear that if the best estimate of storage potential (0.0001) is used then about a kilometre of depth is needed to accommodate the annual precipitation that reaches the water table. If the storage potential is as low as 0.0001, the aquifer will fill quickly and the balance of the available precipitation will probably leave as runoff.

This conclusion is supported by the work of Potter (2001) who notes that the fracture system serving the Mount Belcher Improvement District is fully recharged after a few weeks of precipitation, and by Kohut, Fowler and Hodge(2002) who note that hydrographs show a regular response to rainfall events and significant sub-surface inter-connection. The same conclusion may be drawn from the hydrograph of Observation Well #281 (above).

The following graph shows the depth to water of the new MOE observation on Mount Belcher (well 373) from April 2006 until the end of recharge in January 2007. The anomaly in September is caused by the withdrawal of a bulk water sample.



Clearly, in our need to evaluate our aquifers, it seems to us that we are neglecting a large source of information on the available water in the fractured aquifer by failing to use the existing wells on the island. If in fact the annual drop in the phreatic levels within the aquifer is small then we are probably under-estimating the storage capacity (connected bulk porosity) or not recognizing that much of the water withdrawn by wells is returned to the aquifer through septic drainage fields.

If a widespread monitoring scheme similar to that proposed for the Mount Belcher system (monitoring of well withdrawals and static water levels in the system wells) were put into effect we would go a long way toward an understanding of the net affects of our use of the groundwater resource. This can be accomplished by monitoring existing wells... The wells are there, we have the technology, and we need only to gather the data! However recent experience (R. Potter, Peng) suggests that many well owners are reluctant to grant access to their wells for monitoring. Perhaps an incentive scheme could be devised to facilitate such a program.

Demands

The Role of Expected Demand

There are several estimates of the expected demand from a single family dwelling

The Current OCP indicates 1600 l/d per household, VIHA uses 225 l/d/person required to develop.

The supply/demand study by NSSWW indicates a planning number of 68,000 igal/yr/household (186 igal/d/household, 844 l/d) and an average consumption of about 55,000 igal/yr/household (150 igal/d/household, 681 l/d) calculated from usage data.

G. Hendren, CRD Engineering, (26 Jan07) at SSI Water Council indicated that the volume of water required for subdivision is 300 igal/day per household (1362 l/d), (109,500 igal/yr/household). He went on to indicate that different communities on the Gulf Islands that rely more or entirely on water from rainfall (collected or captured in groundwater) plan around the amounts available and develop accordingly.

These may be summarized for an average single family dwelling as ranging from a maximum of 1600 l/d to about 430 l/d

OCP planning	1600 l/d	
NSSWD planning	844 l/d	
NSSWD usage (dry year)	680 l/d	
VIHA planning	500 l/d	
SS water council	1360 l/d	
Mt. Belcher usage	434 l/d	(95.5 igal/d)

More background statistics on the ground water use can be found in Appendix A

Balance

Annual Water Balance

In principal it is possible to use a figure for expected demand and combine it with the amount of precipitation that is expected to enter the groundwater and calculate the area that would be required to sustain that demand, and thus find the minimum lot size to allow for sustained use of the groundwater. However, there is such a wide variance in demand figures and such uncertainty in the proportion of precipitation that actually enters the groundwater that we have little confidence in the predictive value of such a calculation. We offer such an estimate but recommend caution in its use.
Selecting a planned demand figure of 1600 l/d per household leads to one value but summer usage in a dry summer year is about 760 l/day, and BC MOE Rural Water Design Guidelines are that wells for new subdivisions must be able to supply 900 IG/day. (4090 l/day)

Depending on what we know or assume about effective porosity, there is a very wide range of possible depths required to store the amount of precipitation that is assumed to be available to groundwater.

Assumptions
The storage potential is probably between 0.0001 and 0.001
The amount of precipitation that is available to enter the groundwater is probably about 140 mm/y but might be 50 mm/y or perhaps less.

Storage potential assumed	0.0001	0.001
Depth to hold 140 mm precip	1400 meters	140

If we try to estimate the area needed to capture the water needs of a single family dwelling (SFD) we obtain the following result:

Single family demand l/d	844	500	434
Catchment area for 140 mm	0.54 ac	0.32 ac	0.30ac
Catchment area for 50 mm	1.5 ac	0.89 ac	0.87ac
Catchment area for 25 mm	3.0ac	1.8ac	1.73ac

Depending on what demands we can expect and upon what part of the precipitation is available to groundwater, there is a wide range of catchment area required to supply the needs of a single family dwelling. If a SFD uses 844 l/d and 140 mm of annual precipitation arrives at the water table, then a minimum lot size would be about half an acre, but if only 50 mm of precipitation arrives at the water table a minimum lot size would be about 1.5 acres and if the amount is 25 mm we would need about 3.0 acres. Similarly, if a SFD could get by on 434 l/d and we make an optimistic assumption about rain water capture then a minimum lot size would be about a third of an acre. A 60% reduction of rainfall in a drought year would suggest a minimum lot size of 5.0 acres.

Thus an optimistic assumption on capture indicates that average lot size should be no less than 2 acres, and a less optimistic assumption indicates that the capture area per household should be closer to five acres. We feel strongly that some other method of estimating must be attempted

If we require reliable estimates for sub-regions of the island a full 3-dimensional hydrologic study will be required. This will involve many new bore holes, long-term monitoring, and computer modelling of the data. There will certainly be large costs and time delays in such an approach.

SUPPLY & DEMAND INFERRED FROM WELL RECORDS

Community Groundwater Systems

Several small community water systems experience shortages and or problems now, where they did not in the past.

Scott Point also has generally shallow wells and encountered salt water intrusion that resulted in the installation of a reverse osmosis treatment system by the Improvement District to restore the availability of potable water from a well with high salt concentration. Demand is controlled through a graduated rate structure.

Cedar Lane Improvement District serves 38 dwellings from 3 wells and targets a household use of 4,000 igal or less per month per connection. (600 l/d). The district has encountered the problem of running short of water in the dry season and the need to conserve even more to balance out. It has also noted the reduction in the ability of the wells to supply water during the pump tests for the Bullock Lake Resort and has concerns that there is a growing and sustained problem.

An approximation to the storage and demand balance of this system is interesting. Cedar Lane delivers 8.32 million l/y to 38 subscribers from a land area of approximately 10 ha. This corresponds to approximately 84 mm/y of precipitation that gets into the groundwater system, far less than the 140 mm/y that was estimated from existing runoff and evapotranspiration figures. The 38 users on this system of 10 ha (24 ac) represent an average lot size of 0.63 of an acre, significantly below our estimated minimum lot size.

Mount Belcher Improvement District reports no shortage of water at this time but is concerned about large development in uplands areas that could likely be along a connected fault structure that could impact available water. A MOE monitoring well is in place on Mount Belcher that will help identify unusual changes to the water table.

Almost all other districts or Small Water Systems using groundwater have responded to a limited survey and report that they are managing their demand to match their known or estimated availability. Some districts may have the capability to expand their capacity through drilling new wells, improving existing ones and/or adding storage. The resulting cost/benefit considerations are matters that concern each district.

A universal concern is that nearby or adjacent development can have a negative impact on the productivity of the aquifer serving an individual district.

At the north end of the island the depth to the bottom of the freshwater lens is probably less than in other areas where topographic relief is greater. In addition, historic well depths there tended to be shallower than in upland areas. For these reasons and because of increase in use from development many wells no longer provide water in the dry season. The following data on supplementing water supply by trucking deliveries supports the view that some aquifers are already over-taxed.

In 2005 300,000 Igals were delivered to well-owners in northern Salt Spring
In 2006 490,000 Igals were supplied, mostly by truckloads purchased from NSSWD.

It appears that the water table has been lowered by consumption that exceeds recharge, a situation that now may be approached by the Cedar Lane Improvement District.

GLOBAL CLIMATE CHANGE

Frequency of Extreme Weather Events

Sensitivity to Global Climate Change

The foregoing analysis assumes that our rainfall climate, evaporation and runoff will be similar in the future to what it is in the present. However, it is now widely held that our climates are changing and will continue to change. Reference to two web sites provides some quantitative estimates of what we may expect. The sites are: The Union of Concerned Scientists at www.ucsusa.org and www.climatechange.govt.nz. Both of these sources indicate that extreme weather events, including both rainfall and drought, will become more frequent by a factor of between two and four.

A recent study by Kharin and Zweirs (2005) examines the periodicity of extreme weather events through global climate simulations. They conclude that Extreme events will become more frequent by a factor of two.

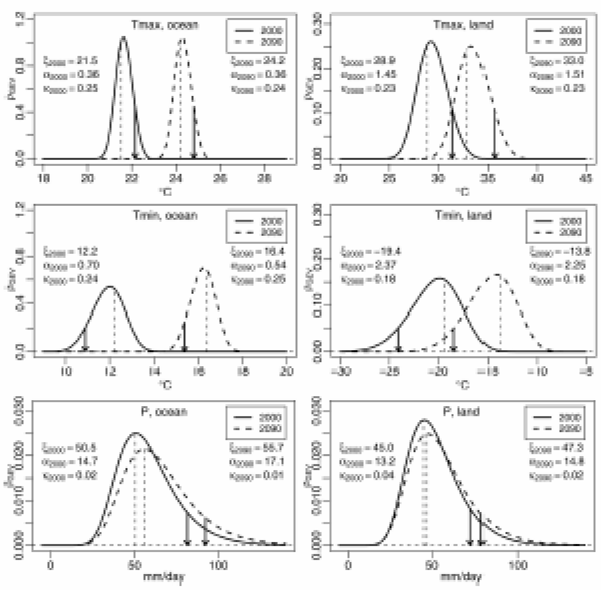


FIG. 3. GEV probability density functions obtained when parameters are set to average estimates over the (left) ocean and (right) land for annual extremes of (top) daily max surface temperature T_{max}, (middle) daily minimum surface temperature T_{min}, and (bottom) 24-h precipitation rate P. Parameter estimates were obtained by fitting the GEV distribution to annual extremes simulated by CGCM2 for the A2 IPCC climate change scenario. Solid (dashed) curves display the estimated density functions in year 2000 (2090). The corresponding 20-yr return values are indicated by the arrows on the x axis.

The curves above due to Kharin and Zweirs (2006) represent changes predicted by the climatic modelling. Those on the left are for oceans and on the right for land masses. The upper two on the right refer to expected temperature changes (max and min) where it will be seen that increase of two to three degrees C may be expected. The lower diagram on the right indicates that precipitation may stay about the same on average. The combination of expected higher temperatures producing higher evapotranspiration with expected increased frequency of extreme events such as droughts suggests that we may face periods when water is much less available than it is at present.

A result of this is that we may expect what is now a 1-in-50 drought to occur about every 25 years, or even more often. These time horizons are not so far in the future that we can risk a failure to plan for them.

Recent work (Allen, personal communication, Simon Fraser University) on the impact of climate change on groundwater for the Gulf Islands indicates that the Gulf Island may see increased rainfall (and recharge) under future predicted climate change (a progressive increase by 7%, 8% and 9% in the 2020's, 2050's and 2080's, respectively, from the current is predicted). However, the increases will be relatively minor and population increase, posing an even higher draw on water demand, will likely result in overall declines in water availability. Furthermore, we must consider the occurrence of extreme rain events, which would likely result in greater runoff as the rainfall intensity exceeds the infiltration capacity of the ground. Consequently, regardless of whether the total amount of rainfall increases in the future, the amount captured may be no greater.

Climate change in coastal regions also brings with it the likelihood of higher sea level. In the Gulf Islands, a rise in sea level will result in a shift inland in the position of the saltwater interface. The saltwater interface lies at depth beneath the islands and a lens of freshwater floats on top of it. This inland shift may result in near-shore wells becoming contaminated with seawater to a greater extent than is currently observed.

We conclude that planning based upon current average precipitation is likely to seriously underestimate the expected stress on the aquifer and that planning should be based upon the expectation that we will experience more frequent droughts. Thus we should plan for precipitation of about 60% of the current average. We should design for lot sizes that are about 50% larger than we would need in a normal year, and we should expect that wells that are not now in a state of stress will become so and will need supplementary supplies.

Summary of Well record evidence

Much of what we can infer from well records is anecdotal but there are enough data from small community systems and from evidence of well failure that we feel forced to take a very conservative view of our groundwater resources. Where calculation is possible it appears that the amount of rainfall that arrives at the water table is much less than one might infer from 'standard' estimates of runoff factors and evapotranspiration.

SUPPLY & DEMAND SUMMARY

1. The amount of water that can reasonably be expected to be delivered to groundwater is small, probably not more than 150 mm/yr and may be much less. Evidence from well records suggests that 84 mm/y may be more representative, and we would caution that this is predicated on a 'normal' average year of precipitation. In a drought it could well be less than 50 mm/y.

2. The storage potential of Salt Spring rocks is relatively small and in some areas this small capacity is annually replenished by precipitation. However the actual capacity of the rocks cannot be accurately calculated from the available data due to absence of monitoring wells, evaporation data, concurrent precipitation data and good runoff data. A value of about 0.0001 is reasonable but not subject proof at the moment.

3. The expected demand of individual households requires, on average, that lot sizes be at least two acres, and perhaps as much as five acres in places where storage potential is low such as the north end of Salt Spring and other areas where massive shales predominate. We believe,

however, that stronger means of estimating minimum lot size must be found. If we conservatively plan for drought conditions the minimum lot size should be more like 3 acres.

4. Further development of groundwater resources should require large average lot size and the utilization of all possible water-efficient appliances, together perhaps with collection of rainfall in cisterns for irrigation and gardening.

5. The expectation that global climate change will make our situation uncertain must be planned for and it should be noted that unusually high precipitation that may occur sometimes will not result in more water in the groundwater system because it does not have the capacity to accommodate it. Rather, the result will be high runoff, not higher storage.

THOUGHTS ON CONSERVATION, QUANTITY AND QUALITY
Alternative Solutions for Quantity:

Storage options

The performance of both private and community systems can be improved by providing additional storage to carry over dry spells and to act as a buffer against irregular withdrawals.
Community water systems usually have some storage (tanks) to make best use of the wells and to ride out periods of low flow or interruption. Storage also helps to distribute the pumping schedule of wells to allow recovery of the water table. System users can decide to add storage at a cost to all members.
For private wells or individual homes, storage tanks can be added to provide emergency reserves, and some capacity for supporting limited gardening (non-potable),
Storage of water over winter months will have little impact on the water table at a time when water tables are highest but could serve for summer watering.

Rainwater collection and storage

The use of rainwater for all household use is possible if demand is very low such as 25,000 gals per year (68 gals/day, 310 l/d) (ref #3, and Larmour May 2006) but requires that the entire household be set up for low demand. As an example, this would take a capture area (roof, etc) of 1400 sq. ft. or roughly a 1700 sq. ft., one floor home to provide enough roof area. Higher demand and lack of attention to water saving appliances, fixtures and practices would quickly increase the required house (or roof network) area to 2500 sq ft. Certainly rainwater collection could be used to offset water use for irrigation and would not involve the same approvals for system design and buildings. Storage and its associated cost would presumably be borne by the homeowner.

At present, there is some movement within the CRD to permit construction purely on the basis of rainwater capture, but there is still some distance to go to arrive at cost effective system options supported by the building code. In addition, criteria could be established for designs to be based on a combination of a (scarce) groundwater resource and harvested rainwater. This could take place either on a lot-by-lot basis or in a community system although improved capacity will also involve increased costs. Cost increases could start to become much higher than the gain in capacity.

About 6000 gals of storage would allow a typical household to last 3 or 4 months during the dry season. Tanks would refill adequately at other times but rainwater capture cannot be expected to fully supply a residence, particularly with current expectations of daily use. Ponds cost about $0.10 per igal and tanks at least $1.00 per igal to install, so a summer's non-potable needs could readily be supplied from roof drains or land runoff in many cases.

Develop current ground water assets along with storage.

The addition of new wells along with the improvement of existing private wells and Community Water Systems might achieve some increased capacity without adversely affecting the aquifer or adjacent properties but caution suggests that this should be proven. In principle, given the amount of runoff that does not get into the aquifer, drawing more water out of the aquifer annually without an adverse affect would increase the amount stored annually and make more efficient use of the aquifer. Attempts to improve capacity will also involve increased costs. Significant cost increases to enhance infrastructure would definitely impact the culture of the island. In the long run, there will be a limit in actual capacity and/or acceptable cost.

Demand Side Management and Increased Conservation

In view of the finite nature of our water resources the most effective long run approach may be to attack the island culture of excessive water use. We may need to find ways to force (rather than to plead for) the careful and conservative use of water. Demand-side control may be the required actions for achieving water balance. How well this may work with private well remains to be seen.

Water Quality:

Implement Watershed Management Plans-

There has been much good work done to advance watershed protection through community participation in the development of the Cusheon Lake plan (8) and the current activity started for St. Mary Lake. Difficulties with the plans revolve around governance and implementation. Land use management authority under Islands Trust does not appear to be enough to assure progress. Watershed management thus becomes a governance question and other solutions such as limiting house sizes may need to be invoked. It may be that higher levels of government will need to take an active part before real progress can be made.

Make every watershed a Development Permit Area

If all the watersheds and well-capture zones for community systems were included in DPA's it would be possible to ensure that any development would meet rigorous standards for protection of water quality, and perhaps even for extraction rates. Individual well owners should implement well protection plans (a tool kit is already available) to ensure that sources are protected, and that potential contamination does not invade the water table over much larger area.

Implement Inspection and Proof of Maintenance for Septic Systems

Other obvious ways to deal with water quality include encouraging the regulation and inspection of septic systems, both new and old, on a rotating basis, with the power to require upgrades where necessary. Further, building codes can impose regulations on new construction to require installation of package treatment plants which produce effluent pure enough to be used for non-potable purposes.

Conservation:

There is significant information on encouraging conservation of water use (10, 11, 14). Effective increase of conservation requires activity on both the incentive and penalty fronts.

Demand side management-
Knowledge of what is being used by whom, and when is a fundamental requirement for implementing conservation measures. Household metering is a significant tool. In conjunction with metering, usage-based rate structures and personal contact with high users can have a beneficial effect. Every professional water group has indicated that meters are an essential tool. These measures are difficult to implement however where private wells are over-drawing the water table. In some jurisdictions in Ontario such problems are handled through litigation.

Control of summer irrigation and watering is one of the primary focus areas to smooth out the month-by-month demand. The increase in our summer population also drives water use so making sure our visitors are water conscious is important. Many of our summer residents come to us with an urban approach to water, assuming it to be inexhaustible. Encouraging drought resistant gardens (Xerology), hand watering (hard work if the garden is large), and encouraging or mandating microdrip watering systems are other focus areas.

Develop groundwater sources only based on measured data

Development of housing should be tied to proper testing of available water quantity, particularly any impact on adjacent properties. This is particularly important for the Gulf Islands where fracture zones significantly influence groundwater movement. The potential for well interference will be greater for wells placed along or close to a fracture zone if it can be identified.

License/regulate groundwater extraction

This will be difficult to have accepted particularly by private well owners. One benefit of regulations is that interference from over pumping can be better controlled. The down side is that we would still not know how much water is drawn collectively if individual owners do not meter their own water and are not required to report it.

Increase penalties, ensure enforcement if conservation encouragement doesn't work.

Regulatory Options and their potential Success

There is substantial information on influencing conservation and how to implement a governance structure for sustainability. See references at the end of the paper (10, 11, 14). A selection of ideas and comments that seem relevant to our circumstances are listed below:
-Watering restrictions
-Penalties
-Direct contact with offenders, publishing use of community water with or without names
-Feebates- use fines from highest users and allocate to lowest users to offset their bill.
-Licensing community and private wells with limits based on location, potential interference, -potential saltwater intrusion, density, existing extraction records or new pump tests.

There is evidence that even with a selection of good measures, some people don't get the message and bring urban-use mentalities (Waterbucket website, Kelowna experience)

Governance Issues: Matters beyond the scope of the Local Trust Committee

There is a need to close the gaps and avoid issues dropping in the cracks.
Who should take the lead? The IT, CRD, MOE, a new municipality?
Success with watershed management plans depends on having a recognized 'authority' that will champion taking up the cause.
There is currently no regulation of groundwater quantity in BC. MOE has begun a 3 phase program which is addressing well identification/data base, licensed drillers/complete records, new well standards, well maintenance and finally potential licensing/regulation of water quantities.
Who can mandate and implement both metering and watering restrictions beyond community systems?

Is there funding to find out more about our groundwater? Improved well monitoring and investigation into fracture zones is highly important. A new water allocation plan should be funded by MOE on Salt Spring.

Changes in Village development

If development in the villages, Ganges in particular, begin to introduce higher multi-storage buildings, say three stories (or just many more two story buildings), for ground commercial and housing above, some consideration must be made of the required changes in building codes (e.g. sprinklers for second story dwelling units) and infrastructure to satisfy water pressures and volumes for firefighting.

Conclusions from Water Use Considerations:
-Until we know more we need to be cautious in land use demands.

-Lot by lot development is at least done on a "caveat emptor" basis and doesn't change the balance significantly particularly if development can be proven not to interfere with adjacent wells.
-Significant rezoning or subdivision relying only on groundwater can severely impact areas currently meeting their water demand. Conversely, a particular area developed with its own community system (with no change in zoning or increased density) could economically provide new water capacity without any more negative impact than developing lot by lot. At the very least, proof of availability without degradation of surrounding lots must be enforced (currently is already in the OCP and Land Use Bylaw). Proof of sustainability should be considered as an addition to this process. However, it is unclear who, or which agency, is required to take responsibility or remediate a proven failure to meet requirements. The ability to enforce is also a concern.
-Adverse effects of over-pumping need to be addressed and may be as MOE moves further into the implementation of ground water regulation
-If our available resources are bounded, we need to attack the demand side of the balance and establish a new culture (or re-establish the old one)

OVERALL RECOMMENDATIONS

Basic conclusion- the groundwater resource is finite, fragile, and will not support extensive exploitation beyond what is already in place. Accordingly we make two sets of recommendations, one set for possible action in revising the OCP and within the powers of the LTC, and one set that needs to be addressed by other forums or higher levels of government.

Recommendations for inclusion in the OCP and Land use Bylaw

1 We recommend that the average lot size in any area be kept large enough to prevent over-extraction from the water table. For a single family dwelling, two acres should be the absolute minimum and 5 acres would be a more sustainable minimum in view of the threat of global climate change. A freeze on up zoning and consideration of some selected down zoning may be required. Determination of the optimum lot size will depend strongly on the location and details of the hydrology and thus may be impossible to implement on a lot-by-lot basis. Thus a 'global' and conservative approach may be required.

2. We recommend that wherever possible, recognized, well-recharge zones, watershed areas, and new subdivisions be identified and placed in Development Permit Areas so as to allow imposition of controls on siting, extraction rates, sewage handling, and installation of water-conservative appliances.

3. We recommend that the Trust encourage vigorous inspection of both old and new septic systems on a regular and rotating basis along with a proof of maintenance system to ensure that effluent does not contaminate the groundwater nor make its way into surface reservoirs and catchment areas. Fracture-based aquifers are especially susceptible to migration of contaminants. Use of package treatment plants should be considered for inclusion in building code for new and upgraded homes or if septic systems fail.

4. We recommend that the regulations that can be imposed in Development Permit Areas be strengthened to facilitate control over water quality in matters such as tree cutting, road building, subdivision development, and sewage handling, including metering of all community groundwater-based water systems

5 Proof of water quantity testing must be strengthened for any sub-division, new construction and significant renovation. Proof of a sustainable water supply with no adverse impact on adjacent or affected properties is mandatory. This can best be implemented by performing pump tests combined with monitoring of adjacent wells either in existence or specially drilled for the purpose of testing.

6. We recommend that the LTC engage consultants in hydrology to formulate in detail the criteria for approving any access to groundwater from new or renovated construction. These criteria should include the details of what pumping and monitoring tests should be considered adequate to ensure that the new work can expect to have sufficient water of acceptable quality and to ensure that use of the groundwater will not have any negative effect on the groundwater capability of surrounding properties. (Note the following excerpt from the Water Act, Ch 483 which makes it illegal to operate a well in a manner that negatively impacts an existing well)

   Any new proposal should be accompanied by the report of a professional groundwater hydrologist, which report should document the results of having performed the tests detailed in the policy above. Lack of such a report or the submission of an inadequate report should be grounds for refusing a permit to proceed with the work.

   Water Act- RSBC 1996, Chapter 483 Part 5- Wells and Ground Water protection, Well Operation page 41.

   78(2) A person must not operate a well in a manner that causes or is likely to cause
   (b)- a significant adverse impact on:
   (i) the quality of the groundwater
   (ii) The existing uses made of the groundwater from any well that drains from that aquifer.

Recommendations for Matters to be Pursued to Higher Government Levels

1 We suggest that it is necessary to clarify where the authority lies in connection with water purity, water allocation, well registry, and control of groundwater extraction. As it is, the Trust is unable to force developers and other citizens to behave responsibly with respect to limited water resources. Authority must be taken or assigned. CRD, MOE and Health Authority need to be coordinated with one another and with the needs of Gulf Islanders

2. We suggest that the Trust actively pursue funding from senior government for a comprehensive study of both the hydrology and its management. A new water allocation plan should be implemented

3. There is a need to make a study that is more than a patchwork quilt of attacks on separate problems such as groundwater, surface water systems, land development, taxation, housing, affordable housing, rental properties, fire safety, road safety standards/right of ways, emergency access, tree wind damage to dwellings/ power lines and security of water mains. Such methods exist, and 'expert systems' have been developed whereby all the variables can be inserted in a large matrix of interactions and the sensitivity of each sub-problem to each individual change can be semi-quantitatively evaluated. The result is an awareness of the general consequences of each proposed action. One such 'expert system' is called 'DRASTIC' and is referred to in the article by Forster and Journeay (2004). We note that such an approach is now being implemented and we applaud this innovation.

4. We recommend that the Trust vigorously continue to pursue senior levels of government to establish building code criteria that will allow proper construction of sustainable water harvesting, surface storage and utilization by private and community users of water in the Gulf Islands.

5. Further to the resolution of item 1, we recommend the implementation of ground water regulation to deal with the licensing of both private wells and community systems including limitation of water extraction depending on local conditions. A precondition for this implementation would be a prior study of aquifer sustainability.

6. We recommend the implementation of demand side management of water to not only conserve what water we have but also to reduce overall use.

7. We recommend the review of all new construction (including renovation) to avoid excessive water use and to require conformance to accepted limits. Mandate the introduction of low flow/low use fixtures and appliances not only for new construction but for renovation and retrofit, and pursue other levels of government to institute complementing tax or rebate incentives. Consider a program of home "certification" to low flow standards that could enhance resale value.

8. We recommend that initiatives to introduce Land Use Bylaws restricting outdoor water use in the dry seasons and the use of economizing watering systems by water districts and local communities should be supported by the Trust and other levels of government.

9. We recommend that a program for well protection and ground water stewardship be initiated to have all private and community system well owners participate in a survey of well condition and statistics, and implement program of well protection measures

10. We recommend that water use and stewardship issues, regulations and constraints be made part of the documentation on the sale of property.

11. We recommend that in the cases of affordable housing, use of seasonal cottages, and legalization of suites in private homes, the principle of no net increase in water demand over that for the individual household/lot be applied.

12. We recommend that all users of water, public and private, be reminded regularly in writing that they do not have the right to operate their well in such a way as to impact negatively other users of the same aquifer. Water is a community asset that must be shared and conserved. Over-consumption and/or interference with adjacent properties may only be resolved by litigation.

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APPENDICES

APPENDIX A

<u>A Look at Some Statistics Surrounding Groundwater Use</u>-

Demographics:
(mostly from Community Profile)
Salt Spring is 183 sq. kms, 45,798 ac, 18,534 ha.

Number of households(from George Ehring's note)
Dwelling units now-4422, allowed 6370, cottages not included
Cottages- built –say 400, allowed 1524 but at cost not likely
Commercial accommodation-
Hotels/motels- 143 now, 659 at build-out under current zoning (likely?)
Cabins/guest houses/tourist hostels- 223 existing, possible total 265

Number of people per household- is about 2 or slightly below
Population Calculation from dwelling unit estimate-
= # unitsX2=10,376 (now), 14,820 (likely build-out), 19,848 (extreme build-out). Is there enough water to almost double our resident population yet alone support summer visitors?.

Trends in population-estimate. 9,381 (in 2001)
From 1996 to 2001, increased by only 35 people

Trends in housing-growth in Water Demand
500 new homes were built from 1996 to 2001

From data provided by NSSWD, the number of new connections 1996 to 2001 inclusive was 115 (145 if from 1995). If these were all new homes, then some portion of the difference would have been within community systems estimated at about 50 new connections total. The community systems number would need to be confirmed with each but it is unlikely to be a growth of 100 as this would represent over 30% and most are near build-out.
That would suggest a majority or over 300 of the new homes are on private wells using this estimation method.

Most Community Systems on ground water are close to build out and may or may not experience shortages depending on current margins, culture of use, demographics, renovations with real estate turn over, and changes in both rainfall and drought season durations.

Growth in Water demand to Build-Out

Growth in NSSWD 2000 to build-out- (existing zoning)
Residential count-
At yr 2000
There were an estimated 1781 DUE's (single plus multi family) or 1822 connections

At build-out
There are estimated to be 2,921 DUE's (single plus multi-family) or 3041 connections

This is a growth (2002 to build-out) of 1,140 DUE's or 1219 connections in the residential sector. There will of course be more due to commercial additions.

<u>Distribution of Users-Surface/Ground/Community Systems/Private Wells</u>
The following table enables another approximation to be made of the number of private wells in use along with those on Community Systems (from VIHA data on water purveyors).

Community Water Systems User Numbers

Name	Surface/Ground	Total #connections	Surface #connections	Ground #connections
Moonstruck Organic Cheese	g	1		1
Carley Springs Water	g	3		3
Fernwood Water District	s	75	75	
Burgoyne Bay Water System	g	3		3
Fulford Elementary- not done				
Cedar Lane Waterworks District	g	37		37
Isles West Water	g	2		2
Cedars of Tuam Water District	g	16		16
Highland Water District	s	254	254	
Cedar View Trailer Park	g	26		26
Salt Spring Island Water	g	2		2
Erskine Water Society	g	30		30
Mount Belcher Improvement District	g	46		46
Merchant Mews		23	23	
Maracaibo Estates	g	86		86
Fulford Inn	g	1		1
Lorraines Kitchen	g	1		1
Harbour View Improvement District	g	21	21	
Fulford Harbour Water District	s	109	109	
Greenacres Lakeside Cottage Resort	s	8	8	
Island Fruitsicles	g	1		1
Salt Spring Island Cheese Co.	g	2		2
Ruckle Park	g	6		6
Reginald Hill Water System	g	24		24
Scott Point Waterworks District	g	57		57
North Salt Spring Waterworks District	s	1700	1700	
Swan Point Waterworks	g	5		5
Soya Nova Tofu Shop	s	2		2
Beddis Waterworks District	s	140		140
Rainbow Beach-not done				
Cottages Resort,The		10		
High Hill Water System	g	9		9
Salt Spring Island Chocolate	g	2		2
Cedar Beach Resort	s	41	41	
		2743	2231	502

From the data on households (about 5000 now) and the number of existing connections to community water systems using surface and groundwater sources, the difference indicates that there could be 2257 dwellings on private wells or 45 % of the dwellings. Most of the groundwater based community systems are near build-out, so most growth in groundwater use if it happened would obviously come from new private wells or the formation of new community systems. Total growth would still have to rely heavily on surface water.

Growth in Groundwater demand-

If the growth in dwellings goes from approximately 5,000 now to approximately 7,400 at build-out (current zoning), where will the 2,400 new water connections come from?

The NSSWW growth would accommodate about 1200, and we might get a total of 100 from existing community systems (low probability).

This means that the growth of 1100 dwellings (or 1200 if we don’t believe in much growth from existing community systems) would have to come from groundwater sources via private wells or newly constituted community systems. This is not the majority of growth but a nearly equal share. It does show, however, that the use of private wells will move up in the share of new development compared with the past.

Well Statistics

The number and location of active wells on Salt Spring Island are still subject to considerable uncertainty. The data on the actual performance of wells is even more limited. Some anecdotal evidence about well problems and good wells provides only an indication of the potential characteristics of a locality.

Number of Wells- Hodge (7) indicated that in (1992) there were about 1535 wells drilled on Salt Spring but that many were abandoned as new ones were drilled. A hand count from the water atlas map indicated 290 wells but it could not be determined what the timeline was for installation of these wells. This is one set of data that is quite uncertain as private owners are not required to register their wells although drillers must now be licensed and register new wells (2005 and later, MOE). The community profile (4) indicates that in 1996-2001 there were 100 wells drilled in the Fulford area and 43 in the Ganges area.

The estimate derived from the listing of community water users and the number of dwelling units from the community profile indicates a possible number of 2257 existing.

Mar 07 data provided by MOE indicated that there were 1449 wells located and 1540 wells in the MOE database. An additional 450 wells were picked up from drillers data that comes from as far back as the mid 1990's but have not been entered into the database yet. A MOE guess is that there are something like 2000 to 2200 wells on Salt Spring but that not all are in use. This shows some correlation with the other estimation technique.

Improving Well data- One way to assess the groundwater situation would be to survey all island residents about the performance of their wells. Done the right way we might get closer to a better well count and assess areas that might be doing better than others. If people were concerned about being named (for real estate resale reasons), we could ask for the area they are in but no name. We need to take more aggressive action to record well data.

Water Use:

-volume per household, person

Current OCP indicates 1600 l/d per household, VIHA is 225 l/d/person required to develop.

The supply/demand study by NSSWW indicates a planning number of 68,000 igal/yr/household and an average consumption of about 55,000 igal/yr/household calculated from usage data.

G. Hendren, CRD Engineering, 26Jan07 at SSI Water Council indicated that the volume of water required for subdivision is 300 igal/day per household (109,500 igal/yr/household). He went on to indicate that different communities on the Gulf Islands that rely more or entirely on water from rainfall (collected or captured in groundwater) plan around the amounts available and develop accordingly.

POLIS project quoted Canada nationally using 334 l/d/person

-most significant problem(s)

Increase in vacation occupancy, and outdoor use of water mainly for irrigation

-Additional annual data-(3)

Consumption per household

The Mayne water study (3) indicated a range of annual household water use as follows: CRD are= 60,000 igal, water rich area= 40,000 igal, water poor area= 29,000 igal, Indoor use/ rainwater only area= 29,000 igal, conservation oriented area= 15,000 igal.

Mount Belcher Improvement district (an uplands water system with a designated well capture zone under DPA) indicates from records (2003-2006) that consumption is 35,250 igal/yr/household or

95.5 igal/d/household. The number of people per household reflects the community profile (at near 2 people/household).

-community profile (4) says ground water demand doubled from 1977 to 1996

- from (2) no permit required at present for groundwater, no permit for less than 75 l/sec. Washington State limits withdrawal to less than 500 usg/day per licence.(2)

-Distribution of use- Surface 72%-Ground 28% (about 1993) (1). Mike Larmer indicates this is from 1979.

-Culture of water use-

Most users dependent on ground water have a serious regard for making best use of the resource. Depending on the location of a private lot or a community system it is commonly known whether the area is water rich, water poor or bordering on water starved. The demand for water and the ability to achieve co-operation in limiting its use can vary (2,3). Threats come from exceptional drought conditions, lack of consideration from vacationers, or a change in culture with new owners bringing urban water attitudes. Perhaps they feel their high demands must be met simply because of the high cost of housing in the Gulf Islands.

Water Balance:

How many people can be supported from available water using different daily consumption figures?
How do we fare on essential vs summer increases?
What are the most significant problems indicated?
Even if there is enough water on an annual basis, there often is not during the dry season of 3-4 months. This is when the greatest outdoor use occurs, mostly for irrigation and gardening. The use at some properties can go up 50 to over 100% at a time when water tables are down.

One Acre Lot- micro test case

Using the data from Mount Belcher, the amount of water stored in a one acre lot would be 6598 igal. If replenished regularly during rainy season, an owner would have to survive 100 days on 6598 igal assuming the aquifer was full at the start of dry season and the owner could in fact access all of the stored water. Existing on 2,000 igal per month for 2 people exercising conservations measures is feasible as long as there is no extensive gardening and that is even conducted by hand watering and using some collected waste water from sinks. Not everyone would think this can be done, but careful use can lower essential demand to 1,000 igal per month for 2 people if needed.

H.J. Greenwood, P. Eng. (ret.)

R.J. Gilleland, P. Eng.,

10.5 Appendix 6

Cusheon Watershed Management Plan – Objectives and Recommended Actions

N.B. The following is an abstract from the Cusheon Watershed Management Plan, 2007. For a fuller understanding and additional detail concerning the recommendations, please refer to the document as a whole.

OBJECTIVES AND RECOMMENDED ACTIONS

The primary goal of the Cusheon Watershed Management Plan is to **protect and restore the quality of surface waters in the Cusheon Watershed.**

Cusheon Lake is a source of drinking water. The main difficulty with the water in Cusheon Lake is excessive algal growth and related toxins caused by nutrient enrichment. The key limiting nutrient is phosphorus. Accordingly, the most important strategy to achieve the primary goal of the watershed plan is to **reduce the loading of phosphorus into Cusheon Lake.** The steering committee recommends an objective of 13.5 parts per billion (ppb) of phosphorus in the springtime lake, and, to achieve that, a reduction of 17 kg or yearly loading from 117 to 100 kg. This is a reduction of 15 percent.

Evidence that this goal is being accomplished would be:

1. Decreased phosphorus concentrations at spring overturn;
2. Increased water clarity, as measured by Secchi disk readings;
3. Reduction and eventual elimination of potentially toxic algal blooms.

Improved fish and wildlife habitat will be an automatic benefit when the above goal is achieved. With reduced nutrients and algae, fish and other aquatic organisms will face fewer problems resulting from oxygen reduction, the release of metal contaminates from the lake bottom, and less danger of kills from cyanobacteria, as occurred in Fraser Lake (Personal communication, Dr. Rick Nordin, U. of Victoria, and Gary Gibson and Michel Riefman, Vancouver Island Health Authority).

Financial and other benefits are associated with improved water quality. Residents can avoid expensive special treatment of drinking water or the need to buy imported water. Better water quality and improved lake aesthetics protect property values. There are also tangible benefits from improved fishing and other recreational uses favourable to tourism.

This management plan provides a set of objectives and actions for achieving the major goal.

The five main objectives that must be accomplished to achieve the Plan's goal are:

1. Define and map Cusheon's watershed, its land uses, creeks, wetlands and the status of riparian vegetation.
2. Define and map Cusheon's watershed, its land uses, creeks, wetlands and the status of riparian vegetation.
3. Reduce inputs of phosphorus from land management activities.
4. Reduce inputs of phosphorus from water management activities.
5. Monitor springtime levels of phosphorus. (See section 2.3.8) When monitoring indicates consistent springtime concentrations of 13.5 ppb of phosphorus, the major goal of the plan will have been achieved.

OBJECTIVE 1: DEFINE AND MAP DRINKING WATERSHED.

Recommended strategy: Inventory and map the land use and key environmental features, particularly riparian zones, within the boundary of the drinking watershed. Translate this mapping into Official Community Plan (OCP), Zoning & Land Use Bylaw (LUB) designations. This Plan adopts a physical definition of the drinking watershed as the upper watershed (i.e., above the Cusheon Lake outlet). The lower Cusheon watershed is crucial for salmon, especially Coho but is not a source of drinking water. In support of the watershed planning process, Islands Trust has mapped the outlines of the upper and lower Cusheon watershed.

1(a) Action: CRD and Islands Trust should develop a set of maps of the Cusheon drinking watershed showing current land uses, zoning and development permit areas, covenants, ecosystem types, and locations of streams, wetlands and other riparian areas within the watershed boundary. All maps need to be compatible, so they can be overlaid.

Mapping and related databases should also include air photos of current status of riparian zones (e.g. state of vegetation and evidence of erosion.) These need to be deciphered and explained by an expert in interpreting aerial photos. In particular, the following items need to be identified.

- Location and type of any dams, barriers, or diversions in watercourses
- Location of buried, abandoned fuel tanks
- Location of man-made ditches
- Information on any existing covenants on riparian lands

The CRD Natural Areas Atlas shows the location of lakes and major streams, the topography within Cusheon Watershed and marks the boundary of the watershed. Islands Trust plotted the boundaries (see Figure 3). Note that Islands Trust maps fail to show many of the creeks.

1(b) Action: The CRD Atlas must be examined with a focus on difficult to map areas in the watershed. Afterwards, these areas must be “ground-truthed” within the physical boundary of the watershed.

Riparian area mapping is still incomplete for Salt Spring and there is no mapping at all of seasonal streams, even though these streams that flow into fish-bearing waters are now to be protected through the adoption of the new Provincial Riparian Areas Regulation. Much of the above information is not available at present and obtaining it is a large undertaking, requiring a good deal of time by people examining maps, atlases, creeks, and other sites. Identifying places where streams come into the three lakes in the Cusheon watershed, and following these creeks upstream during winter months when flows are occurring, could start the process of mapping within the watershed boundaries. Such maps are essential as database for planning and for protecting the drinking watershed.

1(c) Action: Islands Trust should use the watershed mapping described above as a basis for redefining watershed zoning within the OCP and land use bylaw designations. To ensure equity and consistency, it is important that these changes should apply to all properties within the drinking watershed at the same time, rather than on an individual or piecemeal basis.

1(d) Action: Determine desirable lake level objective and install new staff gauge.

OBJECTIVE 2: SURVEY PHOSPHORUS SOURCES IN THE CUSHEON BASIN.

2(a) Determine sources of phosphorus entering lake.

An analysis of phosphorus sources (i.e. phosphorus budget”) has been developed from studies that took place while this management plan was being developed (Sprague 2006 a,b,c). These studies made use of a modeling approach based on direct measurements in tributary creeks and lakes during one year. These studies estimate the amounts and sources of phosphorus inputs to the lake. The information is adequate as a basis for pursuing watershed planning objectives and strategies that will help to reduce phosphorus in Cusheon Lake.

2(b) Determine phosphorus objective. The goal is to return the lake to a level of phosphorus measured at 13.5 parts per billion. A number of actions are recommended to reduce sources of phosphorus. The committee recommends that those actions should be pursued until the lake attains an average springtime concentration of 13.5 parts per billion of phosphorus. As described in section 2.3.5 and 2.3.8, that would represent approximately the historic level of nutrient in the lake.

To achieve that concentration, the total yearly input of phosphorus should be reduced by 15%. That would be a reduction of approximately 17 kg, from the existing load of about 117 kg to a recommended load of just under 100 kg. This could be achieved by a reduction in any one of the sources of phosphorus, or a combination of reductions in several of the sources.

OBJECTIVE 3: REDUCE INPUTS OF PHOSPHORUS FROM LAND MANAGEMENT ACTIVITIES

The phosphorus budget indicates that over fifty percent of phosphorus enters Cusheon Lake with runoff from land. This can be reduced by increasing vegetation within both riparian and non-riparian areas, including forested land, in the watershed. The benefits are:

- Vegetated areas reduce runoff and promote infiltration into the ground;
- Soils are held in place and sediment is kept out of the watercourse;
- Any pollutants in the surface or sub-surface water tend to be stabilized and "filtered out;"
- In summer leaves shade the water, thereby reducing heating, evaporation, light entering the water, and algal growth.

In addition, impervious surfaces should be reduced within the watershed.

3(a) Action: Islands Trust to establish or strengthen/extend Development Permit Areas (DPAs) for riparian areas in all land use designations.

Salt Spring Island’s Land Use bylaws regulate location of buildings, septic systems and farm animal waste but in themselves do not ensure preservation of natural vegetation or prevent farm animals from contacting potable water sources. This need has been partly addressed by the designation of Development Permit Area 4 (see Figure 8), which prohibits clearing of any area larger than 9 square metres within 10 metres of identified watercourses in the Cusheon watershed (Blackburn Creek, Cusheon Creek, and the lake edges). However, the width of the DPA on agricultural lands is only metres.

The B.C. Ministry of the Environment (MOE) has developed new guidelines for Riparian Areas Regulation that require protective measures within 30 metres of fish-bearing lakes and streams. Local governments are expected to bring their bylaws up to the provincial standard. Local government may also decide to exceed provincial guidelines. All three lakes in the Cusheon system have fish and are covered by this new legislation. However, these guidelines do NOT apply to ALR land and current DPA on ALR should be strengthened.

Adopting the 30-metre “buffer area” would strengthen current riparian protection provided by Development Permit Area 4. The new guidelines would also apply to all watercourses, not just the ones currently covered by DPA 4.

3(b) Action: It should also be noted that there may be a flaw in DPA 4, which appears to allow infilling/dumping of fill or diking in riparian areas. This obvious gap should be rectified immediately and wording clarified.

3(c) Action: Islands Trust should seek ways to improve the enforcement of, and education about, DPAs.

Development Permit Areas are not subject to ticketing. In addition to seeking ticketing authority from the province, Islands Trust should find other ways to make DPA offences have more serious consequences for offenders, for example:

- All DPA offences should result in environmental restoration guided by a specialist in the field of riparian restoration, expenses to be paid by landowner.

- Penalties for DP offences should also require covenanting the DPA in perpetuity. Covenants should include significant rent charges and these penalties should be indexed to inflation.
- Tree cutting bylaws that are ticketable should be applied within DPAs.

3(d) Action: Islands Trust, as the lead agency, should limit the number, kind, and size of docks allowed on shoreline properties by working on an agreement with Ministry of the Environment and Ministry of Agriculture and Lands (MAL), Integrated Land Management Branch, to avoid soil disturbance and harm to riparian zones.

3(e) Action: Islands Trust and CRD should seek ways to improve the education of landowners about their responsibilities regarding DPAs.

Examples of such actions could include:

- All property owners within a DPA should immediately be provided with information about the importance and legal responsibilities regarding maintaining riparian vegetation.
- Any sale of a lot in a DP area should trigger a letter informing the new owner of the responsibilities related to the DPA.

3(f) Action: Protect and preserve the shoreline parcel of Crown land in its current undeveloped state.

The Crown land parcel D on the south side of Cusheon Lake, towards the westerly end, should be fully protected. It occupies 880 metres of shoreline and has been left undisturbed since the early 1950's when the Powell River Logging Company logged it. At present, it contributes less phosphorus to the lake than if the shoreline were opened up for use by people. However, even now there is a raised trail going through the woods that should be eliminated and allowed to grow over. In times of heavy rain, surface water is "dammed up" by the trail, and flows to the lake as a muddy liquid carrying a load of nutrient.

CRD Parks has agreed to seek transfer of the Cusheon Lake Crown parcel from the province and has compiled the necessary background information. The Islands Trust Fund has agreed to hold a conservation covenant to ensure that the management priority for the land is watershed management. Currently, CRD is waiting for resolution of the Hul'qumi'num treaty process before initiating the application process.

3(g) Action: Local government could designate the entire drinking watershed a Watershed Development Permit Area with a hierarchy of strictness so that activities potentially harmful to water can be regulated in a way that is less strict than in a DPA but stricter than on land outside the drinking watershed.

This would require landowners to obtain a permit to carry out any extensive land use change. This would not prohibit such activities, but rather provide a process in which watershed management expertise could be used in helping the landowner choose how he or she will go about activities such as logging, ditch digging, altering stream flow, avoiding impermeable surfaces, etc.

3(h) Action: Islands Trust should work with Trust Council to develop an agreement with B.C. Hydro to regulate roadside tree cutting in the drinking watershed. B.C. Hydro prunes roadside trees carefully in Vancouver and Victoria but on Salt Spring applies "rural standards" and employs a damaging technique called "slashing."

3(i)Action: Islands Trust should create a tree-cutting bylaw effective inside DPA 4, (Lakes, streams and wetlands) DPA 6 (Unstable slope and soil erosion hazards) and elsewhere in the drinking watershed.

3(j) Action: Island Trust should seek to create treed buffers between lots such as buffer zones regulated by bylaws on other Trust islands. Treed buffer zones would help slow and filter runoff within the drinking watershed. They will also connect groups of trees to each other and so will help to decrease blow-down and other problems associated with narrow strips of trees or lone trees. Tree cutting bylaws should be implemented within treed buffer zones.

3(k) Action: Local government should work to develop a Gulf Islands FireSmart manual that will fulfill the needs of fire safety while preserving riparian and uplands vegetation within the drinking watershed.

3(l) Action: Islands Trust should restrict soil disturbance by creating a soil removal and deposit bylaw that will regulate and reduce the disturbance of earth in the drinking watershed.

3(m) Action: Islands Trust, in the OCP and LUB, should outline best management practices for development that will reduce exposed earth and silt-laden runoff.

3(n) Action: Islands Trust should change the OCP and LUB, to prevent "up-zoning" within the drinking watershed even as part of an amenity zoning or density transfer proposal.

3(o) Action: Islands Trust, in the OCP and LUB, should institute a way of ending the right to subdivide land for a relative within the drinking watershed.

3(p) Action: Islands Trust should, in the OCP and LUB, uphold and strengthen Islands Trust Policy Statement 4.4.2 that states:

"Local Trust committees and Island Municipalities, shall, in their official community plans and regulatory bylaws, address measures that ensure:

- Neither the density nor intensity of land use is increased in areas which are known to have a problem with the quality or quantity of the supply of freshwater,
- Water quality is maintained, and
- Existing, anticipated and seasonal demands for water are considered and allowed for."

3(q) Action: Islands Trust should disallow those types of home-based businesses that have the potential to pollute water, use large amounts of water or increase sewage effluent unless special measures are undertaken to conserve water, reduce runoff and entirely eliminate pollution. As well, septic tanks must be of sufficient size to meet maximum use. Business parking areas should be regulated and should not add impervious surfaces or reduce vegetation.

3(r) Action: Islands Trust, in the OCP and LUB, should reduce "site coverage" on lots. This means that site coverage (defined as roofed structures and paved areas) should be more strictly limited in the drinking watershed than presently permitted and Islands Trust should consider limiting maximum house size permitted.

3(s) Action: Islands Trust, within the agreement between MOT and Islands Trust, and by negotiation and agreement with the subdivision approval branch of the provincial government, should limit road width to reduce impervious surfaces in the drinking watershed.

3(t) Action: In cooperation with local farm groups, Islands Trust and CRD should promote awareness among farm owners of the importance of riparian areas and waste management regulations, and encourage farmers to follow the voluntary practices recommended by Agricultural Stewardship.

Special regulations are already included in the Salt Spring Island Land Use Bylaw No. 355 to address issues of water quality and some types of agricultural activity. These regulations require large confined livestock areas, manure-based mushroom cultivation and agricultural waste storage to maintain a minimum setback of 60 metres (200 ft.) from Blackburn Lake, Roberts Lake and Cusheon Lake, and 30 metres (100 ft.) from any other water body that drains into one of these lakes. Any collection sites should have a roof or tarpaulin to keep off rain, and should be surrounded by some sort of wall or barrier to prevent runoff of liquids.

If livestock are ranging across fields, they should be kept out of the riparian buffer zone of vegetation. The required distance for maintenance of undisturbed riparian area in agriculturally zoned lands is 3 metres, but this offers little protection and a greater distance would definitely be desirable.

3(u) Action: Document the incidence of commercial fertilization. A periodic recheck should be part of future activities. Understanding the side effects of using fertilizer should be part of stewardship education.

3(v) Action: Local government should work with local farmers' groups to cooperatively protect the drinking watershed by promoting watershed stewardship awareness.

The following activities should be supported:

- Distribute information on best farm practices,
- Complete farm management plans,
- Raise awareness of the Environmental Farm Planning program from Agriculture Canada, which helps landowners to look at their farm operations to see if they are environmentally sound. (It also provides a source of funds for improving the operations if necessary. Local contacts for this program are Sheri Neilson and Dave Tattum of the Farmer's Institute.)

OBJECTIVE 4. REDUCE INPUTS OF PHOSPHORUS FROM WATER MANAGEMENT ACTIVITIES (SEPTIC, STORMWATER.)

4(a) Action: Identify and repair faulty septic systems, particularly those within the drinking watershed and consider establishing a sewage collection and central treatment system.

It is not easy for homeowners to assess poorly functioning septic fields, particularly the nutrient escape. Unless there is surface pooling of liquid above the field, septic field owners will likely be unaware of any problem. The provincial Ministry of Health and Capital Health Region share jurisdiction, but their interest is in bacteria. There needs to be recognition that nutrient escape into lakes is also a health concern, since these nutrients contribute to the development of toxic cyanobacterial blooms. For nutrient input control, the most important fields to check are those within 100 metres of the shoreline or streams. There is no regular inspection program of existing systems. Rather, Vancouver Island Health Authority (VIHA) will respond to complaints. The CRD has committed to the implementation of a septic monitoring program. It is recommended that this program include the following elements:

- Strict inspection of new disposal facilities to ensure that they meet or exceed all aspects of the building code,
- Public information campaign on proper design, functioning, and use of septic systems,
- Regular pumping of septic tanks,
- Investigate the feasibility of a septic effluent collection system and common treatment facility for residences around Cusheon Lake, particularly those between Cusheon Lake Road and the lake,
- Establish protocol agreement between CRD Building Inspection, Islands Trust and VIHA, to ensure a 60-metre setback of septic fields from water courses,
- Consider establishment of incentives to assist property owners to upgrade their septic systems.

4(b) Action: Islands Trust and CRD should request an investigation by Ministry of Environment of potential leachate contamination of water sources associated with the former Blackburn garbage dump.

4(c) Action: Map and prevent removal of aquatic plants

Removal of aquatic plants, or macrophytes, and spreading them on gardens or farms would transfer nutrients, including phosphorus, from the lake to the land. Beds of submerged water plants do develop in Cusheon Lake; however harvesting is not recommended. The plants do not actually contain as much phosphorus as might be thought, and a large tonnage would have to be harvested to cause any appreciable lowering of phosphorus in the lake.

There is also a major question about the effects of stirring up sediments during the harvesting, with consequent dissolving of phosphorus from the sediment to the water. Even special boat-mounted harvesters would cause appreciable disruption of the shallow bottom of Cusheon Lake. Operating on foot would be very disruptive, creating suspended sediment and also destroying fish spawning habitat and the natural habitat of insects and other small creatures around the edges of the lake.

4(d) Action: Initiate a storm water management program to minimize deleterious aspects of direct water runoff.

Paved roads and other impervious areas (roof, patio, etc.) have an immediate and complete runoff. Any such area contributes towards “flashy” local creeks, i.e., they tend to flood, carry off runoff quickly, and then drop off to low flows. This is inherently bad for the plants and animals living in the waterways, but it also increases scouring, erosion, and the carriage of nutrients.

If there are pollutants such as oily substances on roads, household chemicals, or spills accumulated in ditches, the flashy runoff can carry them towards the nearest watercourse. There is a particular concern along Cusheon Lake Road which is very close to the lake. Spills and road runoff can accumulate in ditches. Cleaning out ditches during or just before the wet season will result in direct runoff of contaminated or muddy water.

Highways maintenance officials must recognize that if natural vegetation is retained in ditches, it is a good trap for silt. If natural vegetation must be removed, artificial “silt fences” can partially reduce transfer of sediment. A storm water management program should have several elements, listed below.

- The Islands Trust-MOT protocol agreement should be revised to define best management practices for amelioration of direct runoff from roads, including ditching practices, especially those related to roads in drinking watersheds.
- For existing roads that are close to watercourses (e.g., Cusheon Lake Road), there should be long-term planning of alternative routes for through traffic. These should be recorded in local and provincial government planning departments for automatic consideration when there is any thought of upgrading local road facilities.
- Local government agencies should encourage, in any new developments, drainage techniques that use infiltration, such as pits or ponds for groundwater recharge.
- Storm water drainage ditches should not have a “straight tube” construction, but rather have small pools and steps built in, to slow water flow. Allowing vegetation to grow in ditches also slows water and absorbs nutrients. These measures help to prevent the carrying of silt into receiving waters, and slower flow encourages ground water recharge.
- Storm water drainage ditches should not cross agricultural lands, where they might pick up nutrients from fertilizer or livestock waste. The culvert located near the junction of Lord Mikes Road and Cusheon Lake Road should be blocked by MOT to prevent the current discharge onto the ALR, A2 land.
  This storm water should be allowed to continue its course in the ditch located on the north side of Cusheon Lake Road. The old broken concrete culvert east of Beddis Waterworks should be removed and the storm water should be drained downstream through the new 20” culvert. The culvert at the junction of Stewart and Horel Road drains into the end of Cusheon Lake before the lake water enters Cusheon Creek. This storm water carries large amounts of silt which can flow into the lake. The discharge of this culvert may be redirected directly into Cusheon Creek.

- Narrow roads should be constructed rather than wide ones to limit impervious surfaces.
- Roadside hedgerows should be preserved or restored.
- Install oil/sediment water separators in all culverts that discharge toward the lake.

4(e) Action: Islands Trust and CRD should seek registration of The Cusheon Watershed Management Plan with the Province. The B.C. Drinking Water Protection Act is designed to help protect drinking-water supplies. Under this Act, communities can seek to register Watershed Management Plans, if it can be shown that the Plan is needed to protect local drinking water supplies. If a plan is approved for registration, then the provisions of the plan essentially become legal requirements that supersede current bylaws. Registration would also add a layer of protection that would prevent loosening of local bylaws.

4(f) Action: Local government should initiate an ongoing "Awareness" program. The education program should include the following elements.

- Prepare and distribute an easily understandable brochure that summarizes the highlights of the Cusheon Watershed Management Plan to the community.
- Support Watershed Stewardship groups.
- Educate Islands Trustees and CRD planning and enforcement staff on water quality protection measures.
- Provide workshops and lectures co-sponsored by stewardship groups. Purchase and donate books on watershed protection to the library for community use.
- Provide Septic Savvy information on management of septic systems to all watershed residents. Create a "best practices" guide for builders and developers who will be carrying out their projects on lands within watersheds.
- Distribute watershed stewardship literature to new residents.
- Make watershed residents aware of the uses of protective covenants, including the Natural Areas Protection Tax Exemption Program (NAPTEP). This program provides up to a 65% reduction in total property taxes for owners who covenant natural areas on their land.
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An awareness program will include concepts relevant to reducing inputs of phosphorus from both land and water management activates.

OBJECTIVE 5: MONITOR SPRINGTIME LEVELS OF PHOSPHORUS

5 Action: Monitoring springtime levels of phosphorus. The goal that should be reached to reduce or eliminate blooms of cyanobacteria and their toxins is a reduction of 15 percent from the present yearly load of phosphorus to the lake. The phosphorus objective is 13.5 ppb.