Saturna Island Local Trust Committee
Regular Meeting Agenda

Date:	January 16, 2025
Time:	11:30 am
Location:	Saturna Recreation and Cultural Centre 104 Harris Road, Saturna Island, BC

13.	**CORRESPONDENCE**	1:40 PM - 1:45 PM	
	Correspondence received concerning current applications or projects is posted to the LTC webpage		
	13.1	**Diane Allen re Salt Water Intrusion Mapping Saturna Island**	13 - 58
14.	**APPLICATIONS AND REFERRALS**	1:45 PM - 2:15 PM	
	14.1	**PLDVP20240324 (Anielski) - Staff Report (attached)**	59 - 75
	14.2	**North Pender Island Local Trust Committee Referral for Draft Bylaw No. 235 (for Response) (attached)**	76 - 78
15.	**LOCAL TRUST COMMITTEE PROJECTS**	2:15 PM - 2:45 PM	
	15.1	**Minor Housing Amendments Review Project – Staff Report (attached)**	79 - 90
16.	**REPORTS**	2:45 PM - 2:55 PM	
	16.1	**Work Program Reports (attached)**	
	16.1.1	Active Projects Report Dated Jan 2025	91 - 91
	16.1.2	Future Projects Report Dated Jan 2025	92 - 92
	16.2	**Applications Report - Verbal Update**	
	16.3	**Trustee and Local Expense Report Dated Nov 2024 (attached)**	93 - 93
	16.4	**Adopted Policies and Standing Resolutions (attached)**	94 - 98
	16.5	**Local Trust Committee Webpage**	
	16.6	**Islands Trust Conservancy Report Dated Nov 2024**	99 - 101
17.	**NEW BUSINESS**		
18.	**UPCOMING MEETINGS**		
	18.1	**Next Regular Meeting Scheduled for April 24, 2025 at the Saturna Recreation and Cultural Centre, Saturna Island**	
19.	**TOWN HALL**	2:55 PM - 3:10 PM	
20.	**CLOSED MEETING - None**		
21.	**ADJOURNMENT**	3:10 PM - 3:10 PM	

Saturna Island Local Trust Committee

Minutes of Regular Meeting

Date: November 7, 2024
Location: Saturna Recreation and Cultural Centre
104 Harris Road, Saturna Island, BC

Members Present: David Maude, Chair
Lee Middleton, Local Trustee
Mairead Boland, Local Trustee

Staff Present: Brad Smith, Island Planner
Warren Dingman, Bylaw Compliance & Enforcement Manager (electronic)
Carly Bilney, Recorder (electronic)

Others Present: Paul Brent, Capital Regional District (CRD) Electoral Area Director for the Southern Gulf Islands

There were 4 members of the public present.

1. CALL TO ORDER

Chair Maude called the meeting to order at 11:32 a.m. He acknowledged that the meeting was being held on the territory of the Coast Salish First Nations.

2. APPROVAL OF AGENDA

By general consent the agenda was approved as presented.

3. TRUSTEE REPORT

Trustee Middleton's report included the following comments:

- Slow movement with conservation projects including Judy Myers' property that has been referred back to the Ministry of Transportation and Infrastructure as a regular subdivision request
- It is unclear if a conservation project at a wetland at East Point is advancing at this time as the landowner has not come forward with a proposal

Trustee Boland's report included the following comments:

- At the Trust Council meeting in September there was almost unanimous consent for drafting a letter to the Province asking for a review of the *Islands Trust Act*; the letter has since been sent
- A new Chief Administrative Officer has been hired for the Islands Trust

4. CHAIR'S REPORT

Chair Maude made the following comments in his report:

- The new Chief Administrative Officer Rueben Bronee starts on December 1, 2024
  - Rueben Bronee comes from the provincial government with a management background and expressed enthusiasm about joining the Trust
- The Policy Statement review continues and there is relative confidence that the document has addressed previous concerns ; once it reaches First Reading, the public will have greater opportunity to provide input

Trustee Boland commented that it was the job of local Trustees to engage with their communities about the Policy Statement review; she added that the updated draft of the Policy Statement is now much more readable and easier to understand, and can be found in agendas of recent Committee of the Whole meetings

5. ELECTORAL AREA DIRECTOR'S REPORT

In his report, Paul Brent, Capital Regional District Electoral Area Director for the Southern Gulf Islands, made the following comments:

- His focus has primarily been on housing initiatives and slow progress is being made
- Justine Stark has been working to address the secondary suite issue
- Islands Trust incoming Chief Administrative Officer Rueben Bronee was with the Ministry of Communications, Learning and Engagement, and should be good fit for working on the Trust Policy Statement
- The Capital Regional District is in budget time, and costs are increasing everywhere
- A lot of what the Capital Regional District does has to do with infrastructure and infrastructure costs are way higher than the consumer price index
- The financial costs of reconciliation, including engagement, are considerable

6. TOWN HALL AND QUESTIONS

Island Planner Smith commented that because this is not an electronic meeting the public is only able to view the proceedings online rather than actively participate. Trustee Boland suggested electronic participation be considered for Community Information Meetings.

Town hall was held and the following comments were made:

- Support was expressed for referring the Minor Amendment Housing Project to the Saturna Island Advisory Planning Commission (APC) to provide opportunity for discussion to unfold in a casual setting – Island Planner Smith clarified this would need to be referred to the APC from the LTC
- Frustration was expressed for the lack of participation at meetings and the public was invited to provide input about meeting times that might work better
- A lot of islanders are concerned about housing issues and want to participate

- The Islands Trust process can accommodate discussions about housing; additionally, discussions can be organized by other groups who could then bring the material to Local Trust Committee meetings

7. COMMUNITY INFORMATION MEETING – None

8. PUBLIC HEARING – None

9. MINUTES

9.1 Local Trust Committee Minutes Dated July 18, 2024 (for Adoption)

The following amendments to the minutes were presented for consideration:

- On page 6 of agenda (Page 3 of the Minutes), in the third bullet under Item 7.1, change: "A building permit can not been" to "A building permit cannot be"

By general consent the Saturna Island Local Trust Committee meeting minutes of July 18, 2024 were adopted as amended.

9.2 Section 26 Resolutions-without-meeting Report Dated Oct 2024

Received for information.

10. BUSINESS ARISING FROM THE MINUTES

10.1 Follow-up Action List Dated Oct 2024

Received for information.

11. DELEGATIONS

12. CORRESPONDENCE

Correspondence received concerning current applications or projects is posted to the LTC webpage

12.1 Janet Land re LTC Housing Amendments Review

Trustee Boland responded to correspondence from Janet Land and noted that:

- The salt water intrusion information maps are from the Province which has updated its analysis
- A letter went to fifteen First Nations to draw their attention to the start of the Minor Amendments Project, as is standard practice of engagement at the beginning of a project

12.2 Fisheries and Oceans Canada re Southern Resident Killer Whale Proposed Management Measures

Received for information.

13. APPLICATIONS AND REFERRALS

13.1 PLDP20240229 (Anielski) – Staff Report

On behalf of Planner Testemale, Island Planner Smith presented the staff report. Discussion ensued and the following comments were made:

- The applicants were asking to be able to build a deck that encroaches into the bluffs development permit area
- They plan to apply for a development permit variance for exceeding lot coverage after they complete their lot consolidation and Trustees can discuss this further at that time
- Applicants have suggested they would be willing to donate their density to the Community Amenity Density Reserve after lot consolidation
- Acquiring another density into the density bank would be advantageous given there may be opportunities to create affordable housing options in the future
- Support was expressed for the application because the proposed deck would extend into the Bluffs Development Permit Area which is hard rock

SA-2024-034
It was Moved and Seconded,
that Saturna Island Local Trust Committee approve issuance of Development Permit application SA-PLDP20240229 (Anielski).

CARRIED

14. LOCAL TRUST COMMITTEE PROJECTS

14.1 Minor Housing Amendments Project – Staff Report

Island Planner Smith provided an update on progress to date in the Minor Housing Amendments Project and made the following comments:

- The proposed bylaw would bring changes regarding cisterns and secondary suite mapping and could be achieved as a land use amendment rather than as an amendment to the Official Community Plan
- The Province provided updated data and staff has been directed to review Schedule E to determine which properties could enable a secondary suite
- As drafted, a cistern would be applicable to all new builds on the island (it is currently only applicable at East Point)

Discussion ensued and the following comments were made:

- The risk of salt water intrusion should be specified when appropriate rather than referring to it as “aquifer vulnerability”
- Preference was expressed for proceeding in a layered, step-by-step approach that assesses salt water intrusion maps, private water provider systems and other aspects of water vulnerability
- We should engage with private water providers explicitly and explain the proposal so they can make their own decision about how they want to proceed

- It would be helpful to have list of development applications over the last few decades to see data on new wells and to assess observation wells; this would allow for more engaged discussion at the Community Information Meeting
- We should consider the cost of water collection tanks before imposing them as a requirement across the island
- Caution was expressed in increasing the demand on wells that secondary suites would create
- The Province has indicated a willingness to communicate with the Local Trust Committee and they will be involved throughout the process
- The Local Trust Committee should dictate a standard for quality and quantity for water as part of increasing sustainable options for housing – this is the foundational piece we should work on as a first step
- Evaluating potable water standards in development regulations is a much bigger and different conversation than requiring a cistern to apply for a building permit
- The Province would respect local standards about the provision of water catchment as a legitimate source for the purposes of subdivision or secondary suites
- Concern was expressed that the cost of installing tanks might make or break a proposal that includes a secondary suite
- The reason for the Minor Housing Amendments Project is to increase the possibility for secondary suites where appropriate – water would be the basis for developing a secondary suite or cottage
- Trailers might be able to fulfill the need for housing
- There is a need for increased affordable housing to some degree and we need to address all options, including secondary suites
- The Capital Regional District has approved funding for housing incentives in a program that can be stacked with the Province's Secondary Suite Incentive Program
- One or two secondary suites on Saturna Island – tiny increments – would be great
- Trustees should look at existing additional accommodation that is currently for private use and could potentially be rented
- A housing survey would be helpful and the Local Trust Committee should consider one for Saturna
- A recent housing survey on North Pender that seeks input on demographics, housing solutions and need has so far received 375 responses
- Habitat for Humanity is collaborating with the Mayne Island Local Trust Committee to seek land for housing young families
- One limitation to increasing the number of people on a lot is water supply
- We are looking into changing mapping for secondary suites, but should also look at access to water for other types of housing (accessory dwelling units) that are less expensive to build (e.g. trailers, workshops)
- About five years ago the Local Trust Committee on Mayne allowed secondary suites on most of the island, but there has been little uptake due to regulations and construction costs

- A number of groups have discussed housing issues on Saturna over the years and they may be willing to initiate a new project

Discussion continued about the recommendations in the staff report. Comments were made that the Local Trust Committee could consider the updated maps as well as land suitability analysis data and groundwater recharge mapping.

SA-2024-035
It was Moved and Seconded,
that Saturna Island Local Trust Committee directs staff to prepare a draft bylaw that would amend the Saturna Island Land Use Bylaw No 119, 2018 by:

a. Revising the associated Schedule "E" Secondary Suites map in consideration of updated 2022 provincial saltwater intrusion mapping;
b. Changing all references of 'rainwater' to 'freshwater' to be consistent with other recent amendments and the advice of the Islands Trust Senior Freshwater Specialist;
c. Removing Schedule "C" East Point Water Management Area, and updating water storage requirements in Section 2.18 Water Storage, for any new residential building, visitor accommodation unit, or addition to a residential building or visitor accommodation unit to apply across the entire Saturna Island Local Trust Area; and
d. Simplifying secondary suite provision 2.18.5 by deleting the reference to areas having moderate to high aquifer vulnerability to salt water intrusion.

CARRIED

SA-2024-036
It was Moved and Seconded,
that Saturna Island Local Trust Committee directs staff to schedule a Community Information Meeting on the Minor Amendments Housing Project at the January 2025 regular business meeting, and to advertise the meeting in the Saturna Scribbler.

CARRIED

Discussion ensued and support was expressed for waiting until after the Community Information Meeting to advertise for additional members for the Advisory Planning Commission. It was noted that a draft bylaw is still very malleable and after the Community Information Meeting the Local Trust Committee could direct staff to make changes.

15. REPORTS

15.1 Work Program Reports

15.1.1 Active Projects Report Dated Oct 2024

Received for information.

15.1.2 Future Projects Report Dated Oct 2024

Received for information.

15.2 Applications Report – Verbal Update

15.3 Trustee and Local Expense Report Dated July 2024

Received for information.

15.4 Adopted Policies and Standing Resolutions

15.5 Local Trust Committee Webpage

15.6 Islands Trust Conservancy Report Dated July 2024

Received for information.

16. NEW BUSINESS

16.1 Dark Sky Principles Adoption Advocacy Briefing

Discussion was held and support was expressed for waiting to see how the topic proceeds at Trust Council.

16.2 Phase 4 Community Engagement Options – Policy Statement Amendment Project (PSAP) - Staff Report

Discussion was held about the best way to engage the community on Saturna Island.

SA-2024-037
It was Moved and Seconded,
that Saturna Island Local Trust select Engagement Option 3 for Phase 4 community engagement about the new draft Islands Trust Policy Statement.

CARRIED

16.3 Local Trust Committee Compliance and Enforcement Policy – Staff Report

Bylaw Enforcement Manager Dingman reviewed the report and described the goal to provide a comprehensive compliance and enforcement policy that incorporates previous standing resolutions.

Discussion ensued and the following comments were made:

- Gratitude was expressed for the presence of bylaw enforcement when issues have arisen on Saturna
- Support was expressed for engaging the community about how to update the reference to short-term vacation rentals
- Support was expressed for drafting policy language related to short-term vacation rentals that could be presented following the Community Information Meeting in January
- A request was made for feedback in January about the degree to which other Local Trust Committees have made changes to the policy

- Generally, the reason a file has not been closed is because there is has not been compliance
- Responsiveness to respondents that are subject to complaint is rapid
- Part of the policy contains a provision for regular reporting to the Local Trust Committee on the status of complaints
- The Local Trust Committee establishes discretion by policy to give direction to bylaw officers to provide a minimum of 30 days notice prior to an investigation; the notice period is shorter in some cases that are outlined in the proposed Bylaw Compliance & Enforcement Policy
- Temporary Use Permit violations are investigated in a different manner which is stated within the proposed Bylaw Compliance and Enforcement policy to maintain consistency
- The proposed policy does not override a bylaw
- Support was expressed for including stronger language to explain that although the bylaw allows for a 24-hour notification period prior to an investigation, the policy instructs that notification should be at least 30 days (ie. "...and provide minimum of 30 days notice despite Saturna Island Land Use Bylaw 119 Section 1.4.2")

Consideration was raised about changing the Temporary Use Permit policy to a 24-hour notification period, and to drafting a land use bylaw and an enabling bylaw to enshrine the 30-day notification period. Staff agreed to present at the Community Information Meeting on options for bylaw enforcement regarding short term vacation rentals.

17. UPCOMING MEETINGS

17.1 Draft 2025-2026 LTC Meeting Schedule (for Adoption)

SA-2024-038
It was Moved and Seconded,
that Saturna Island Local Trust Committee adopt the 2025-2026 regular meeting schedule for the next fiscal year as proposed by staff.

CARRIED

18. TOWN HALL

Town hall was held and the following comments were made:

- The Community Information Meeting should be scheduled for a weekend so more people can attend; however, not many people came to a special meeting scheduled on a Saturday on Pender Island
- The Community Information Meeting should be electronic so people can join via Zoom
- The Community Information Meeting could be in person one day and via a Zoom a few days later

19. CLOSED MEETING (Distributed Under Separate Cover)

19.1 Motion to Close Meeting

SA-2024-039
It was Moved and Seconded,
that the meeting be closed to the public in accordance with the Community Charter, Part 4, Division 3, s. 90(1)(f) for the purpose of considering:

> (f) law enforcement, if the council considers that disclosure could reasonably be expected to harm the conduct of an investigation under or enforcement of an enactment;

AND that the recorder and staff attend the meeting.

CARRIED

19.2 Recall to Order

The meeting was recalled to order at 3:39 p.m.

19.3 Rise and Report – None

20. ADJOURNMENT

By general consent the meeting was adjourned at 3:39 p.m.

_____

David Maude, Chair

Certified Correct:

_____

Carly Bilney, Recorder

Print Date: January 8, 2025

Follow Up Action Report

Saturna Island

07-Nov-2024

Progress		Activity	Responsibility	Dates	Status
0%	1	9.1 July 18, 2024 LTC meeting minutes adopted as amended (amendment recorded in minutes)	Emily Bryant	Target: 21-Nov-2024	Completed
0%	2	13.1 PLDP20240229 (Anielski) - DP approved as presented, staff to issue permit and close file.	Jas Chonk Phil Testemale	Target: 21-Nov-2024	Completed
0%	3	14.1 Minor Housing Amendments Project: - Draft amending bylaw consistent with direction in Nov 7 staff report - BL-143 - Schedule a CIM for January meeting and advertise in Saturna Scribbler - Done - Review secondary suite mapping in more detail and provide recommendations	Brad Smith Emily Bryant Jas Chonk	Target: 22-Nov-2024	Completed
0%	4	16.2 Policy Statement Phase 4 Engagement - LTC selected Option 3 - staff to arrange CIM prior to regular meeting	Jason Youmans	Target: 21-Nov-2024	In Progress
0%	5	16.3 BL compliance and enforcement policy - Manager Dingman to present options around STVR policy at the January 16 LTC meeting as a CIM - staff to schedule CIM and advertise in Saturna Scribbler - Done	Jas Chonk Warren Dingman	Target: 28-Nov-2024	Completed
0%	6	17.1 2025/26 meeting schedule approved as presented	Emily Bryant Lisa Millard	Target: 28-Nov-2024	Completed

Cc: "Jessica WLRS:EX Doyle" <[redacted]>
Subject: Fwd: Salt Water Intrusion Mapping Saturna Island

Re: Secondary Suite Bylaw proposed changes

Please see correspondence from Dr. Diana Allen [redacted]

Begin forwarded message:

> **From:** Diana Allen <[redacted]>
> **Date:** November 29, 2024 at 2:24:11 PM PST
> **To:** Janet Land [redacted]
> **Cc:** Diana Allen [redacted]
> **Subject: Re: Salt Water Intrusion Mapping Saturna Island**
>
> Hi Janet
>
> I finally had some time to review the two approaches used to generate these two vulnerability maps.
>
> The report that describes the older map is attached - let's call it R1. I have highlighted a couple of paragraphs that I will explain below.
>
> The second report - let's call it R2 can be downloaded from https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-science-data/water-science-series
> The report was published in 2021 and is titled "GIS Modelling of Sea Water Intrusion Risk along British Columbia's Coast". Unfortunately, the website has been down for a few days. I have a draft copy of the report (but I cannot send it because it is not the published version).
>
> Below, I describe the differences between the two approaches used to generate the vulnerability maps. The grid cell size used for mapping differed. R1 used 25 m and R2 used 150 m. So, the resulting maps from R1 are more granular - finer detail.
>
> The vulnerability maps combine two things: 1) the susceptibility of the aquifer (determined from the distance to the coast and topographic slope) and 2) the hazard or threat (due to pumping).
>
> 1) Susceptibility - For R1, the ratings for "distance from the coast"

and "topographic slope" were ADDED together. The ratings range from 1-5 (Figure 15 in R1). Areas with a shallow slope where the grid cell on the map is close to the coast get a high rating, like 4 or 5. It's hard to see on Figure 15, but I think East Point has some red cells, which makes sense because the peninsula has low topographic slope and it is narrow. In second study, the rating scheme for bedrock aquifers was modified from Klassen and Allen (2016) (see Table 4 in R1). R2 used a matrix with the highest ranking of 5 being associated with slopes less than 1 degree and distance from the coast < 150 m. The steeper the slope and the further away from the coast, the ranking drops. Ultimately, if you compare Figure 13 a in R1 with Figure B3 in R2, there isn't much visible difference in the susceptibility ratings for East Point.

2) Pumping Threat - I think this is where the big difference lies. In R1, we used a point density method - that is, how many wells lie within a neighbourhood of a cell. The density of wells was used to represent this pumping threat (see Table 2 in R1). East Point ends up with a high rating of 5 (see Figure 6b in R1).

In R2, the authors state (section 3.4 on pumping threat) "...we did not to use well density to infer Pumping Threat as Klassen and Allen (2016) did for the Gulf Islands because of the wide range of groundwater use along BC's coast. Instead, we relied on information on pumping rate to inform Pumping Threat. Total pumping within a grid area was inferred from various sources...." They also made some adjustments (scaling). Table 7 in R2 shows the ratings assigned to pumping rates. The pumping rate for domestic wells is < 2 m3/day. The Pumping Threat rating ranges from 1 to a maximum of 5. For grid cells that did not have any reported wells (pumping of <2 m3/day), a pumping threat rating of "1" was assigned to the grid cell. If you look at Figure B6, East point ends up with a rating of 3 (mostly) with a portion with a rating of 4 - yellow and orange, respectively. So, no red.

So, how pumping threat was assessed is the difference between the two approaches. In R2, they needed a pumping threat matrix (Table 7) that could go all the way up to wells pumping at > 10,000 m3/day due to the large number of big wells throughout coastal BC. In our study, we only focused on the Gulf Islands, so places like East Point ended up with the highest ratings.

Ultimately, I don't think the new maps are giving an accurate picture of the pumping threat, and thus vulnerability, of the Gulf Islands Aquifers. The maps may be reasonable for the entire coastal BC region, but they downplay the vulnerability in the Gulf

Islands because there are no big pumping rates.

I hope this helps.

Diana M Allen
Professor
Department of Earth Sciences
Simon Fraser University
[redacted]

On Nov 13, 2024, at 3:15 PM, Diana Allen [redacted] wrote:

Hi Janet
Yes, I am familiar with both maps. The original one was from our research and the updated one was done by consultants (I was on the advisory board). Slightly different approaches were used. Notably, the new one is for all of the south coastal region of BC so the scale applied to low, moderate, high… is different than our original scale for just the southern GI. It makes areas mapped as moderate to high seem not as bad when compared to other regions.

My feeling is that our original one is more representative of conditions on the islands, particularly Saturna. We know that the well density is high on East Point and that here are high salinities, so it should be rated very high in my view.

I would have to dig into both reports to find the specific differences in the approaches, if that is needed.

Diana M Allen
Professor
[redacted]

On Nov 13, 2024, at 9:41 AM, Janet Land [redacted] wrote:

Hi Diana,

The current bylaw prohibits secondary suites in areas of moderate to high aquifer vulnerability to salt water intrusion. The Islands Trust is now proposing the following changes to this bylaw.

"Simplify secondary suite provisions 2.18.5 by deleting the reference to areas having moderate to high aquifer vulnerability and
Revising the associated Schedule E Secondary Suites map in consideration of updated 2022 provincial saltwater intrusion mapping"

The original secondary suites map
[image3.jpeg]

"Updated provincial mapping"
[image4.jpeg]

I would very much appreciate your comments on these proposed changes to the bylaw and specifically which map best represents the risk of salt water intrusion at East Point since they are very different. Or perhaps there is another map that is more accurate?

Sincerely,

Janet Land

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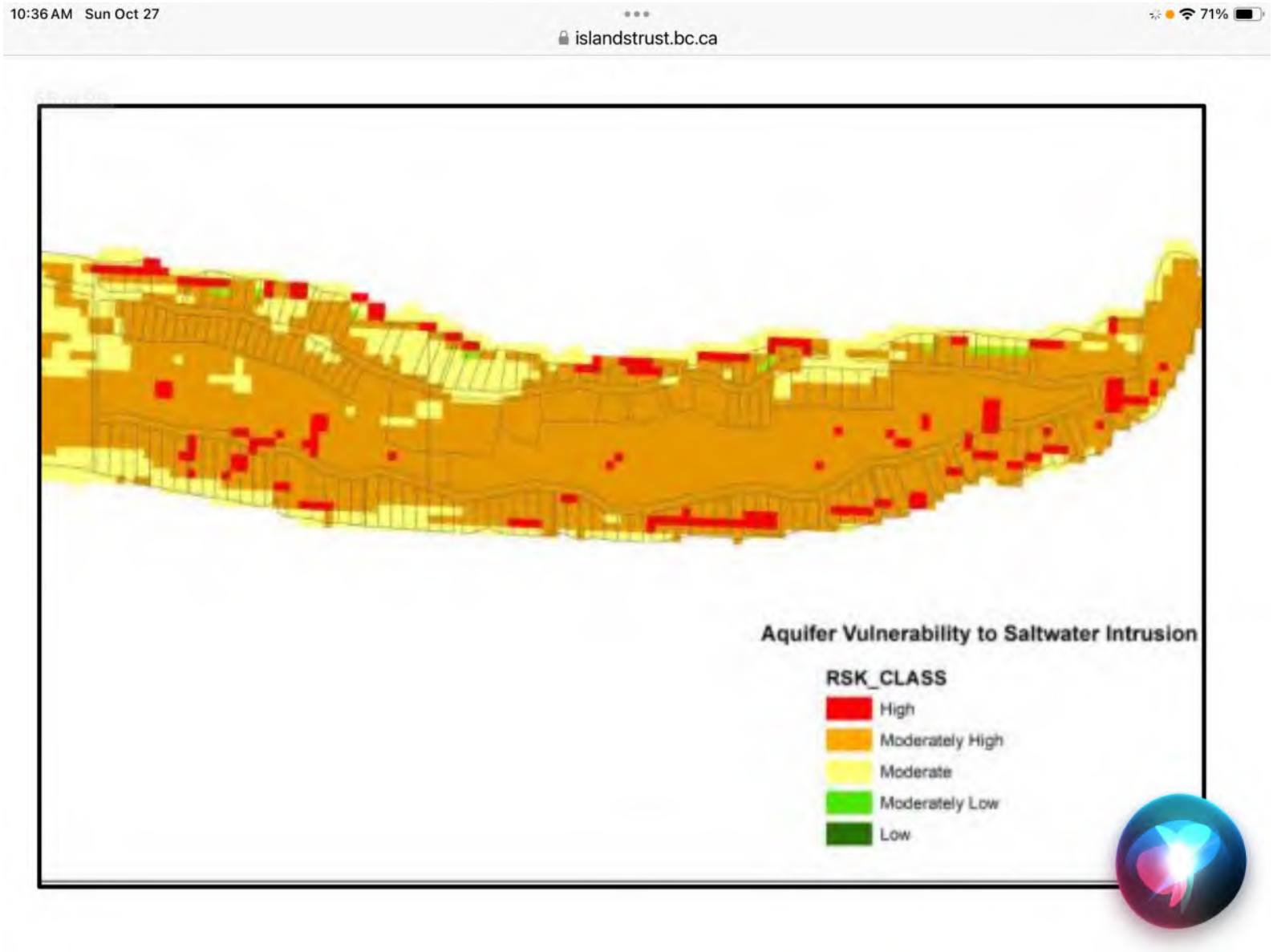
<image4.jpeg>

image3.jpeg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islandstrust.bc.ca
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Aquifer Vulnerability to Saltwater Intrusion
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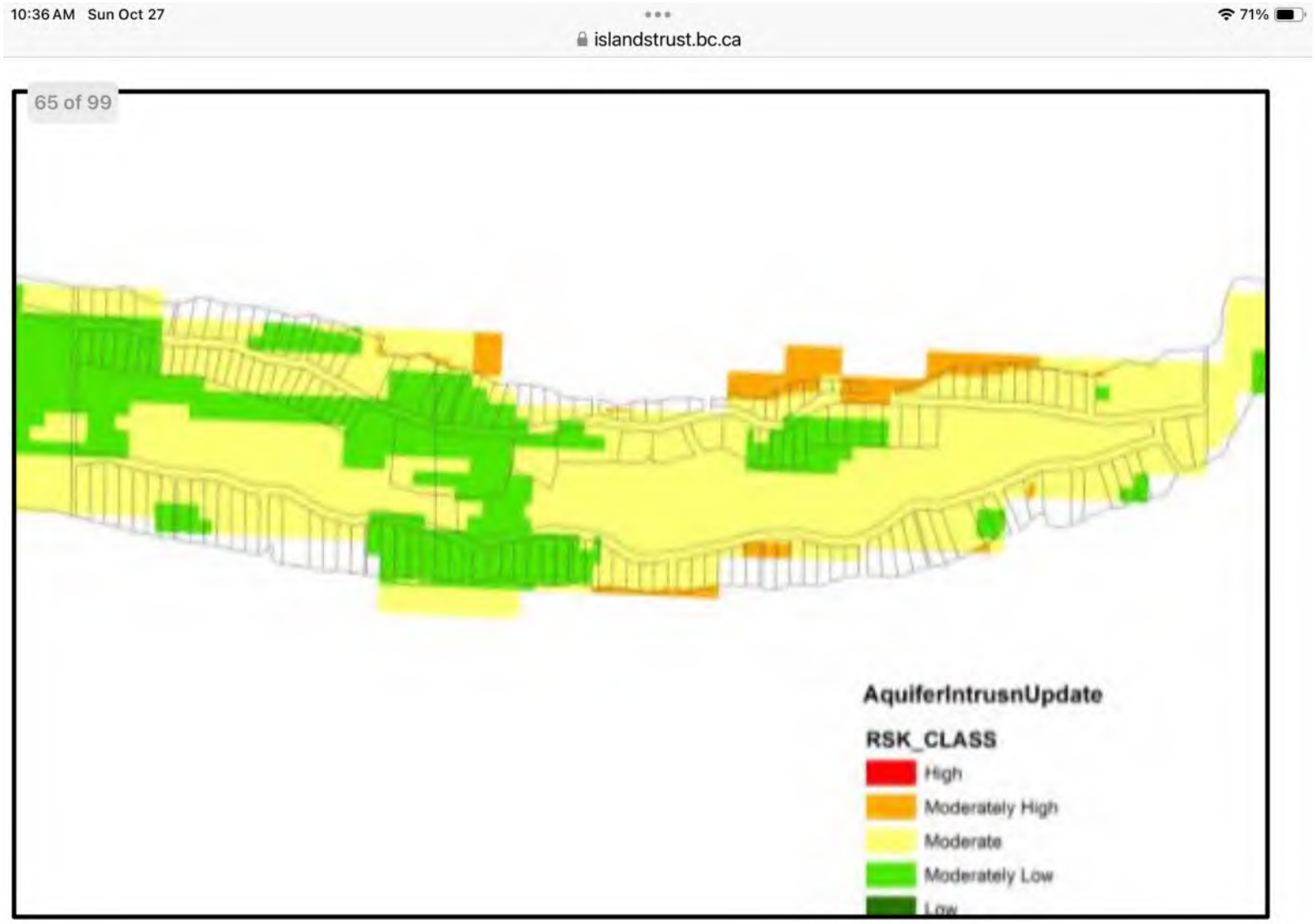
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Department of Earth Sciences
Simon Fraser University

Risk of Saltwater Intrusion in Coastal Bedrock Aquifers: Gulf Islands, BC

An overview of the assessment of risk of saltwater intrusion in the bedrock aquifers of the Gulf Islands completed as part of a study conducted by Simon Fraser University and BC Ministry of Forests, Lands and Natural Resource Operations as part of a project "Risk Assessment Framework for Coastal Bedrock Aquifers"

Jeanette Klassen (M.Sc.) and Diana M. Allen (Ph.D)

Department of Earth Sciences, Simon Fraser University

January 2016

Table of Contents

1 Introduction

Simon Fraser University is conducting a study "Risk Assessment Framework for Coastal Bedrock Aquifers" in collaboration with BC Ministry of Environment and the BC Ministry of Forests, Lands and Natural Resource Operations. The project is funded by Natural Resources Canada under the "Enhancing Competitiveness in a Changing Climate" program.

Unlike other water quality risk assessment methodologies used for source water protection that focus on chemical hazards related to contaminants that may be related to land use (agriculture, spills), the more important hazard in coastal aquifers is contamination associated with salinization. Salinization can occur from multiple directions: from above due to inundation or storm surge, laterally due to encroachment of the freshwater/saltwater interface, and from below due to upconing of saline groundwater due to pumping. Because of the diverse pathways of contamination in coastal aquifers, a different approach is required for conceptualize and assess risk to the aquifer.

The overall aim of the study is to develop a risk assessment methodology for source-water protection purposes in coastal bedrock aquifers. The risk framework, highlighted in this report, was tested in the Gulf Islands in coastal British Columbia.

The research was carried out in three Phases. Phase 1 includes a characterization of the hydrogeological system and the various stressors and potential effects of climate change on this system. Phase 2 includes the development of the risk framework, and mapping hazards related to salinity that may be caused by a range of stressors. Phase 3 is involves knowledge translation to government to inform policy. There is overlap between the three phases.

This report is based on research carried out by Jeanette Klassen towards her MSc degree in the Department of Earth Sciences at Simon Fraser University (Klassen 2015). The report provides an overview of the risk assessment framework and the results of the risk mapping carried out in the Gulf Islands, British Columbia. Aspects of Ms. Klassen's MSc thesis related to assessing chemical indicators of saltwater intrusion are not included, but have been addressed in a companion report (Klassen et al. 2014). Two additional companion reports provide an overview of the hydrogeological system using Salt Spring Island as an example (Larocque et al. 2015), and a summary of the results of drilling, hydraulic testing and sampling (for water chemistry and isotopes) of the monitoring well on Salt Spring Island (Allen et al. 2015).

The scope of work reported upon herein includes:

1. Identifying and mapping the hazards (natural and anthropogenic) that may lead to saltwater intrusion (SWI);
2. Mapping the aquifer susceptibility to SWI;
3. Mapping the aquifer vulnerability to SWI and verifying against the chemical indicators of SWI;

4. Developing an approach to assess loss (consequence); and
5. Mapping the risk of SWI.

2 Coastal Aquifers

In coastal areas, freshwater aquifers are in direct contact with the ocean. The dense seawater typically circulates inland through the sediments or rock, creating a saline zone or "wedge" below the less dense overlying freshwater aquifer (Figure 1) (Bear et al. 1999). The contact between the freshwater and saltwater is referred to as the freshwater/saltwater interface. This interface may be sharp and characterized by an abrupt transition from freshwater to saltwater, but more commonly, it is transitional due to mixing and diffusion processes as shown in Figure 1 (Barlow 2013). Under natural conditions, fresh groundwater flows towards the ocean; flow of freshwater is predominantly driven by topography but is influenced by the aquifer hydraulic conductivity. The position of the freshwater/saltwater interface depends on the magnitude of freshwater discharge, which varies due to natural and anthropogenic factors by moving seaward if the hydraulic gradient increases, or moving landward if the hydraulic gradient decreases (USGS 2000). Changes in the hydraulic gradient impact the natural balance between the freshwater and saltwater.

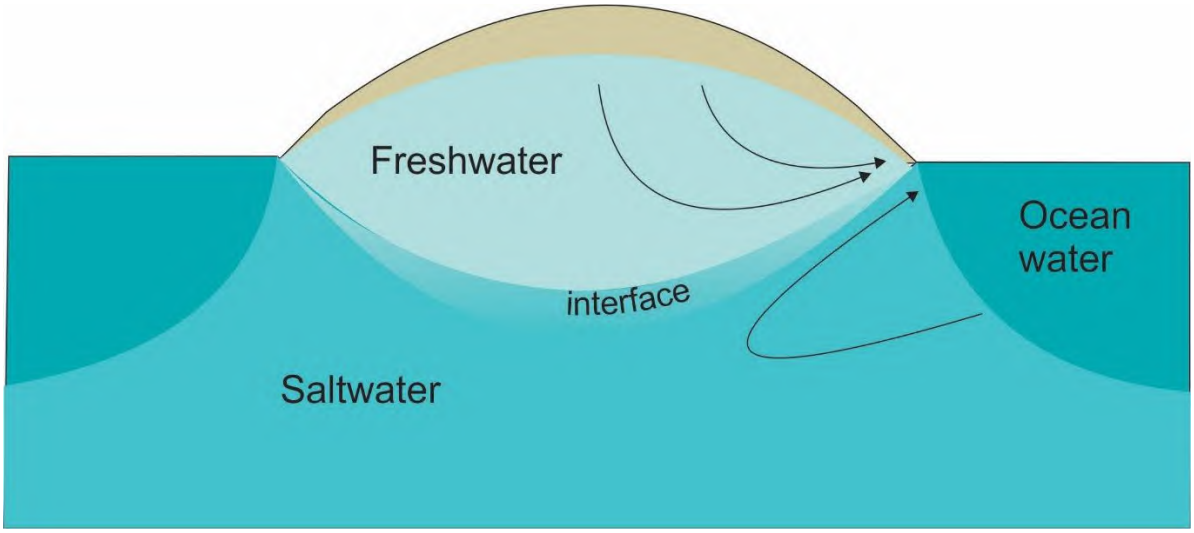

Figure 1. The freshwater/saltwater interface on an island. Freshwater floats on top of seawater due to its lower density. Note: The salinity distribution around the interface typically varies with depth.

Saltwater intrusion occurs when saltwater moves into a freshwater aquifer. In the context of coastal aquifers, technically this process is referred to as seawater intrusion, because "saltwater" can derive from different sources (i.e. septic effluent, landfill leachate, road salt). For the purpose of this study, the common term "saltwater intrusion" (SWI) is used.

One potential driver of SWI is sea level rise (Figure 2). Sea level is currently rising due to changes in atmospheric pressure, thermal expansion of oceans, and melting of ice caps and glaciers. Global sea level is predicted to rise up to 0.6 m by 2100 (Nicholls et al. 2007). A rise in sea level can lead to a

reduction in the hydraulic gradient; particularly in coastal aquifers that are constrained by topography (Michael et al. 2013). A reduction in recharge due to lower precipitation in a warming climate would also likely lead to SWI (Holding and Allen 2015a).

Storm surge is another hazard associated with coastal areas. Storm surge is an abnormal rise in sea level that is associated with a storm event (Danard et al. 2003). Storm surge causes land erosion and flooding; when the surface becomes flooded, the saltwater can infiltrate into the freshwater lens from the land surface and cause localized salinization (Figure 2). Storm surges vary in size based on the morphology of the coastline and the topography of the ocean floor (Stoltman et al. 2007; Debernard et al. 2002). The topography of the ocean floor influences storm surge because currents are obstructed by shallow waters and wave heights increase. The shape of the coastline may also increase the damage potential of storm surge because tidal energy can be focused, and wind and water funnelled to the shoreline (Romanowski 2010; Christiansen 2009).

SWI can also be exacerbated by pumping freshwater at high rates or by pumping numerous wells simultaneously (high well density locations) (Figure 2). Pumping can cause the freshwater/saltwater interface to move inland by reducing the natural gradient to the sea (USGS 2000). Other mechanisms leading to salinization include upconing from depth due to pumping (Reilly and Goodman 1985; Washington State Department of Ecology 2005) and localized intrusion by reversal of the hydraulic gradient near the well or well field (Fetter 2001). In fractured rock, saltwater has been shown to enter wells through discrete fractures (Allen et al. 2002).

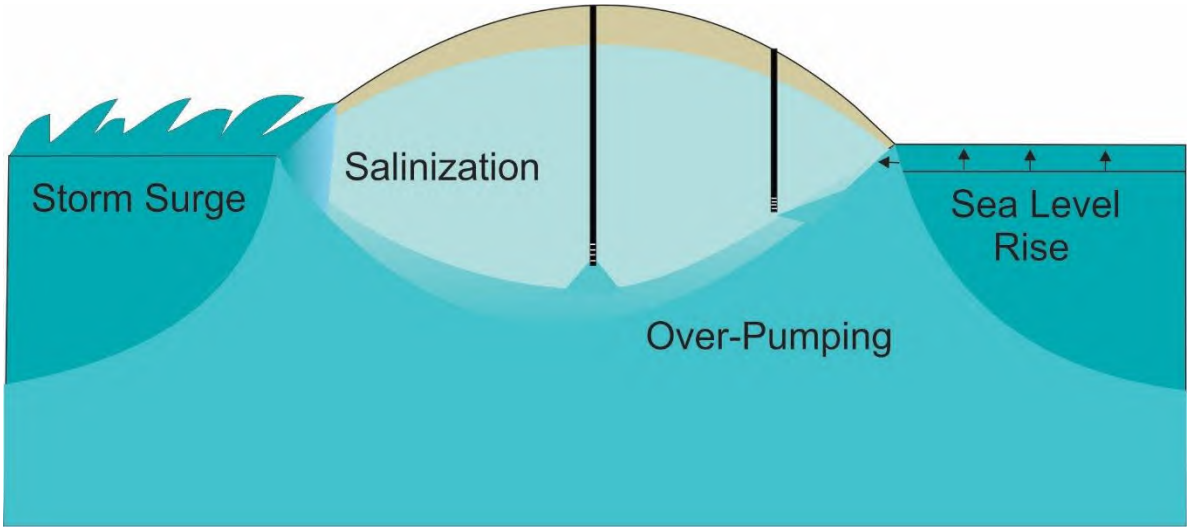

Figure 2. Salinization due to sea level rise, storm surge and over-pumping of groundwater by pumping.

3 The Study Area: The Gulf Islands, BC

The Gulf Islands are located in the Strait of Georgia, between Vancouver Island and the mainland of British Columbia (Figure 3). Locally, there are a few natural lakes on the islands, some of which support domestic and agricultural use. But the majority of residents use groundwater from the fractured

bedrock aquifers as their primary source of freshwater (Denny et al. 2007). The quality of groundwater on the Gulf Islands has been impacted locally by several sources, both natural (i.e. arsenic, manganese, iron) and anthropogenic contaminants (improper disposal of agricultural waste, failed septic systems, pesticides) and saltwater intrusion (Denny et al. 2007). During the summer months, when precipitation is low and water demand is high, the groundwater levels decline and the quality of the water can deteriorate (Allen and Suchy 2001).

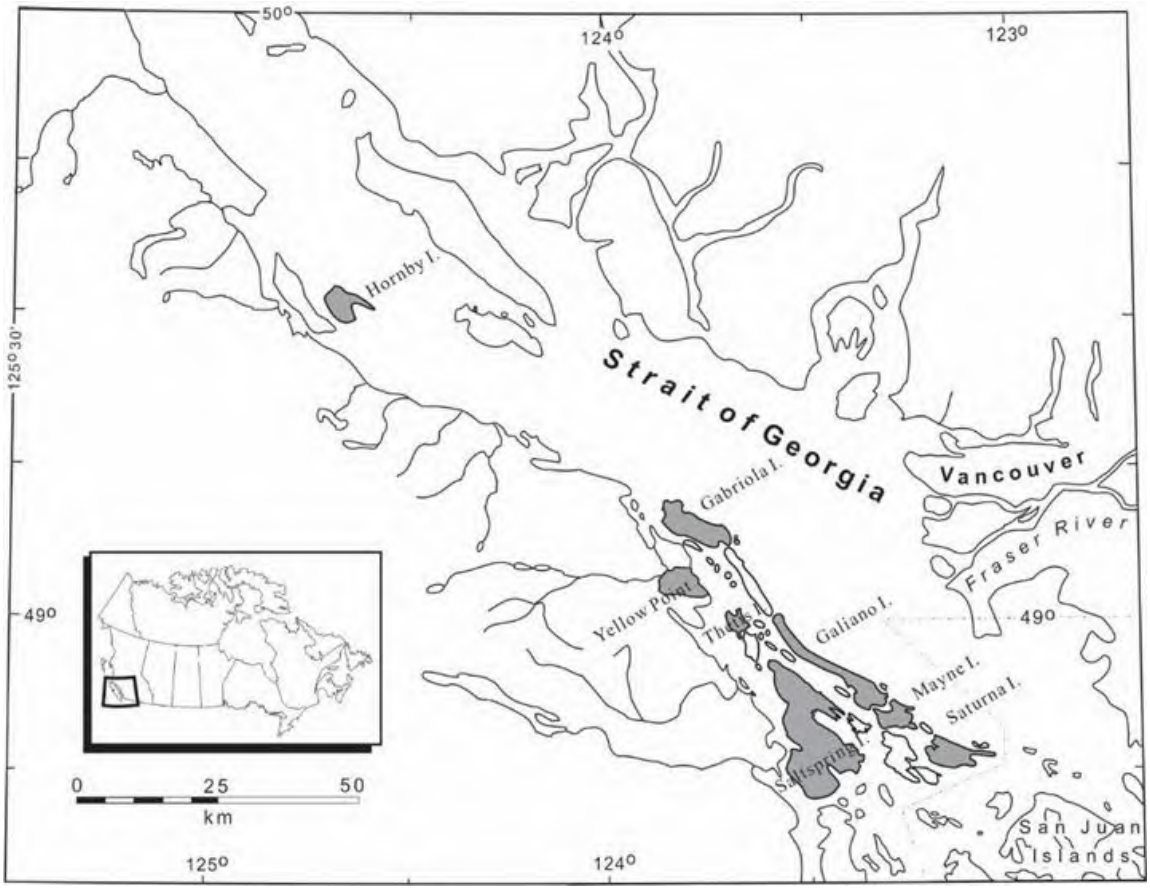

Figure 3. The Gulf Islands, British Columbia. Islands shown in grey have groundwater chemistry data that were used for verifying the results of the aquifer vulnerability assessment.

Surficial materials comprise glacial and/or marine sediments, but form only a thin veneer over the bedrock in most areas. However, these surficial materials may have a significant control on recharge (Denny et al. 2007). The bedrock comprises Paleozoic to Jurassic igneous and sedimentary rocks (Wrangellia Terrain) present only on Salt Spring Island, and Upper Cretaceous rocks of marine origin which form the Nanaimo Group present on all the islands (Denny et al. 2007). The Nanaimo Group consists of interbedded sandstone, shale (mudstone) and some conglomerate (Mustard 1994). During the Eocene, the Nanaimo Group was compressed into a fold and thrust belt and was uplifted and eroded during the Neogene (Mustard 1994). Due to the structural history of the Nanaimo Group, fractures and faults are present throughout the islands at a local and a regional scale (Journeay and Morrison 1999). Hydrogeologically, fractures and faults represent zones of high permeability due to the high density of fracturing, and influence groundwater flow at different scales (Surrette and Allen 2008; Surrette et al.

2008). This fracturing results in a complex groundwater flow system which is more influenced by structure than lithology and stratigraphy (Allen et al. 2003). Consequently, the bedrock aquifers in the Gulf Islands have been divided based on hydrostructural domains (Mackie 2002), which are identified based on their relative permeability. The sandstone-dominant and mudstone-dominant formations of the Nanaimo Group (and the older Wrangellian rocks) have similar hydraulic properties based on discrete fracture network modeling (Surrette and Allen 2012) and aquifer testing (Larocque 2014), and are conceptualized as equivalent porous media, while the fault and fracture zones tend to be more permeable and influence flow at a larger scale (Surrette and Allen 2008).

During the Pleistocene, the Gulf Islands underwent regional depression due to the weight of the overlying glaciers. The land surface was depressed by as much as 300 m below present sea level (Clague 1983). During the period of submersion below sea level (approximately 500-1000 years), there was sufficient time for seawater to intrude into the bedrock aquifers (Allen and Liteanu 2006). Following rebound of the islands, fresh groundwater has gradually displaced the conservative and mobile chloride (Cl) (Allen and Liteanu 2006), but sodium (Na) has been left behind on the clay exchange sites within the mudstone units; these mudstones exist both as massive mudstone, but also as mudstone interbeds within the coarser-grained sandstone. As a result of these geological processes, the groundwater on the Gulf Islands has undergone a chemical evolution (see Klassen et al. 2015 for more details on the groundwater chemistry evolution), which results in groundwater compositions varying spatially due to natural processes.

Saltwater intrusion has been observed on the Gulf Islands, particularly in coastal wells that have been drilled to depths at or near the saltwater interface or in wells where pumping either draws in seawater laterally or from below (upconing). Mixing with seawater can also occur along discrete fractures that connect a well to the ocean (Allen et al. 2002). A complicating factor on the Gulf Islands is that while the Cl originating from submergence is thought to have been flushed from these rocks (Allen and Liteanu 2006), some Cl-rich water may be present in areas or at depths where the rocks were not sufficiently flushed. This means that it is difficult to determine if salinization is due to saltwater intrusion or simply trapped seawater dating back to the late Pleistocene (see Klassen et al. 2015 for the detailed geochemistry results as well as a discussion of indicators of salinity).

4 Overview of the Risk Assessment Framework

Risk assessments determine the risk (probability of a harmful event and its potential consequence/loss) by analysing the potential hazards and the vulnerability of a region. Quantitative risk assessment requires calculations of two components of risk (R): the magnitude of the potential loss (L) and the probability (p) or likelihood that the loss will occur:

$$Risk\ (R_i) = L_i * p\ (L_i) \qquad \text{(Eq. 1)}$$

where the subscript *i* relates to a specific hazard. The total risk is expressed as:

$$Risk_{total} = \sum R_i \quad \text{(Eq. 2)}$$

Simpson et al. (2014) defined risk to groundwater quality due to chemical contamination originating at the land surface as:

$$Risk\ (R_H) = Vulnerability\ (V_H) * Loss\ (L) \quad \text{(Eq. 3)}$$

This equation differs slightly from Equation 1 in that the probability is embedded in the Vulnerability (V_H) term. Simpson et al. (2014) calculated the spatial risk to groundwater quality (according to Equation 3) using maps of aquifer vulnerability and potential loss. Vulnerability included aquifer susceptibility and hazard threat, and the probability of occurrence was attached to each hazard threat (Simpson et al. 2014):

$$Vulnerability\ (V_H) = aquifer\ susceptability\ (S_A) * hazard\ threat\ (T_H) \quad \text{(Eq. 4)}$$

Holding and Allen (2015a) adapted the risk assessment approach for use in small islands. Using the results of a chemical hazard and water use survey, risk to water security was assessed on Andros Island, The Bahamas. Risk due to climate change, encompassing sea level rise, storm surge and a reduction to recharge was also assessed. The approach outlined in this report follows a similar framework as Holding and Allen (2015a) as shown in Figure 4. Aquifer susceptibility is assessed based on specific metrics that may be more suitable for identifying areas that are more susceptible to SWI (distance to coast and topographic slope) rather than according to the aquifer properties that reflect the ease of infiltration of chemical contaminants at surface as conceptualized in traditional aquifer vulnerability mapping. Various hazards related only to salinization (sea level rise (SLR), storm surge, pumping) are then superimposed to assess the aquifer vulnerability. Risk is assessed by considering the consequence of the loss of the groundwater supply. The mapping is carried out in ArcGIS 10 ©.

Each component of the risk assessment is discussed briefly below using examples from the literature that describe how each can potentially be assessed.

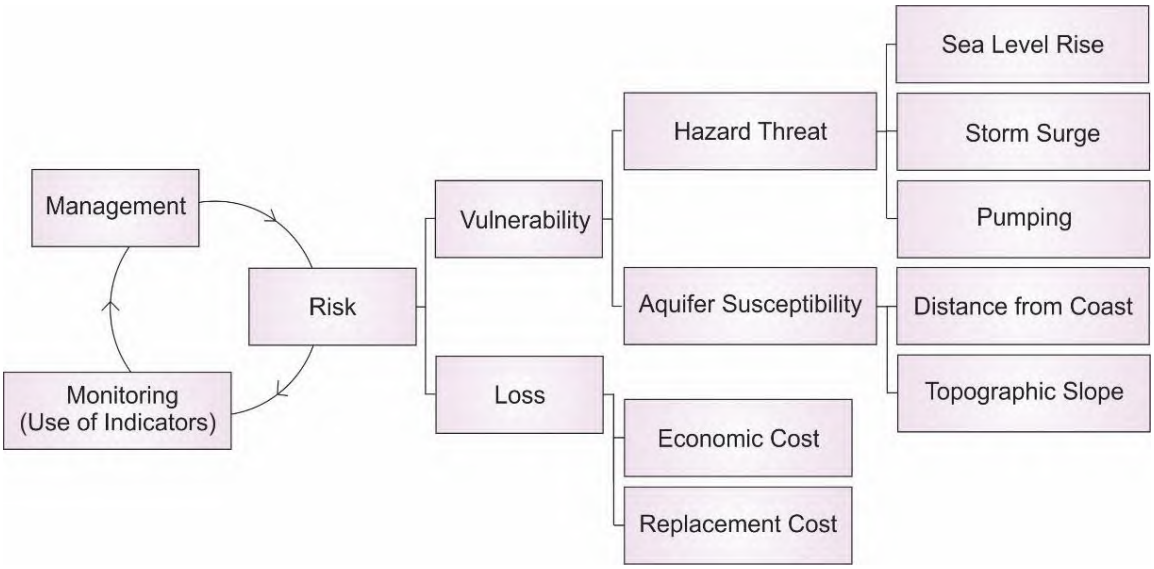

Figure 4. Risk Assessment Framework for coastal aquifers (adapted from Holding and Allen 2015a)

4.1.1 Hazard Threat

In the context of coastal aquifers, hazard threats are related to natural phenomena, specifically coastal hazards, such as SLR and storm surge, and human stressors such as over-pumping. As mentioned above, the position of the freshwater/saltwater interface depends on the magnitude of freshwater discharge, moving seaward if the hydraulic gradient increases, or moving landward if the hydraulic gradient decreases (USGS 2000). This interface can be controlled by natural processes; either a rise in sea level which can push the interface landward, or reduced recharge which permits the interface to move landward. In addition to SLR, tides and storms can result in overtopping or flooding of the land surface by seawater (Holding and Allen 2015b).

Flood hazard maps can be generated to show areas potentially at risk of inundation from SLR and storm surge. In past studies, estimating the flood hazard associated with tides and storms was based on a stationary mean sea level and coastal flood construction level was based on a natural boundary of 1.5 m. The natural boundary represents where the action of water is so common that it begins to leave its mark on soil or edges of the water; for coastal areas the natural boundary is the natural limit of permanent terrestrial vegetation (Auscenco Sandwell 2001). This approach has become problematic because SLR is already occurring, and it is believed that the rate of SLR will increase in the future (Kerr Wood Leidal (KWL) 2011; Nicholls et al. 2007). Therefore, determining a natural (static) boundary has become an inefficient guideline for land use planning and developing floodplain bylaws (KWL 2011). According the new guidelines and specifications for Coastal Floodplain Mapping (KWL 2011), coastal flooding is due to high tides, storms and tsunamis. The new procedures for floodplain mapping incorporate a combination of parameters; 1) higher high water large tide, 2) allowance for future SLR (1 m by 2100 and 2 m by 2200), 3) estimated storm surge (changes in atmospheric pressure, effects of

strong winds blowing over water surface, waves, changes in ocean currents or temperature), 4) estimated wave effect associated with storms (flooding and erosion) and 5) freeboard (0.6 m of uncertainty) (Ausenco Sandwell, 2011).

Coastal morphology and local wind set-up also influence water levels along coastal regions. Winds may generate local surge in water depths less than 30 m (Ausenco Sandwell 2011). In small areas, such as bays, tidal energy is focused, and wind and water are funnelled to the shoreline. This funnelling of water may cause the local sea level to rise significantly higher than expected (Romanowski 2010). Local surge is typically only generated when there is a substantial body of shallow water depth (<30 m) in front of a shoreline (KWL 2011).

Over-pumping in coastal aquifers represents a significant hazard to groundwater quality because it can cause SWI. SWI can impact an individual well because 1) the well is situated too close to the coast, 2) it is too deep, 3) it pumped at too high a rate, or 4) a combination of two or more of these factors. SWI, however, can impact an aquifer, thereby degrading the freshwater supply. Such larger scale impacts may be caused by a single well for the reasons above, but more often it is caused by concentrated pumping in a location where the well density is too high to be sustained by the amount of recharge received. Kennedy (2012) used civic point (residential density) in a GIS based approach for assessing relative SWI vulnerability in Nova Scotia. Holding and Allen (2015a) assessed water demand hazards on a property by property basis.

4.1.2 Aquifer Susceptibility

The term “aquifer vulnerability” is often used interchangeably with “aquifer susceptibility”. In this report, the term “aquifer susceptibility” is used to describe whether or not the aquifer is susceptible to SWI. Aquifer susceptibility maps have been created for the Gulf Islands (Denny et al. 2007). These maps were constructed using the DRASTIC-Fm methodology (a modification of DRASTIC – Aller et al. 1987). DRASTIC-Fm is an acronym for the following parameters; (D) depth to water, (R) net recharge, (A) aquifer media, (S) soil media, (T) topography, (I) impact of vadose zone media or conductivity of vadose zone, (C) aquifer hydraulic conductivity, and (Fm) fractured media. The aquifer susceptibility mapping method was developed specifically to assess the intrinsic properties of the aquifer in relation to chemical contaminants that may be introduced at the land surface. As mentioned above, in coastal aquifers, salinization is one of the greatest threats to groundwater quality and this can occur from many directions: 1) surface (storm surge and inundation), 2) lateral intrusion due to SLR and pumping or 3) upconing from below due to pumping.

To address the multi-directional pathways for SWI, alternative approaches for mapping aquifer susceptibility in coastal regions are required. For example, Holding and Allen (2015a) mapped aquifer susceptibility based on the location of the freshwater lenses (FWLs) on Andros Island. They used numerical modeling to approximate the location and thickness of the FWLs, verifying the results using available data. If the lens was present and thick, it represented a viable long term source of freshwater

and therefore was susceptible to contamination. Areas with thin or no lenses, were considered less susceptible.

Kennedy (2012) used five parameters to characterize the vulnerability of coastal aquifers. The parameters include: 1) distance from the coastline, 2) topographic slope, 3) civic point (residential) density, 4) large groundwater users (daily non-domestic groundwater withdrawal rates) and 5) water level elevation relative to mean sea level (RMSL).

Erlandson (2014) used the DRASTIC-Fm maps for the Gulf Islands to rate the relative groundwater flux. The C (hydraulic conductivity) and Fm (fractured media) were combined into a composite C. Using two different approaches, Erlandson (2014) combined the composite C with the T (topography or slope) parameter to create a two relative groundwater flux maps. The first method used the topography parameter rating from the original DRASTIC methodology (Aller et al. 1987) and the second method used topography parameter ratings from the Nova Scotia based study (Kennedy 2012). The Fm parameter highly influenced the composite C (hydraulic conductivity) and, consequently, the groundwater flux values.

4.1.3 Loss

Loss can be evaluated in a variety of ways. For example, a risk assessment could consider economic consequences due to the contamination of groundwater supply, impacts to human health if a well is contaminated, or the consequences to ecological systems. In some cases, the contamination of a well impacts more than a single homeowner; for example, a water intensive business such as agriculture (Simpson et al. 2014), commercial developments related to tourism, or a water supply system which provides water to multiple dwellings in a subdivision or area. For agriculture, if no other water resource is available, the business may be required to shut down. For commercial development, rather than closing down, the owner may be required to import large amounts of water or install a rainwater collection system or water treatment facility.

Simpson et al. (2014) identified four potential sources of water if a well becomes contaminated; these include 1) hooking up to municipal water supply where available, 2) drilling a deeper well if the geology allows, 3) importing water, or 4) investing in another expensive long term solution such as water treatment or rainwater harvesting. For islands and coastal aquifers in general, drilling a deeper well will typically not yield freshwater, as saltwater lies below the freshwater lens. Although drilling deeper is not an option for coastal regions, there is the option to drill another shallower well on the same property. For individual homeowners or small businesses in the commercial or industrial sector these may be suitable options, but for larger businesses, such as those in the agricultural sector, they would be impractical.

5 Methodology

The risk assessment framework from Figure 4 was further refined to create a detailed risk assessment framework (Figure 5). This detailed risk assessment framework was used to develop a GIS based Risk Assessment Methodology for coastal aquifers. Details concerning how each variable was mapped and the results are provided in the following sections.

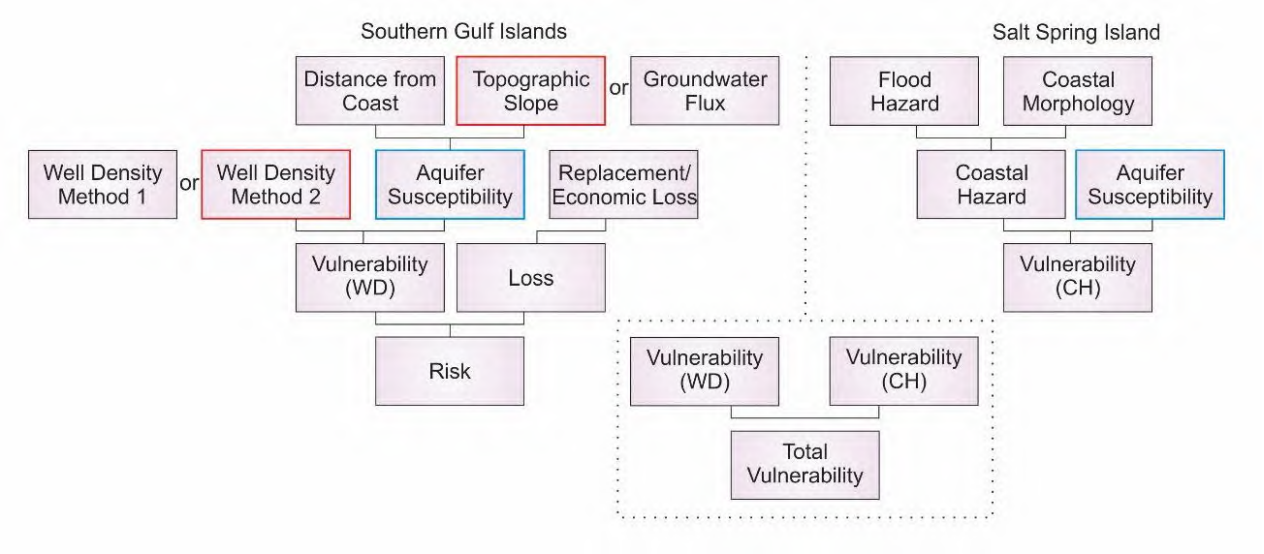

Figure 5. Risk assessment framework (modified from Figure 4). Red outlines indicate which parameter was chosen of the two options evaluated in the risk assessment. Blue outlines show results used in common. Two methods were used to calculate vulnerability (well density (WD) and coastal hazards (CH) - WD was applied to all southern Gulf Islands and CH was applied only to Salt Spring Island.

5.1 Hazard Threat

This section describes the methodologies employed to map hazard threats, and the results, including **pumping** and two **coastal hazards**: 1) flooding, which is associated with sea level rise, tidal fluctuations and storm surge, and 2) coastal morphology. Ultimately, the flood hazard map and coastal morphology map were merged in ArcGIS and rescaled (1 to 5) to create the coastal hazard map for naturally occurring stressors.

5.1.1 Pumping

Pumping was represented by creating a groundwater well density map in ArcGIS. A list of groundwater wells for the Gulf Islands was downloaded from the BC WELLS database (BC MoE 2014). In the province of BC, groundwater wells are reported on a voluntary basis, which results in the WELLS database being

incomplete[1]. When the WELLS Gulf Islands dataset was compared with the wells sampled for groundwater chemistry (see Klassen et al. 2014), 200 of 870 sampled wells were not reported in WELLS. There are also 69 water supply system wells (more than one connection). Therefore, the well dataset for this study was enlarged to include all of the sampled groundwater wells and the water supply systems wells. Wells were weighted 1 to 5 to represent low to high water use (relative rating) in order to take into consideration different potential pumping rates (Table 1). Water supply systems were further divided (and weighted) based on number of units/houses they supply. Water supply systems either obtain water through deep or shallow wells, surface water or combined. If a water supply system used surface water, it was assigned a value of 0.

Table 1. Designated weight for different well uses.

Weight	Well Use	
0	Abandoned	
0	Observation	
1	No Label	
1	Other	
1	Private Domestic	
1	Unknown Well Use	
2	Commercial/Industrial	
3	Irrigation	
(3-5)	Water Supply System	# Units
3	Water Supply System	n/a
3	Water Supply System	1
3	Water Supply System	2-14
4	Water Supply System	15-300
5	Water Supply System	301-10,000

Two methods were used to represent well density: Method 1 calculates the density of wells per grid cell (used by Kennedy 2012) and Method 2 calculates a magnitude per unit area from point features that fall within a neighbourhood around each cell (point density). Well density (for both methods) was assigned a rating according to Table 2.

Table 2. Rating table for well density (as described in Kennedy 2012)

Rating	Well Density
5	>20
4	10-20
3	5-10
2	1-5
1	0

[1] It is estimated that 30 percent of all wells in BC are NOT reported in WELLS. http://www.rdn.bc.ca/cms/wpattachments/wpID2501atID4277.pdf

Each method was evaluated based the relationship between the electrical conductivity (EC) indicator for sampled wells (see Klassen et al., 2014) and well density rating. Specifically, groundwater samples above the EC threshold values (95th and 90th percentile were plotted against the rating extracted from the well density map at the well point. Groundwater wells that have high EC values (above threshold) are more likely to experience SWI. As a result, they should coincide with a high well density rating.

Results of the two methods used to create well density maps for the southern Gulf Islands are shown in Figure 6a (Method 1: calculated the density per grid cell) and Figure 6b (Method 2: calculated according to point density).

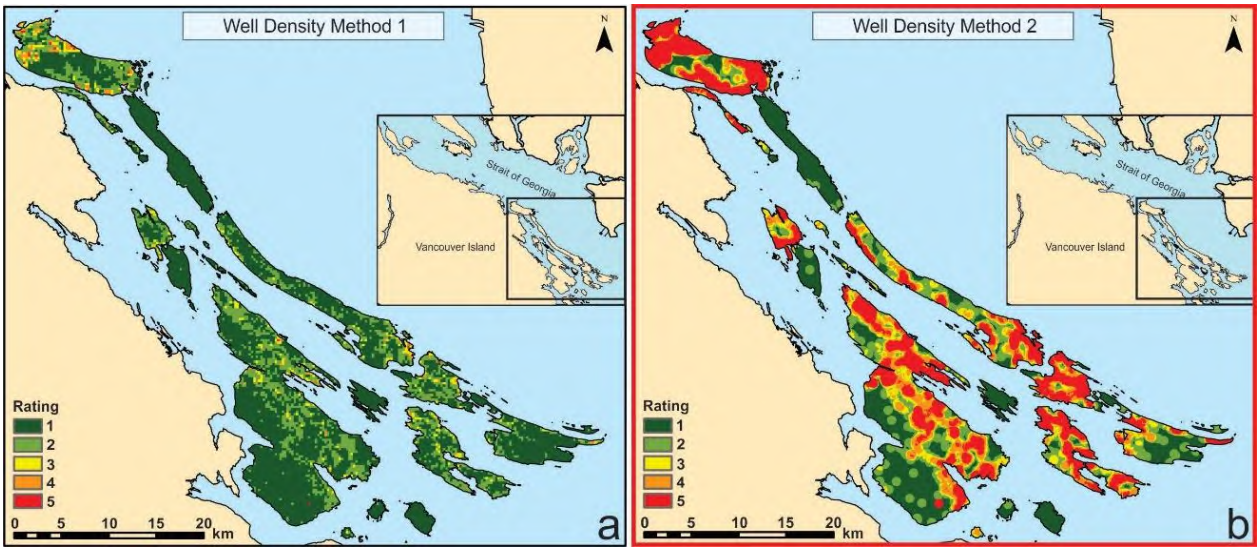

Figure 6. Comparison between (a) Well Density Method 1 and (b) Method 2 (red outline represents the method carried through to the risk assessment)

Well density ratings for sampled groundwater wells with EC above the two thresholds (95th and 90th percentiles) are summarized in Table 3. The well density rating for sampled groundwater wells in Method 1 are between 2 and 3 for both the 95th and 90th percentiles and have mean ratings of 2.6 and 2.7, respectively. Using Method 2, the majority of sampled groundwater wells have a rating of 5 and the mean ratings for the 95th and 90th percentiles are 4.5 and 4.6, respectively. Thus, the method carried through to the risk assessment is Method 2 because the high EC values tend to better coincide with cells with high well ratings. Moreover, Method 1 also has an inverse relationship between well rating and frequency of threshold exceedances; the most frequent rating is 2, and as the rating increases, the frequency decreases (Figure 7).

Table 3. Comparison between well density ratings for Method 1 and Method 2 for sampled groundwater wells with EC values above the 95th and 90th thresholds

Rating	Method 1				Method 2			
	95th Well Count	95th %	90th Well Count	90th %	95th Well Count	95th %	90th Well Count	90th %
1	0	0	0	0	0	0	0	0
2	15	51.7	28	50.9	3	10.3	4	7.3
3	11	37.9	19	34.5	1	3.4	2	3.6
4	3	10.3	6	10.9	3	10.3	4	7.3
5	0	0	2	3.6	22	75.9	45	81.8
Mean	**2.6**		**2.7**		**4.5**		**4.6**	

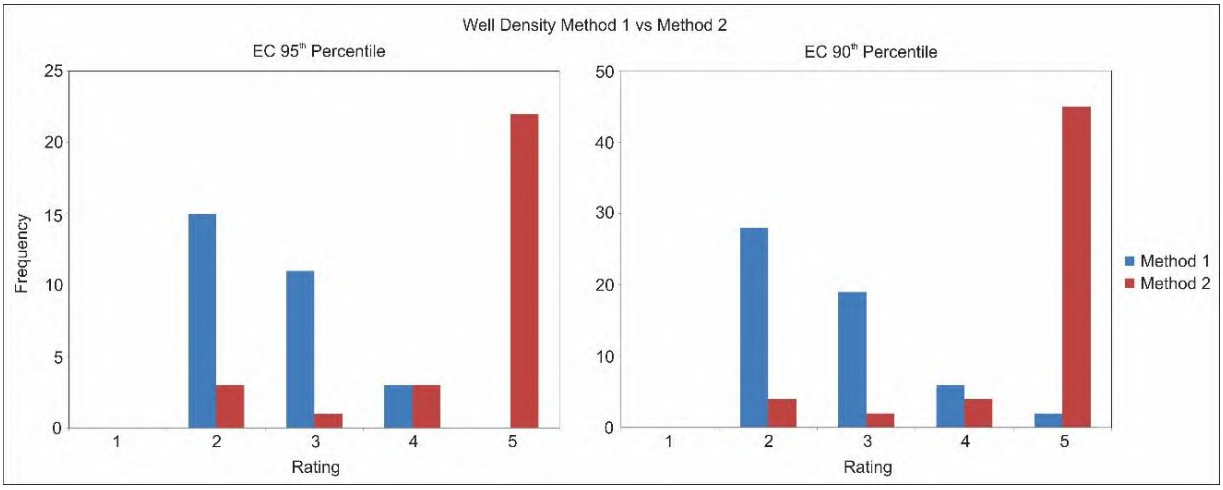

Figure 7. Frequency diagram used to compare well density calculated using Method 1 and Method 2

Limitations of both methods include the incomplete WELLS database. As a result, the well density maps may not be a true representation of the Gulf Islands. The sampled groundwater database is only a partial dataset (556 wells with both map rating and EC value, Hornby and Yellow Point samples, excluded) of the entire groundwater well database (8,754 wells). Finally, the sampled groundwater database may be biased; high salinity wells may have been abandoned and thus not included in the groundwater sampling study.

5.1.2 Coastal Hazards

5.1.2.1 Flood Hazard

Designated Flood Level (DFL) is the appropriate allowance for future sea level rise, tide and the total storm surge expected during the designated flood:

$$DFL = HHWLT + SLR + Storm\ Surge \quad \text{(Eq. 5)}$$

Highest high water large tide (HHWLT) is the average of the highest high water levels over approximately 19 years of data, and was obtained through the Canadian Hydrographic Service (CHS) for Fulford Harbour and Ganges Harbour (both tide gauges on Salt Spring Island). The average of the two tide gauges was used to represent the HHWLT on Salt Spring Island (Table 4). Mean and maximum sea level rise (SLR) projections were derived from Thomson et al. (2008). Regional adjustment was added to mean and maximum SLR projections to determine overall SLR (overall SLR is not shown in Table 4).

The storm surge component was assessed based on the results of an analysis of historical (Department of Fisheries and Oceans Canada (DFO) 2014) and predicted (Mike Foreman, direct communication) tide data for Fulford Harbour on Salt Spring Island (Klassen 2015). The residual (or storm surge) was calculated by subtracting the hourly predicted tide data from the hourly observed tide data. In total, there were 344,063 residual tide measurements, spanning from November 1952 to July 1992. These include positive and negative residuals. As the study focused on storm surge, only the 167,615 positive residuals were analyzed. Following the methodology employed by Tinis (2011) for residual tide data at Point Atkinson and Victoria, only residuals >20 cm at Fulford Harbour were considered. As a result, 26,021 positive (>20 cm) residuals were analyzed statistically. The observed the tidal range was 4.74 m (max = 4.33 m and min = -0.43 m) at Fulford Harbour. The predicted tidal range was 3.97 m (max = 3.74 m and min = -0.23 m). A frequency analysis for residuals >20 cm indicated that at Fulford Harbour, the 90th and 95th percentiles are 43 and 49 cm, respectively. The largest predicted tide was 3.74 m and the largest residual was 0.92 m. Therefore, the 95th percentile (49 cm) and maximum storm surge height (0.92 m) were carried through this analysis (Table 4).

Table 4. Summary of DFL components for Fulford Harbour and Ganges Harbour on Salt Spring Island

Location	HHWLT (m)	Mean SLR (m)	Max SLR (m)	Regional Adjustment (m)	95th Percentile Storm Surge (m)	Max Storm Surge (m)
Fulford Harbour	1.57	0.87	1.17	-0.119	0.49	0.92
Ganges Harbour	1.57	0.87	1.17	-0.119	0.49	0.92
Salt Spring Island Average	1.57	0.87	1.17	-0.1	0.49	0.92

Combinations of SLR (mean and maximum) and storm surge (95th percentile and maximum) were added to HHWLT to determine a range in DFL values, which were then assigned a ranking from 1 to 5 (Table 5). The lowest DFL is the most conservative and is assigned the highest rating because it is most likely to occur, whereas the largest DFL is the least likely to occur and therefore has the smallest rating.

Uncertainty, therefore, was incorporated into the hazard rating, resulting in a hazard threat of greater magnitude having an overall lower rating than a hazard threat of smaller magnitude.

Table 5. Rating table for Flood Hazard Map

Rating	SLR	Storm Surge	DFL (m)
5	Mean	95th Percentile	<2.8
4	Max	95th Percentile	2.8-3.1
3	Mean	Max	3.1-3.2
2	Max	Max	3.2-3.5
1	Max	Max	>3.5

The DFL values were then represented in ArcGIS using topographic data. The topographic data available for the Gulf Islands includes a LiDAR map (resolution 2 m grid) (Bednarski and Rogers 2012) and a Canadian Digital Elevation Model (CDEM) (25 m grid) (Natural Resource Canada). Because the magnitude of the DFL is small relative to the resolution of the topographic data, the DFL could only be represented for islands with LiDAR data. Of the islands with LiDAR data, Salt Spring Island was the only island with a tidal station with projected SLR, calculated HHWLT and an analysis of historical storm surge. Therefore, coastal hazards were only mapped for Salt Spring Island.

5.1.2.2 Coastal Morphology

The coastal morphology hazard map is intended to capture a greater range of hazards than simply those related to DFL. The parameters included in the coastal morphology map are: 1) depth of ocean, and 2) distance from coast seaward in combination with either the DFL (from the previous section) or the Flood Construction Level (FCL). These parameters were chosen because ground topography influences where inundation will occur (shallow vs steep coastlines), and ocean floor topography and coast morphology influence where and if funnelling of water will occur.

To generate the depth of ocean map, bathymetry data (Carignan et al. 2013) were contoured using a 30 m interval. To represent distance from coast, a 200 m buffer was created along the coast. FCL represents a more extreme DFL:

$$FCL = DFL + Wave\ Effect\ and\ Freeboard \quad \text{(Eq. 6)}$$

Flood construction level adds a wave effect and freeboard to the DFL. Wave effect includes wave run up during a storm event, and freeboard accounts for uncertainties associated with estimation of the calculated water level. For this study, the maximum DFL from the flood hazard map was used. DFL and FCL, associated with coastal topography, were represented in ArcGIS using the available LiDAR data.

Ratings from 1 to 5 were assigned to the coastal morphology map based on combinations of water depth (<30 m), distance from coast (> or < 200 m), and coastal topography (DFL and FCL) (as summarized in Table 6). A high rating (4 or 5) was assigned if there is a substantial body of shallow water

(<30 m depth at a distance >200 m from coastline) along a shallow sloping coastline where inundation would occur (DFL or FCL). The area between the shoreline and DFL was assigned a 5, and the area between the DFL and FCL was assigned a 4 because the DFL was the smaller elevation and therefore more likely to occur (Figure 8).

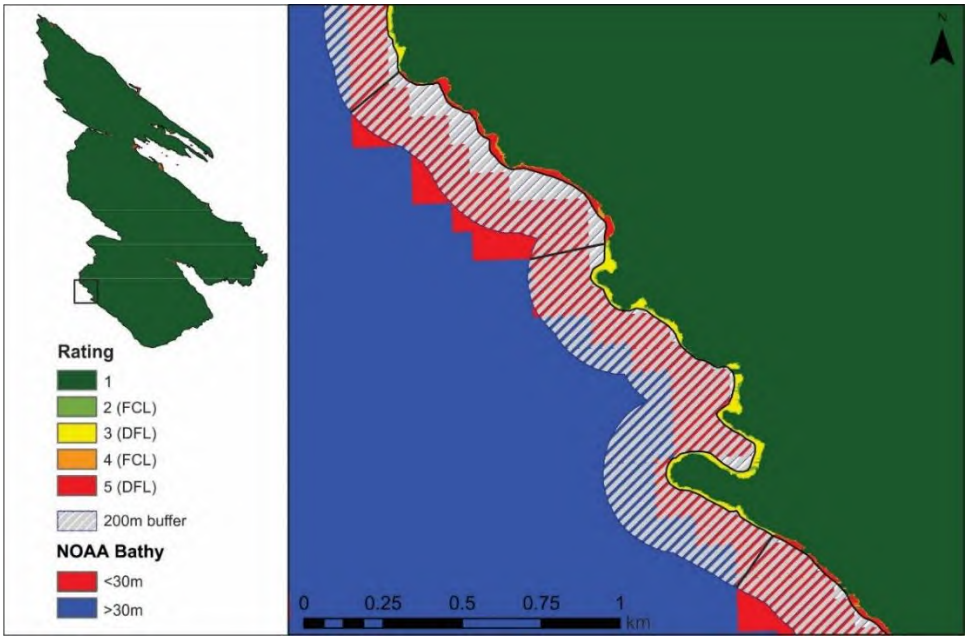

Figure 8. Illustration of how ratings were assigned for coastal morphology

Table 6. Rating table for the Coastal Morphology Map

Rating	Combination
5	<30m water depth at distance >200m beside DFL coastal zone
4	<30m water depth at distance >200m beside FCL coastal zone
3	<30m water depth at distance <200m beside DFL coastal zone
2	<30m water depth at distance <200m beside FCL coastal zone
1	<30m water depth at distance <200m beside steep coastline

5.1.2.3 Coastal Hazard Map

The flood hazard map and coastal morphology map were added together to create the coastal hazards map; all maps are shown in Figure 9. Although the coastal hazard map has a very low rating, there are several regions that are characterized by high ratings, such as around Ganges Harbour and Long Harbour on Salt Spring Island.

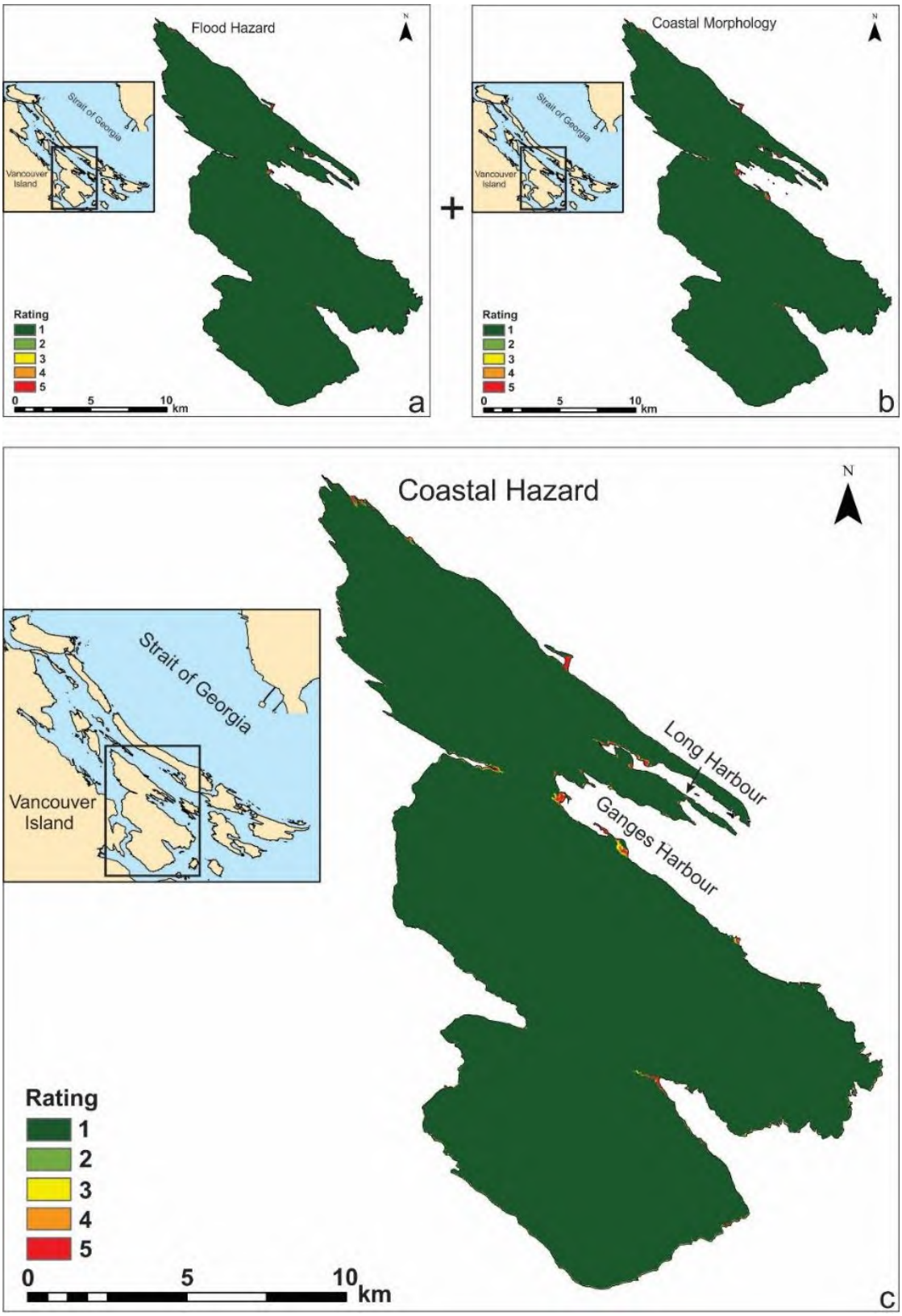

Figure 9. Maps of a) flood hazard, b) coastal morphology and c) resulting coast hazard

The coastal hazards map was overlain on a land use map for Salt Spring Island (Figure 10) to show the impacts of flooding and storm surge. Arrows point to regions where inundation may occur in agricultural, commercial, community and residential areas.

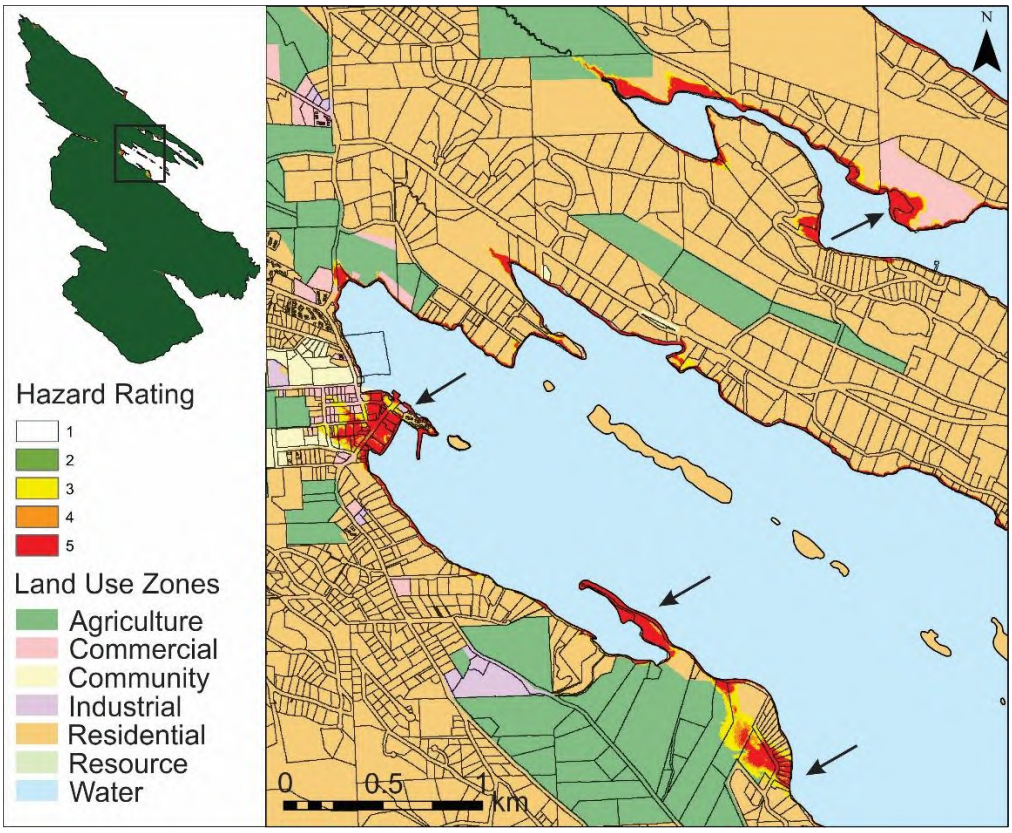

Figure 10. Overlay of coastal hazards onto land use zones near Ganges Harbour, Salt Spring Island

5.2 Aquifer Susceptibility to Saltwater Intrusion

Theoretically, under natural conditions, the freshwater-saltwater interface will extend inland from the coast such that areas closer to the coast will be more likely to become contaminated by saltwater should some disturbance (such as pumping or sea level rise) occur. Similarly, the interface is shallower closer to the coast. Thus, distance from the coast is an important parameter to consider in a SWI aquifer susceptibility map. The position of the saltwater interface is largely determined by the groundwater flux. Where the groundwater flux (from inland to the coast) is high (such as in steep topography), the interface will be closer to coast, whereas if the flux is low (such as in low topography terrain), the interface may be further inland. Therefore, either topography itself or some representation of the flux is important to consider in an aquifer susceptibility to SWI map.

Thus, to characterize aquifer susceptibility to SWI in this study, two parameters were used: 1) distance from coast (Kennedy 2012) and 2) either topographic slope (Kennedy 2012) or groundwater flux (combination of hydraulic conductivity and topography) (Erlandson 2014). Ultimately, distance from coast is added to topographic slope/groundwater flux (depending on which best represents the groundwater chemistry) to create the aquifer susceptibility map.

5.2.1 Distance from Coast

The distance from coast map was created by generating buffers at the assigned distances from the coast in Table 7 and assigned a rating from 1 to 5 based on Kennedy (2012). The distance from coast map is shown in Figure 11. With an increased distance inland, the rating decreases.

Table 7 Rating table for distance from coast (based on Kennedy 2012)

Rating	Distance from Coast (m)
5	0 - 50
4	50 - 250
3	250 – 500
2	500 – 1000
1	1000 - 1500
0	>1500

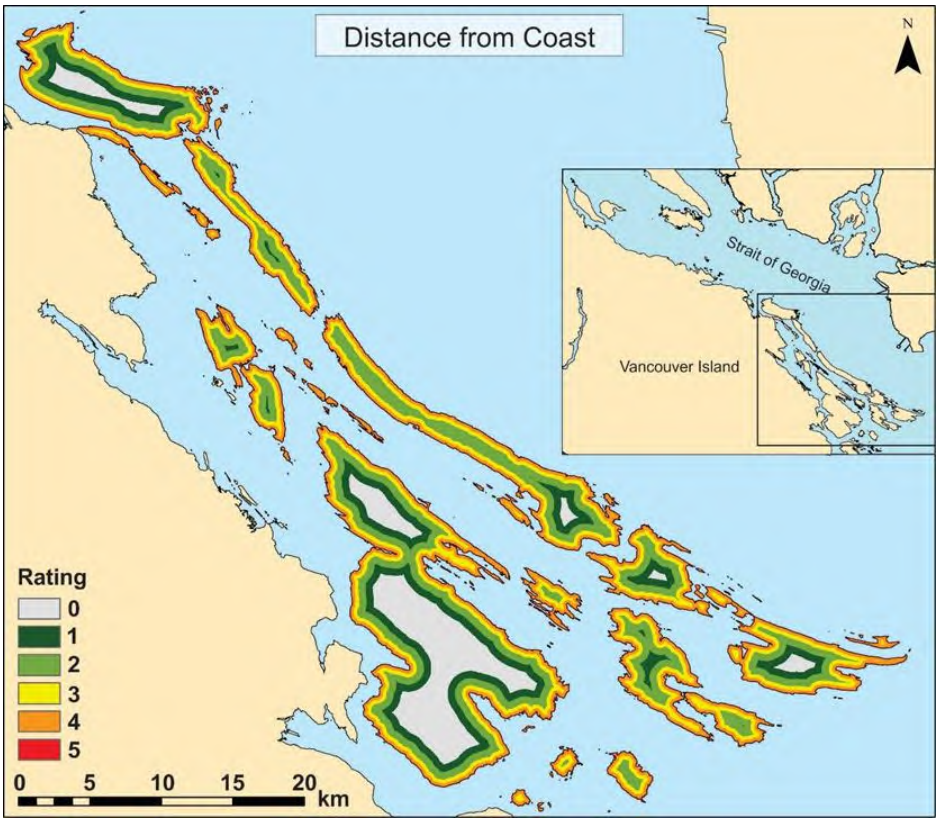

Figure 11. Distance from coast parameter for aquifer susceptibility

Figure 12 shows the relation between well depth and electrical conductivity (EC) measured in a groundwater sample collected from the well. Note: the groundwater sample is considered a mixed sample over the open well and are not depth-specific. Groundwater samples in Figure 12 are coloured based on distance from the coastline (only 32% of sampled groundwater wells have well depth data and could be included in this figure). Groundwater samples with an EC greater than the 95th percentile (2090 µS/cm) are typically within 250 m from the coast (red and orange symbols) (with 1 sample between 250 and 500 m), and groundwater samples with an EC greater than the 90th percentile (960 µS/cm) are within 500 m of the coast (yellow, light green and dark green symbols) (with 1 sample between 1000 and 1500 m). Groundwater samples with EC values above the 90th and 95th percentile are drilled to depths between approximately -6 to -40 m (-20 to -135 ft) below sea level.

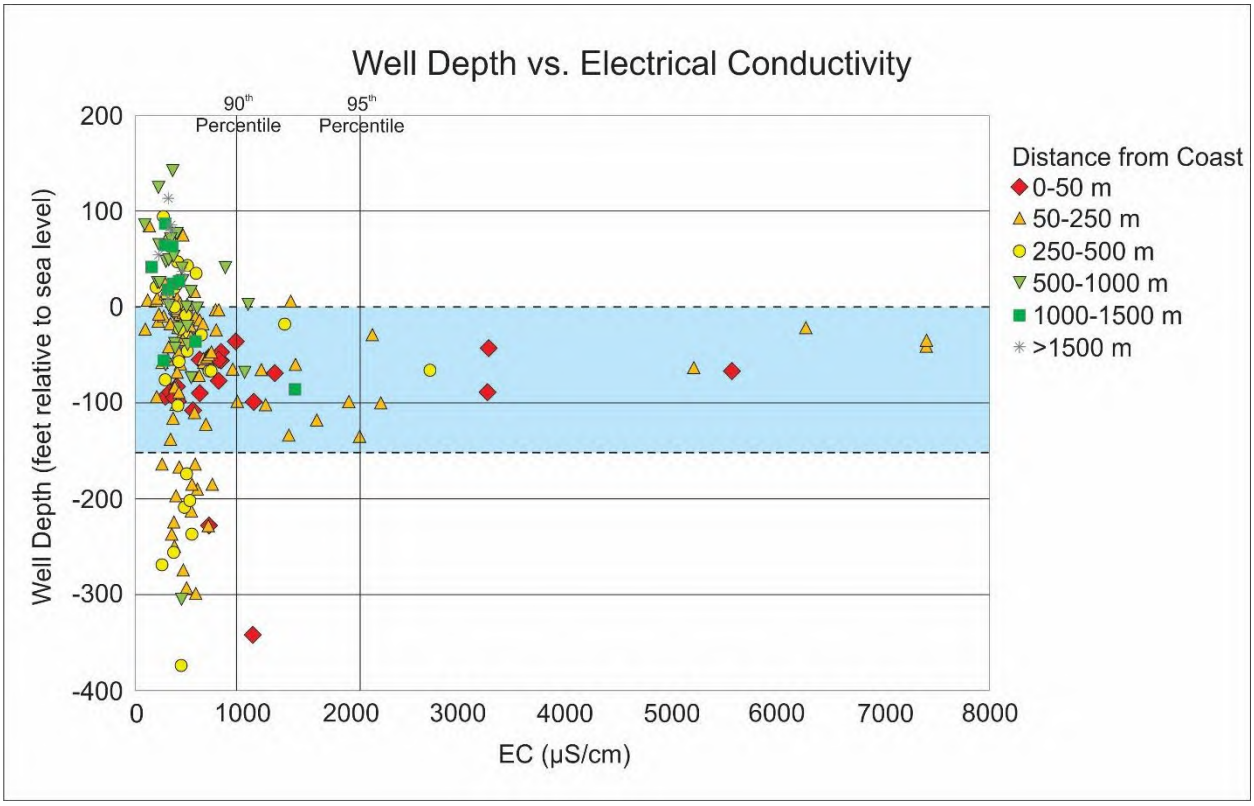

Figure 12. Well depth vs electrical conductivity (EC) for groundwater samples drilled at different distances from the coastline (using the same colours as in Table 7). The horizontal blue section highlights the depth (0 to 40 m) at which groundwater samples have EC values above the 90th and 95th percentile thresholds

5.2.2 Topographic Slope and Groundwater Flux

The topographic slope map was created by calculating the slope from the LiDAR and CDEM maps in ArcGIS. The lower resolution CDEM was available for all of the southern Gulf Islands. LiDAR data were available for North and South Pender Islands, Salt Spring Island, Moresby Island and Portland Island;

however, as Salt Spring Island was a focus for this project the LiDAR data for this island only were used. A rating from 1 to 5 was assigned to the final topographic slope map according to Table 8.

Table 8. Rating table for topographic slope (based on Kennedy 2012)

Rating	Topographic Slope
5	<1°
4	1-5°
3	5-10°
2	10-20°
1	>20°

The groundwater flux map was created by Erlandson (2014) by combining the ground surface topography (i.e. the slope) and hydraulic conductivity of the aquifer. "Percent of slope" data were acquired from the BC Provincial data warehouse as a 25m TRIM DEM. Hydraulic conductivity was estimated by combining the C and Fm parameters from DRASTIC-Fm[2] maps of the southern Gulf Islands (Denny et al. 2007). Erlandson created two maps, one that used the topography parameter ratings from the original DRASTIC methodology (Aller et al. 1987) and the other according to an approach used by the Nova Scotia Department of Natural Resources (Kennedy 2012).

For this study, the groundwater flux map based on the ratings by Kennedy (2012) was chosen so as to better compare the results with the topographic slope map. Both methods were evaluated based the relationship between topographic slope/groundwater flux and the groundwater chemistry data (extracted rating for sampled groundwater wells); specifically, groundwater samples above the threshold values (95th and 90th percentile) for EC. The approach that best represents the groundwater chemistry data was carried through to generate the final the risk map.

The distance from coast map and the slope/groundwater flux map were added to produce a map with a rating from 1 to 10, which was then rescaled to a rating of 1 to 5 for the final aquifer susceptibility map.

Topographic slope and groundwater flux are compared in Figure 13. Gabriola and Salt Spring Island have the largest difference between the two methods. On Gabriola Island, topographic slope produces high ratings, and groundwater flux produces low ratings, whereas the opposite is observed along the southwestern coastline of Salt Spring Island and coastal areas along Saturna Island (refer to Figure 3 for island names). The fractured media component of the composite C (hydraulic conductivity) heavily influences the groundwater flux, which may be why the two methods produced different ratings for Gabriola and Salt Spring Island.

[2] DRASTIC maps incorporate seven main characteristics of aquifers to approximate their intrinsic vulnerability to surface contaminants (Aller et al. 1987). Among these seven is the 'C' or hydraulic conductivity parameter. Denny et al. (2007) modified the DRASTIC model by including an additional 'Fm' or fractured media parameter. This Fm parameter characterizes linear zones of higher bedrock susceptibility based on the orientation, length and intensity of fractures (Denny et al., 2007).

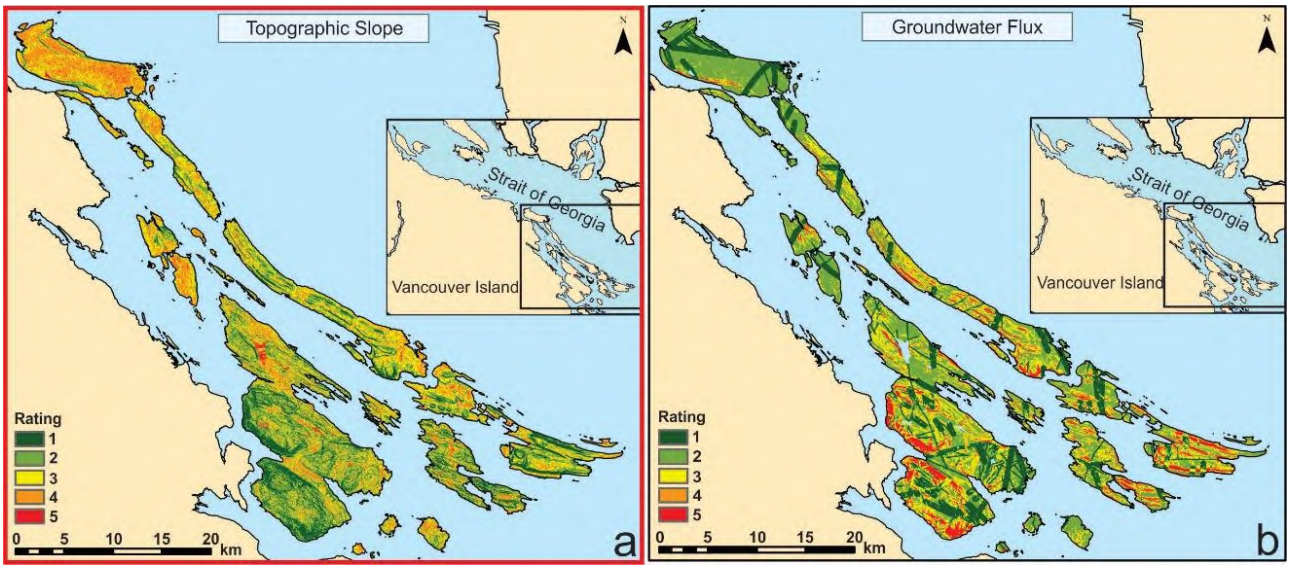

Figure 13. Comparison between topographic slope and groundwater flux. See Figure 3 for map of island names.

Topographic slope and groundwater flux ratings for sampled groundwater wells above the 95th and 90th percentile are summarized in Table 9. Groundwater wells typically have ratings of 3 and 4 for topographic slope and a rating of 2 for groundwater flux (Figure 14). Although groundwater flux is perhaps a better indicator of aquifer susceptibility than simply topographic slope, based on Table 9, topographic slope corresponds to higher ratings for high EC values (above the threshold) and was thus is considered to be the more applicable method for this study area.

Table 9. Comparison between topographic slope and groundwater flux ratings for sampled groundwater wells with EC values above the 95th and 90th percentile thresholds

Rating	Topographic Slope				Groundwater Flux			
	95th Well Count	95th %	90th Well Count	90th %	95th Well Count	95th %	90th Well Count	90th %
1	3	10.0	6	10.5	6	21.4	13	24.1
2	4	13.3	6	10.5	18	64.3	30	55.6
3	10	33.3	22	38.6	2	7.1	7	13.0
4	11	36.7	20	35.1	0	0	1	1.9
5	2	6.7	3	5.3	2	7.1	3	5.6
Mean	**3.2**		**3.1**		**2.1**		**2.1**	

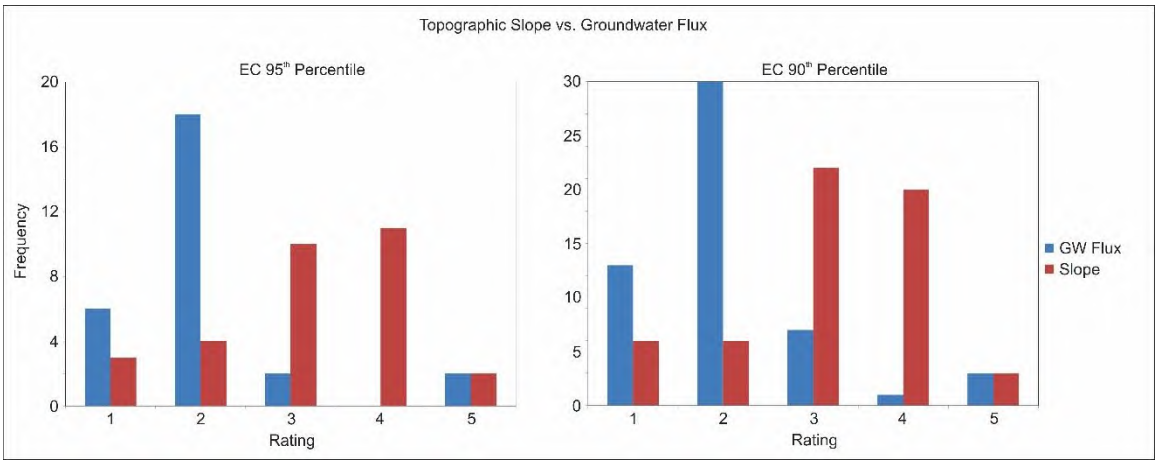

Figure 14. Frequency diagram used to compare topographic slope and groundwater flux

5.2.3 Aquifer Susceptibility to SWI Map

The distance from coast map and topographic slope map were added together to create the aquifer susceptibility map for the southern Gulf Islands (Figure 15).

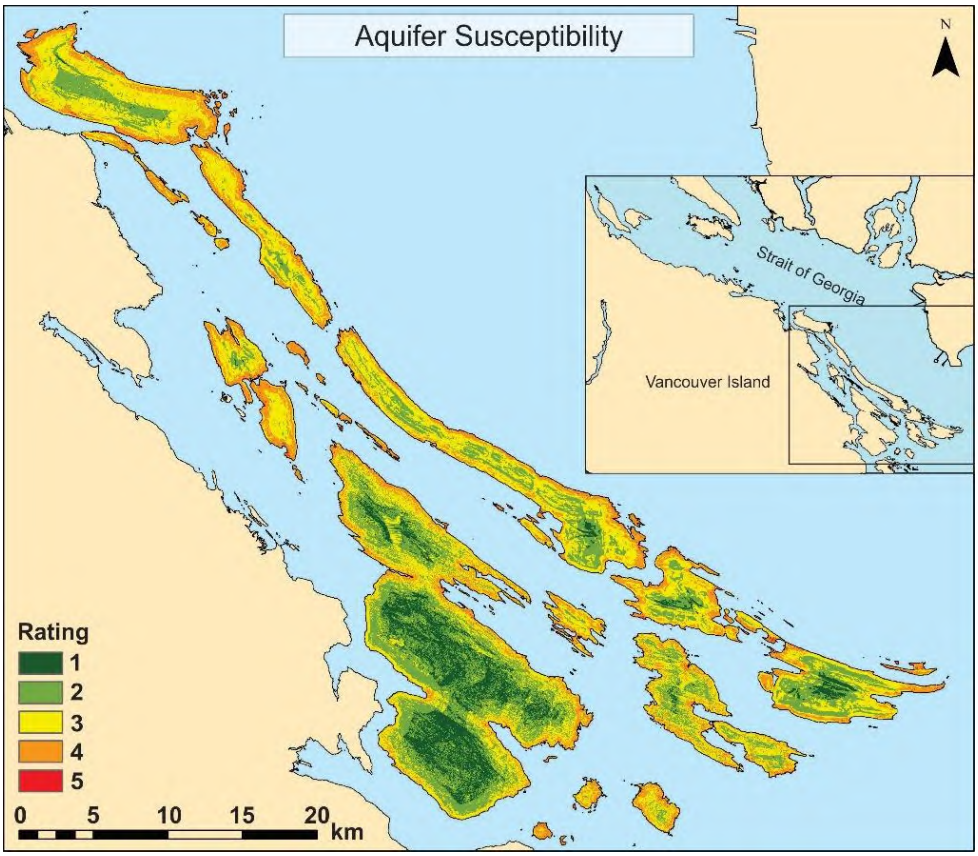

Figure 15. Aquifer susceptibility map calculated from distance from coast and topographic slope for the southern Gulf Islands

5.3 Final Vulnerability Maps

Two hazard threat maps (pumping and coastal hazards) were multiplied with the aquifer susceptibility map to create two vulnerability maps (Eq. 4); one that shows the aquifer vulnerability to pumping (southern Gulf Islands) and the other to coastal hazards (Salt Spring Island). The pumping vulnerability map was created for all of the Gulf Islands, whereas the coastal vulnerability map could only be created for Salt Spring Island (limited based on available LiDAR data). The two vulnerability maps were added to create a total vulnerability map for Salt Spring Island. Because the pumping vulnerability map was for all the southern Gulf Islands, it was used in the complete risk assessment which considers loss.

The aquifer vulnerability based on well density (pumping) is shown in Figure 16 for the southern Gulf Islands. The well density and aquifer susceptibility maps were assigned equal weight in the creation of the aquifer vulnerability map. Features from the well density map are quite prevalent in the aquifer vulnerability map, but the aquifer susceptibility map either reduces the influence of pumping (where aquifer susceptibly rating is low) or highlights areas where the aquifer is highly vulnerable (high susceptibility and high well density).

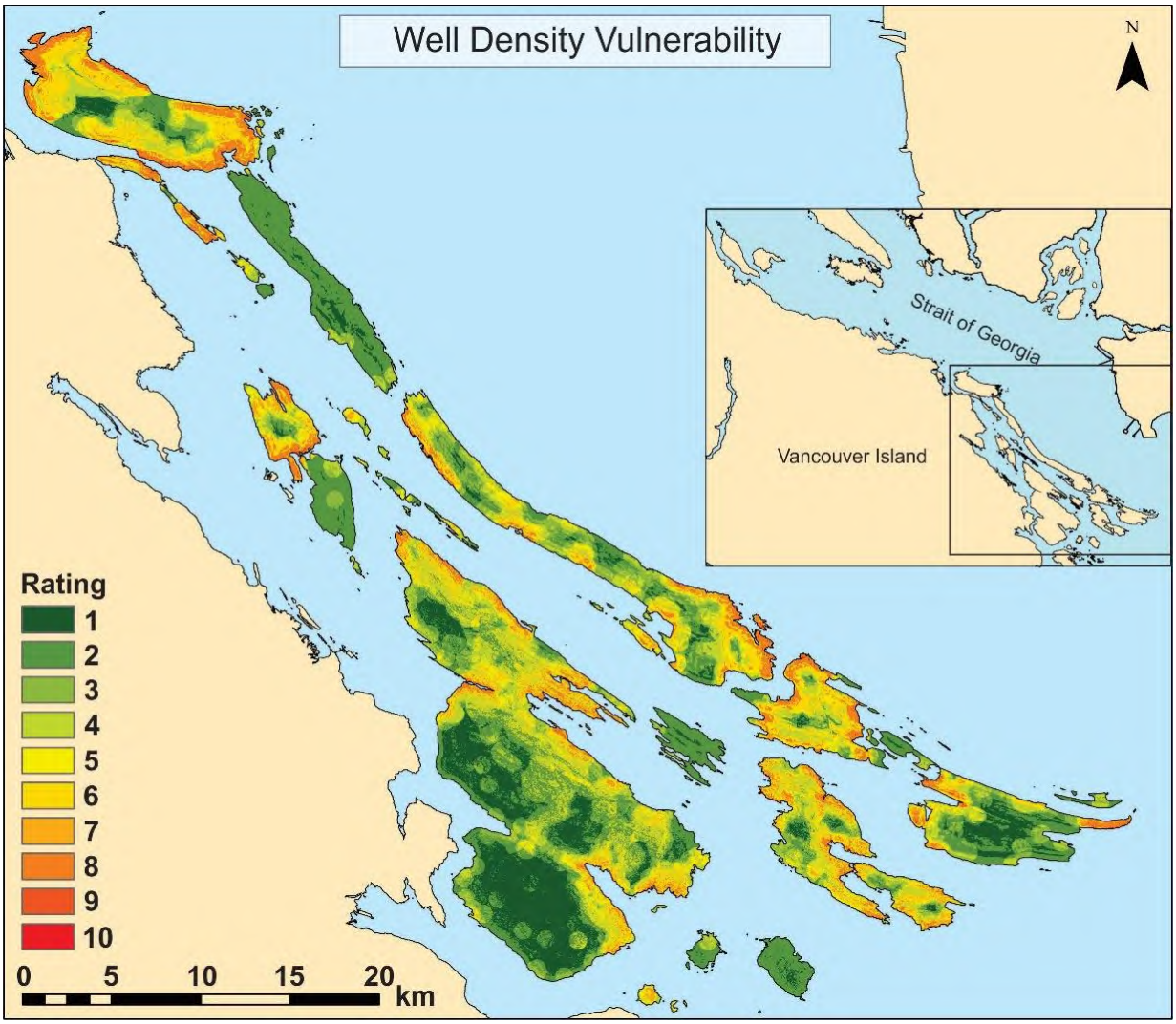

Figure 16. Vulnerability map calculated from pumping and aquifer susceptibility for the southern Gulf Islands

Wells with electrical conductivity (EC) values exceeding the 90th and 95th percentile thresholds were overlain on the aquifer vulnerability map (Figure 17) to qualitatively assess whether aquifer vulnerability correlates with high salinity. Wells that have EC values above the thresholds are typically found along the coast or in other areas mapped as vulnerable to saltwater intrusion. But there are inconsistencies. For example, East Point (eastern peninsula on Saturna Island) has a high vulnerability, and yet some wells are above the EC thresholds and others are not. Low values of EC could be explained by the occurrence of fractures. Fractures may act as conduits for freshwater (from recharge areas) or saltwater (from the ocean; see Allen et al. 2002), and thus, may locally influence individual wells.

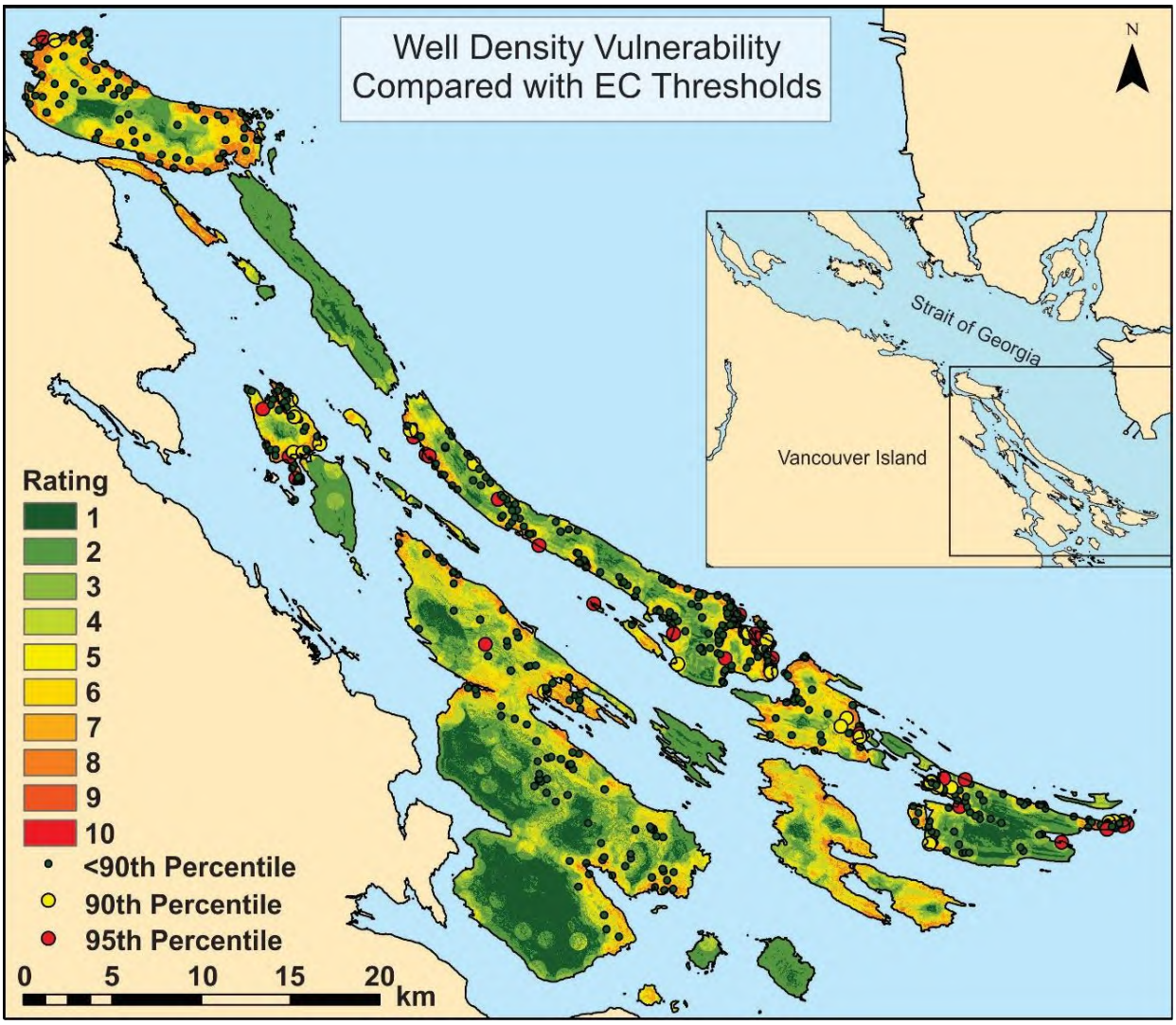

Figure 17. Vulnerability map compared with groundwater chemistry for the southern Gulf Islands

The vulnerability maps for both pumping and coastal hazards are compared in Figure 18 for Salt Spring Island. The pumping vulnerability map has a range of ratings throughout the island (higher ratings in the north/northeast and lower ratings in the south/southwest), whereas the coastal vulnerability map is dominated by ratings of 1 with higher ratings at a few coastal regions.

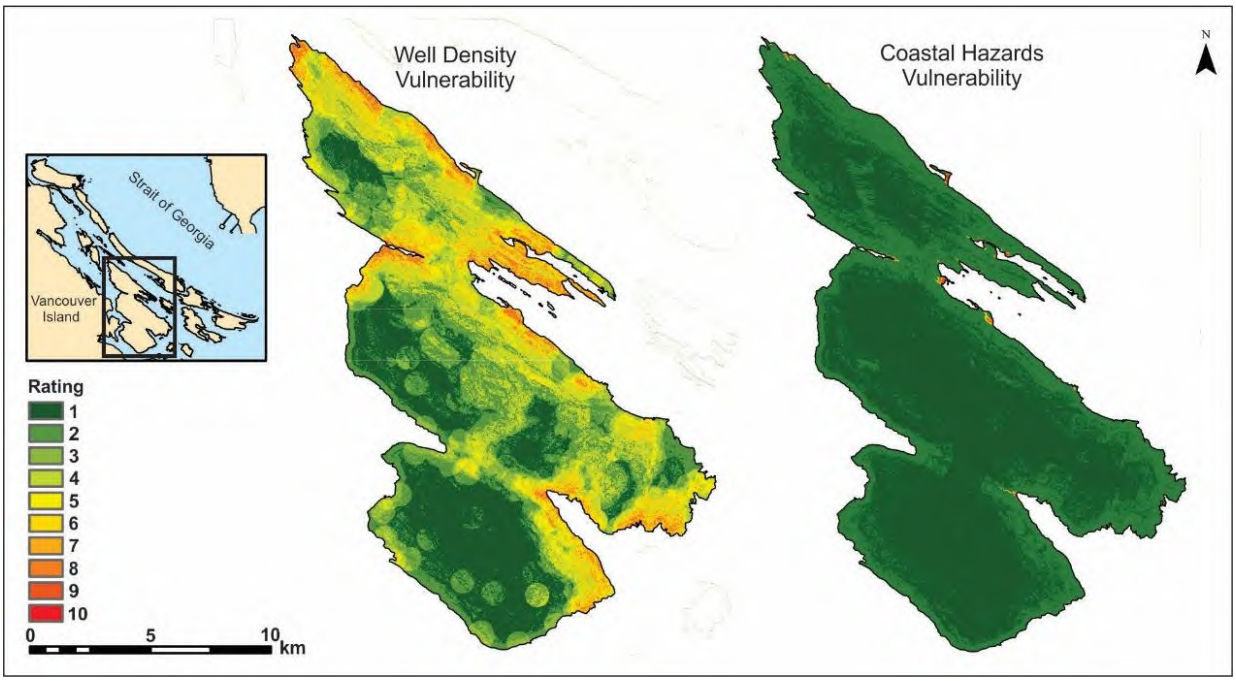

Figure 18. Comparison between pumping vulnerability and coastal vulnerability

The two vulnerability maps were compared with chemistry data from Salt Spring Island. Only two groundwater samples were above the 95th and 90th percentile (1 each). Therefore, all of the chemistry data, regardless of percentile, were included in the analysis (Table 10). The two samples that were above the 95th and 90th percentile had ratings of 4 and 6, respectively, for pumping vulnerability, and 1 and 2, respectively, for coastal vulnerability. The pumping vulnerability ratings are relatively more evenly distributed than the coastal vulnerability ratings, which are dominated by ratings of 1 and 2.

Table 10. Comparison between pumping and coastal vulnerability for all sampled groundwater wells on Salt Spring Island

Rating	Pumping Vulnerability		Coastal Hazards Vulnerability	
	Well Count	%	Well Count	%
1	1	1.1	42	46.2
2	10	11.0	47	51.7
3	0	0	0	0
4	34	37.4	0	0
5	6	6.6	1	1.1
6	22	24.2	1	1.1
7	1	1.1	0	0
8	17	18.7	0	0
9	0	0	0	0
10	0	0	0	0
Mean	**5.1**		**1.6**	

There are several limitations with comparing pumping and coastal vulnerability with the chemistry data. First is that the chemistry dataset is a partial dataset of all the wells on Salt Spring Island and the sampled wells are not evenly distributed throughout the island. Second, for coastal vulnerability, most of the high ratings are within 250 m of the coast (see Figure 12). Generally, groundwater samples that are within 250 m of the coast have EC values above the 95th and 90th percentile and out of the 97 groundwater samples for Salt Spring Island, only 24 (25%) are within that distance. As a result, the other 75% control the low ratings for the coastal vulnerability.

The two vulnerability maps were added to create the final vulnerability map for Salt Spring Island (Figure 19).

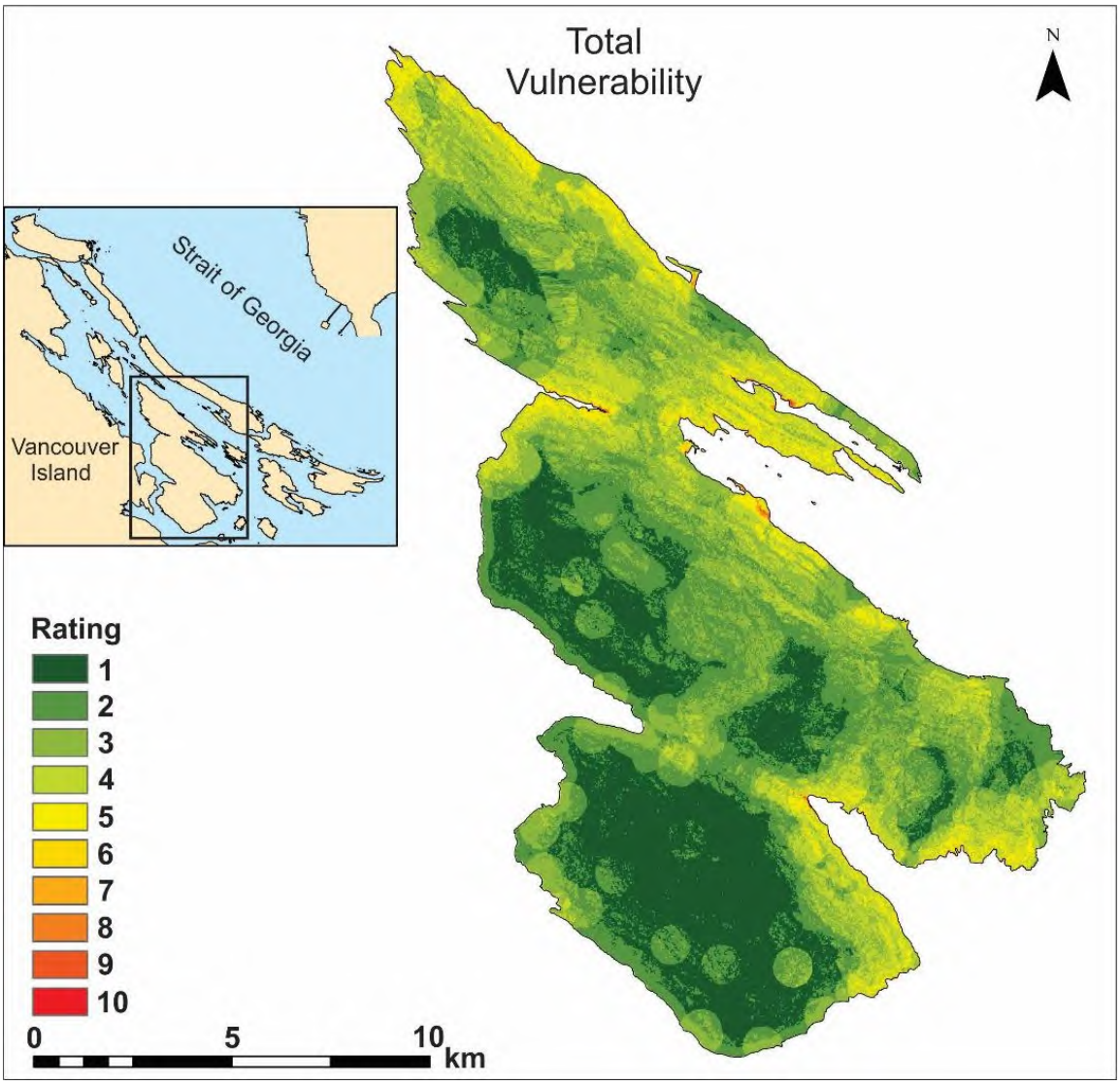

Figure 19. Total vulnerability for Salt Spring Island

5.4 Loss

A land use zoning dataset was obtained through the Islands Trust (Mark van Bakel, Islands Trust, personal communication). The Islands Trust is a federation of small governments serving islands in the Strait of Georgia. Map Islands Trust (MapIT) contains a series of maps which provide information about ecological, property and other valuable mapping information maintained by the Islands Trust Geographic Information System.

A dollar value representing loss was assigned to each zone. If a groundwater supply is lost due to SWI, the water source could be replaced with either a rainwater collection system or water could be imported from the mainland or elsewhere on the Gulf Islands. Installation of a rainwater collection system costs between $25,000 to $50,000 (Bob Burgess, Gulf Islands Rainwater Connection Ltd, personal communication) and importing water costs around $500 per month ($6,000 per year) for a household of two people (Dan Foley, Summer Rain Water Delivery, personal communication). Financially, the best long term solution would be to install a rainwater collection system; as a result, a conservative value of $25,000 was assigned to residential, industrial and commercial zones as a conservative estimate for replacement cost.

The method by Simpson et al. (2014) was used to determine the economic loss associated with the loss of a groundwater supply in an agricultural area. Simpson et al. (2014) assigned a loss value based on annual revenue generated by business. Income information on a farm by farm basis was not available, so average annual revenue ($/acre) was used from Statistics Canada (2007). Simpson et al. (2014) assigned values based on the type of farm (dairy, berries, etc.), but detailed information on the type of agriculture was not available for the southern Gulf Islands. Therefore, an average of $2,632/acre (value of farmland and buildings) obtained from Statistics Canada (2006) was used to determine the economic loss for agricultural land. The values in Table 11 were used to assign a rating (1 to 10) to the zone codes based on the total loss to create the final loss map.

Land use zones, such as community or resource, which would not necessarily be affected if there were no groundwater resource available were assigned a value of 1 rather than 0 so that when the loss and vulnerability map are multiplied together to create the overall risk map, features are not lost. The replacement cost of $25,000 was assigned to commercial, industrial and residential land zones and the economic loss was calculated for agriculture land based on a generic value of $2,632/acre, which results in the loss map for the southern Gulf Islands (Figure 20).

Table 11. Rating table for Replacement and Economic Loss for different zone codes (based on Simpson et al. 2014)

Rating	Replacement/Economic Loss ($)
10	>5,000,000
9	1,000,000 to 5,000,000
8	500 - 1,000,000
7	250 - 500,000
6	100 - 250,000
5	50 - 100,000
4	25 - 50,000
3	10 - 25,000
2	5 - 10,000
1	1 - 5,000

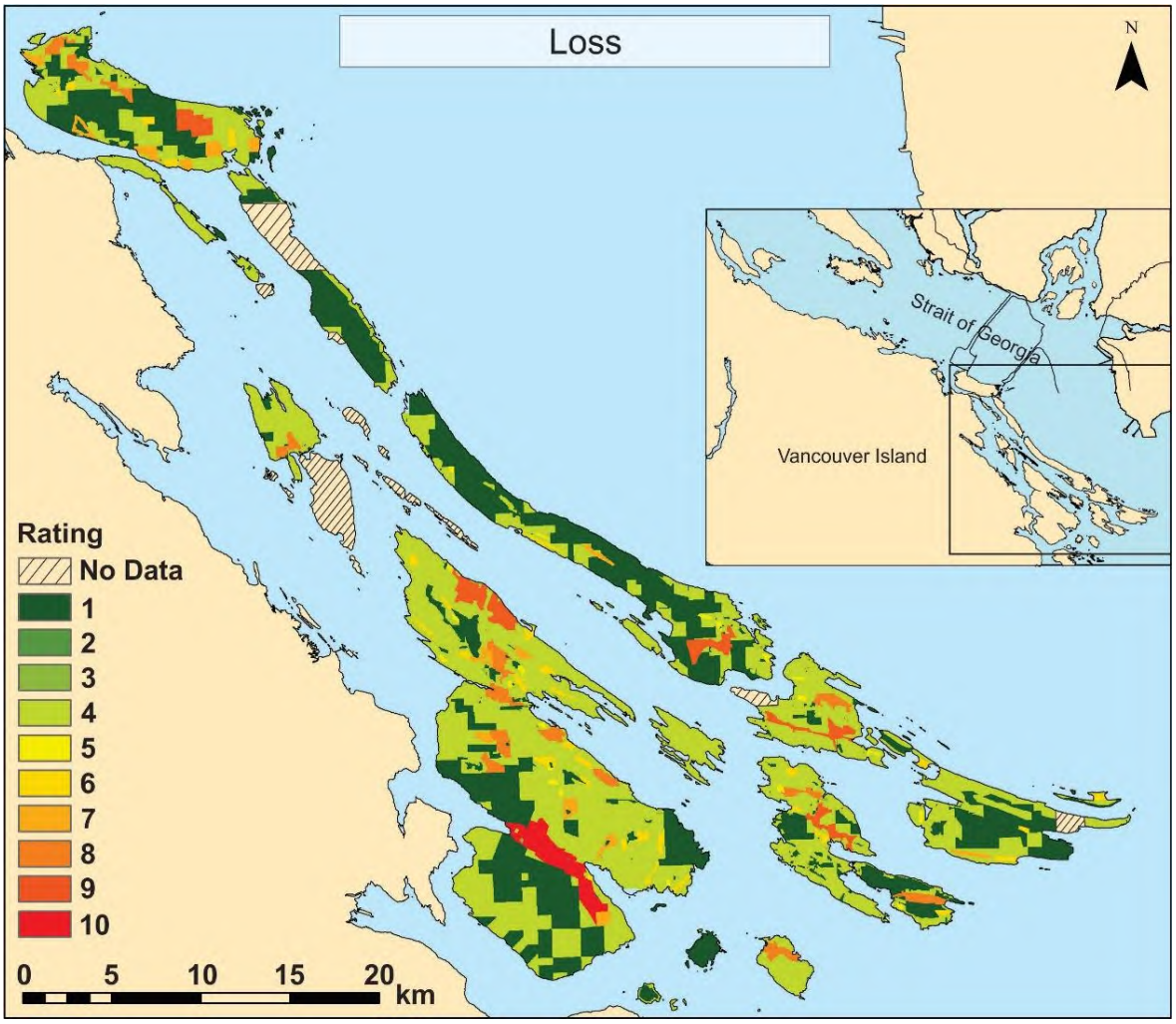

Figure 20. Replacement and economic loss for the southern Gulf Islands

One limitation of the loss map is that it can vary depending on the value assigned to each zone code. For example, a conservative value of $25,000 was assigned to commercial, industrial and residential zones, but this value could be $50,000 or larger depending on if the household has more than two occupants or if rainwater harvesting is not a suitable solution for the commercial and industrial sectors. If the value assigned to these zones is increased, it would shift the majority of the ratings from 4, to 5 or 6, which would in turn influence the final risk map.

There are alternative ways of representing loss. For example, loss could also include the change in property value if no water were available or there could be increased cost to a water utility and improvement for district users. Although this study considered some of the financial implications associated with losing a fresh groundwater supply, a more comprehensive evaluation of loss could be undertaken.

5.5 Overall Risk Map

Pumping vulnerability represented by well density (Figure 16) and loss (Figure 20) were multiplied (Eq. 1) to create the overall risk for the southern Gulf Islands (Figure 21). The loss map significantly influences the outcome of the risk map. Therefore, the risk map should be viewed with caution because it reflects a subjective evaluation of loss, as described above. Nevertheless, there is potential value to including loss as it represents (in this case) a potential financial burden to a well owner and a negative economic consequence for agricultural land.

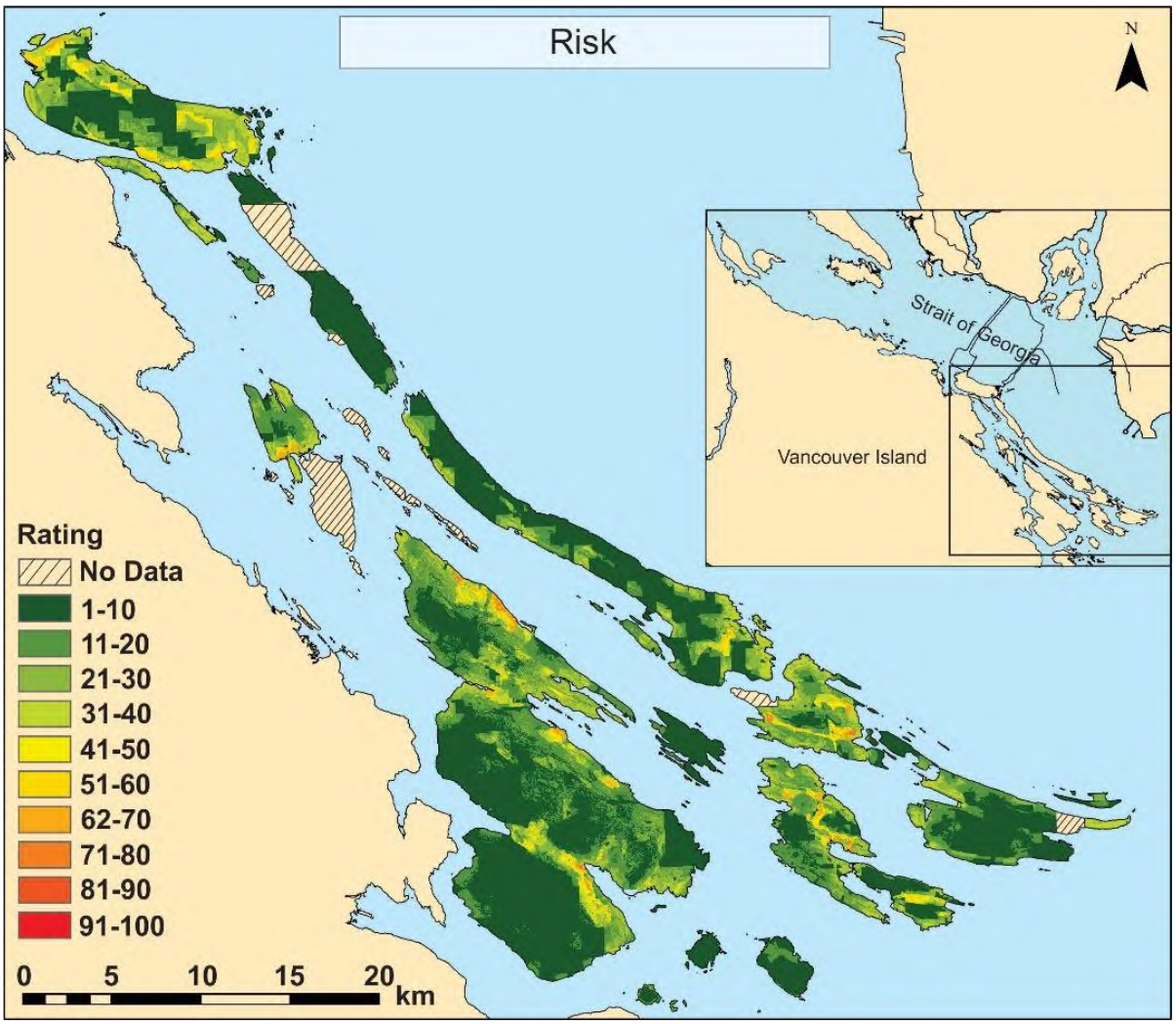

Figure 21. Overall risk for the southern Gulf Islands calculated from pumping vulnerability and loss.

6 Conclusions

This research mapped aquifer vulnerability specific to saltwater intrusion. The approach required mapping coastal hazards, anthropogenic hazards (pumping) and aquifer susceptibility.

Several hazards were identified for this coastal area that have the potential to lead to salinization of aquifers, including storm surge, sea level rise, and pumping. The various coastal hazards were mapped for the Gulf Islands, with greater detail provided for Salt Spring Island where LiDAR data were available. Natural (SLR and storm surge) and anthropogenic (pumping) hazards were mapped separately, employing different datasets and techniques and comparing the results.

The final coastal hazard map (Figure 9c) suggests that coastal hazards are limited to a few areas on Salt Spring Island, particularly in narrow bays and inlets (e.g. around Ganges Harbour); these areas could experience inundation (up to ~400 m inland) related to sea level rise and storm surge. Overall, however,

coastal hazards are relatively limited across most of Salt Spring Island. Other Gulf Islands or portions of islands that are low-lying may be more impacted by coastal hazards. It is recommended to expand LiDAR mapping be carried out throughout the Gulf Islands in order to apply the coastal hazard mapping methods outlined for Salt Spring Island throughout the rest of the region.

Pumping hazards were significant on many islands (Figure 6b). Gabriola and Mayne Islands in particular stand out as having high well density ratings. It should be pointed out, however, that well density was based on wells reported in the provincial WELLS database, plus 69 water supply system wells and some 200 wells that had been sampled for water chemistry but were not reported in WELLS. It is well known that the WELLS database is incomplete – a province wide estimate is that 30% of all wells are not reported. Therefore, it is possible that well density is underestimated for the Gulf Islands. Equally, however, WELLS includes older wells that may not be active. In this study, relative weights were applied to each point for calculation of point density, giving more weight to wells that were reported in WELLS as being for irrigation use and for water supply system wells. This information may be inaccurate. Therefore, it is recommended that an accurate inventory of wells on the Gulf Islands be carried out and that more accurate estimates of water use be obtained to improve the pumping hazard results.

The aquifer susceptibility map was based on distance from coast and topographic slope. Topographic slope was chosen over groundwater flux because there was a stronger relation between high susceptibility ratings and high salinity as reported by Klassen et al. (2014). It is unfortunate that using groundwater flux as a parameter yielded inferior results for susceptibility (when compared with the groundwater chemistry data) because the groundwater flux map incorporates geological variation, and particularly emphasizes large scale fracture zones. These fracture zones act as conduits which could either transport freshwater from recharge areas to areas along the coast, thereby lowering their susceptibility, or alternatively, draw saltwater in to areas that might otherwise not be susceptible. Not including geological variability in the susceptibility rating is a limitation of this study. Nevertheless, the approach used adequately captured areas with high susceptibility close to the coast and where the lens is thin (shallow topography) and lower susceptibility further inland and/or where the lens in thick (steep topography). Additional validation of the susceptibility map is warranted. This could be accomplished by developing three-dimensional density-dependent groundwater flow and solute transport models for each island and comparing the susceptibility map ratings to the model results (which would indicate the depth and thickness of the freshwater lens) (e.g. see Holding and Allen 2015a). Models of this type are currently being developed by SFU for the Gulf Islands.

Each of the two hazard maps (coastal hazards and pumping) was combined with the aquifer susceptibility map to create two aquifer vulnerability maps (for natural and anthropogenic hazards, respectively). For Salt Spring Island, a total vulnerability map was generated. The aquifer vulnerability was compared with the observed chemistry for the Gulf Islands. Generally, wells which have high EC values, fall in areas with high vulnerability, but there are also groundwater wells with high EC in low vulnerability areas or wells with low EC in high vulnerability areas. This variability is likely due to the fact that the aquifer susceptibility map does not take into account geological variability associated with fracture zones as noted above. The variability may also point to differences in geology at the well scale (i.e. individual small fractures) that may influence groundwater flow and chemistry locally.

Notwithstanding, the water chemistry data used to verify the mapping results were not collected for this purpose. As mentioned, only 25% of groundwater samples were collected from wells situated near the coast. To better validate these results, samples should be collected in high vulnerability areas in order to verify the connection between the vulnerability map and observed groundwater chemistry.

Determining loss for the risk assessment considered the financial consequence of a well becoming contaminated. A loss of $2,632/acre was assigned to agricultural land and a replacement cost of $25,000 was assigned to commercial, industrial and residential areas were a rainwater harvesting system could be installed. A limitation of this method is that it is controlled by the dollar value assigned to each land use zone. No distinction was made between different types of agriculture on the Gulf Islands, and the replacement cost of $25,000 was the lower estimate for a rainwater harvesting system; commercial and industrial sectors may require a larger system which could cost up to $50,000. In order to better characterize loss for the Gulf Islands, several parameters could be introduced, for example, the change in property value if a property were to lose its water supply, the potential increase in cost of water supply systems if more people are required to use them, as well as environmental impacts such as the ecological cost associated with altering the natural hydrological balance if saltwater intrusion were to occur. The various ways of characterizing loss could greatly change the impact on the overall risk.

The final risk to bedrock aquifer map for the Gulf Islands was created by combining the aquifer vulnerability map with the loss map. The risk map shows overall risk throughout the Gulf Islands, but it does not include natural hazards (due to limited LiDAR data). As mentioned above, loss heavily influenced the overall risk map, and depending on how loss is characterised (financial or ecological), the overall risk outcome could be quite different.

Overall, the combination of chemical indicators of saltwater (Klassen et al. 2014) and risk assessment maps (this study) are useful tools which can be used to improve decision-making related to monitoring and community development for this particular coastal area of BC and elsewhere. The aquifer vulnerability map, in particular, is suited for determining areas which are salinized or most likely to become salinized, and therefore is potentially useful for water allocation decision-making or groundwater / land use development planning.

7 Acknowledgements

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STAFF REPORT

File No.: SA-PLDVP20240324 (Anielski)
SA-PLDP20240229

DATE OF MEETING:	January 16, 2025
TO:	Saturna Island Local Trust Committee
FROM:	Phil Testemale, Planner 2 Southern Team
COPY:	Brad Smith, Island Planner
SUBJECT:	Development Variance Permit Application Applicant: Tomasz Anielski, AVRP Architecture Inc. Location: 373 Campbell Bay Road

RECOMMENDATION

1. **That the Saturna Island Local Trust Committee approve issuance of Development Variance Permit PLDVP20240324 (Anielski).**

REPORT SUMMARY

The purpose of the report is to consider a Development Variance Permit for the construction of a dwelling with decks and an accessory building that would exceed the maximum lot coverage provisions in the zone.

RATIONALE FOR VARIANCE

Granting the variance will allow the construction of the proposed buildings and structures with the rationale that the elevated decks represent the overage and have been designed to minimize environmental impacts on the site.

BACKGROUND

The application is the result of a Preliminary Plan Review (PPR - SA-PLBP20240064) for a new dwelling on the two (2) abutting properties. The proposed dwelling would straddle what is currently a shared property line, however, the owner is in the process of consolidating the properties into a single title with the Land Title Office (Figure 2). That application has been submitted to the Ministry of Transportation and Infrastructure (MoTI) with an unknown timeframe for finalizing.

The specific variance to Saturna Island Land Use Bylaw No. 119, 2018 (LUB) is to the Rural Residential (RR) zone as follows:

a) Subsection 4.1.6 which states that on lots less than 0.4 hectare (one acre) in area, lot coverage for buildings and structures shall not exceed 20% is varied to permit a maximum lot coverage for buildings and structures of 24.5%.

The extent of proposed development consists of a dwelling with an attached garage and elevated decks with a total area of 878 m² (9,450 ft²) (Attachment 2.2). As the garage is sited within 5 metres of the dwelling and connected with a breezeway, it is considered part of the principal dwelling (LUB Subsection 2.4.1).

The consolidated property would be 0.36 ha (0.88 ac) in size and applying the 20% limit would allow 720 m² (7750 ft²) lot coverage[1]. As the proposed area exceeds 20% by 4 ½ %, a variance must be obtained or the proposed plans adjusted to conform to the regulation.

According to an the environmental assessment report submitted as part of the Development Permit application (below), the site has likely been disturbed by clearing or selective logging, however, much of the characteristics of the sensitive bluff ecosystem remains intact. There is a dilapidated house on 180 Cliffside as well as a damaged concrete set of stairs and fencing along the bluff crest.

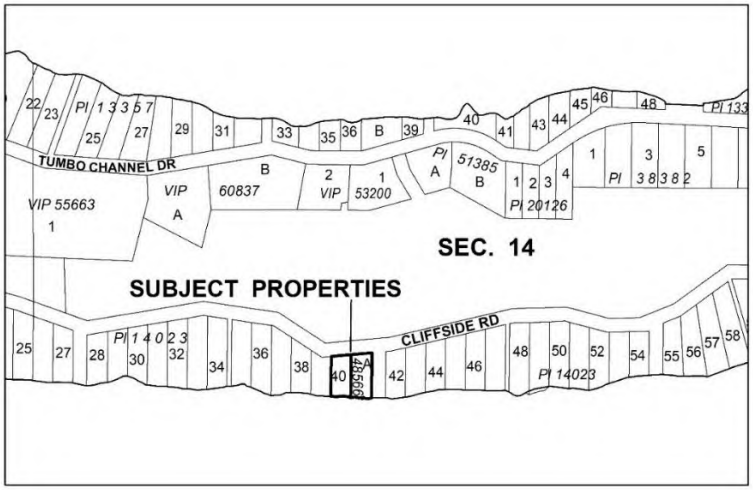
The applicant has submitted a letter explaining the rationale for the variance which is Attachment 3.

If the application is denied, the owners could apply to the Board of Variance, or adjust the plans to comply with the regulation.

A development permit (SA-PLDP20240229) for the proposed development was issued in November of 2024.

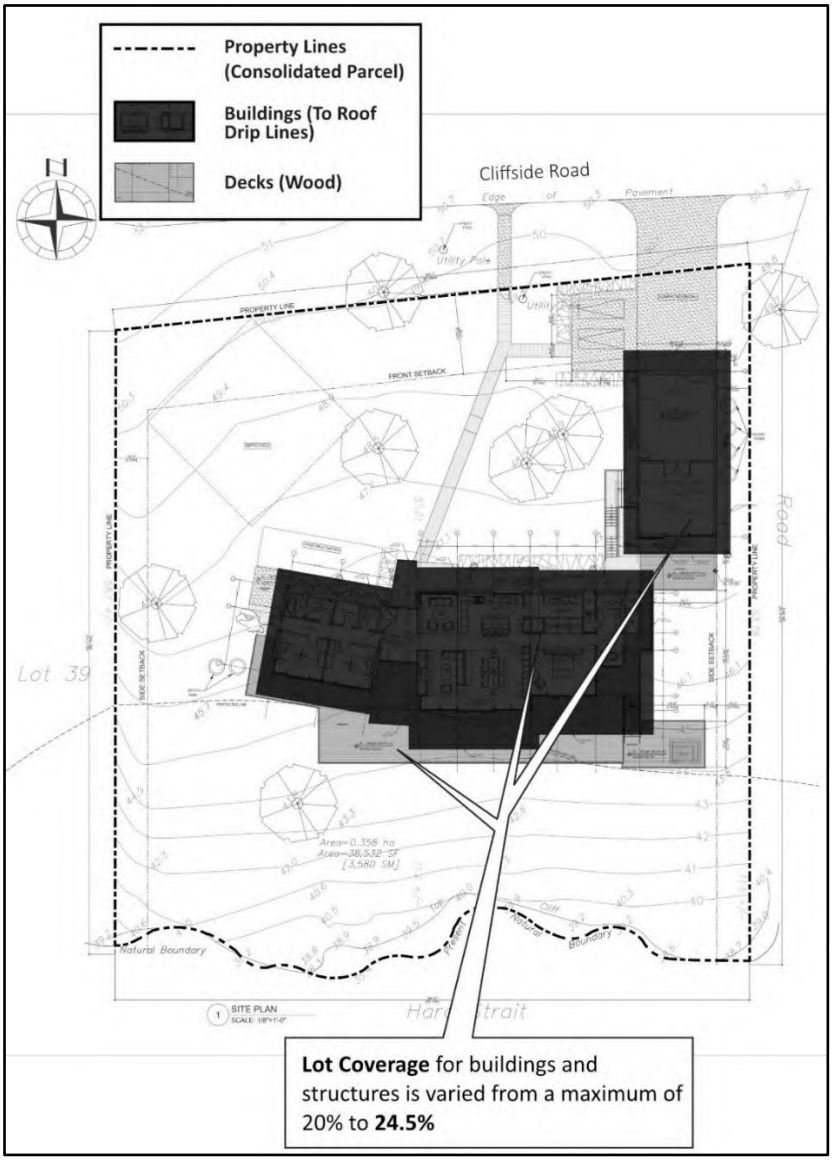
A copy of the Notice and proposed permit PLDVP20240324 (Anielski) are Attachments 4 & 5.

Figure 1 – Subject Property



[1] ""**lot coverage"** means the total area of those portions of a lot that are covered by buildings and structures, divided by the area of the lot, and for this purpose the area of a lot that is covered by a building or structure is measured to the drip line of the roof…" (LUB, p. 48)

Figure 2 – Site Plan



ANALYSIS

Policy/Regulatory

Official Community Plan:

The property is designated as **R- Rural** in the Saturna Island Official Community Plan No. 70 (Attachment 1).

The Bluffs Development Permit Area (DPA) is designated on the subject property as shown in Attachment 1. As above, PLDP20240229 for portions of the decks within the DPA was issued on November 23, 2024.

Land Use Bylaw:

The property is zoned **Rural Residential (RR)** in the Saturna Island Land Use Bylaw No. 119, 2018 (LUB – Attachment 1). The proposed residential and accessory uses comply with the LUB.

Issues and Opportunities

Impact on Neighbouring Properties

The proposed dwelling and accessory building are all single storey and therefore necessarily cover more property area in order to achieve the same floor area as a two storey dwelling for example. Further, the visual impacts of the proposed design is lessened with the reduced height.

The applicant's rationale focused on the elevated deck portions as representing the exceedance of lot coverage stating that these would be wooden decks designed to be partially permeable with spacing between boards which will help to mitigate environmental impacts such as altered hydrology, soil compaction and loss of natural vegetation (Attachment 3).

The Intent of the Regulation being Varied

The overall purpose of lot coverage regulations are to minimize impacts related to:

- Visual impacts to neighbouring properties and the public realm.
- Protection of the natural environment by ensuring the majority of property remains unbuilt and permeable.
- Establishing a consistent development pattern within a local area.
- Protection of views, scenic areas and distinctive features contributing to the overall visual quality and scenic value of the Trust Area.
- Maintaining a rural character.
- Establishing certainty with respect to development by maintaining consistent height and siting regulations.

Potential Impacts of Granting the Variance

Granting a variance can potentially create an expectation in the community with regard to future applications. As variances consider the unique circumstances pertaining to a particular situation that may warrant the relaxation of a specific zoning regulation each application should be evaluated on its own merits.

Consultation

DVP Notices were circulated to surrounding property owners and residents. The notification period ended at 4:30 p.m. on January 7, 2025.

At the time of writing, staff have received no submissions in response to notification. Any submissions received prior to the LTC Meeting will be forwarded to the LTC and reported at the meeting.

First Nations

The Islands Trust reviews all applications to ensure the preservation and protection of cultural heritage, archaeological sites, and ancestral places. As reviewed, the DVP application is consistent with respect to LTC Standing Resolutions on reconciliation. Notwithstanding, to provide applicants with awareness regarding unknown archaeological areas, staff will forward the Islands Trust Chance Find Protocol and the provincial Archaeological Branch guidelines on *Heritage Act* directly to the applicants.

Rationale for Recommendation

Staff is recommending that the resolution on page 1 be supported for the following reasons:

- The proposed variance is minor.
- The rationale for the variance is reasonable.
- Impacts on neighbouring properties and the public realm from approval would be minor.
- The proposed variance does not challenge the intent of the regulation.
- At the time of writing, there has been no response to the notification.

ALTERNATIVES

1. **Request further information**

   The LTC may request further information prior to making a decision. If selecting this alternative, the LTC should describe the specific information needed and the rationale for this request. This should be debated in a regular meeting.

   Recommended wording for the resolution is as follows:

   That the Saturna Island Local Trust Committee request that the applicant submit to the Islands Trust_____.

2. **Deny the application**

   The LTC may deny the application

   Recommended wording for the resolution is as follows:

   That the Saturna Island Local Trust Committee deny application PLDVP20240324 (Anielski).

Submitted By:	Phil Testemale, Planner 2	January 7, 2025
Concurrence:	Robert Kojima, Regional Planning Manager	January 7, 2025

ATTACHMENTS

1. Site Context
2. Plans and Photographs
3. Rationale from applicant
4. Notice
5. Draft Development Variance Permit PLDVP20240324 (Anielski)

ATTACHMENT 1 – SITE CONTEXT

LOCATION

Legal Description	LOT 40, SECTION 14, SATURNA ISLAND, COWICHAN DISTRICT, PLAN 14023 and, LOT A, SECTION 14, SATURNA ISLAND, COWICHAN DISTRICT, PLAN 48566
PID	004-454-006 and 013-995-839
Civic Address	180 and 182 Cliffside
Lot Size	0.36 ha (0.88 ac)

LAND USE

Current Land Use	Rural Residential (Vacant - dilapidated dwelling and stairs on Lot 40)
Surrounding Land Use	Rural Residential & Rural General

HISTORICAL ACTIVITY2

File No.	**Purpose**
PLDP20240229	Portion of decks in Bluffs DPA – Permit issued November 23, 2024
PLBP20240064	Subject Dwelling (in abeyance pending current application/consolidation)

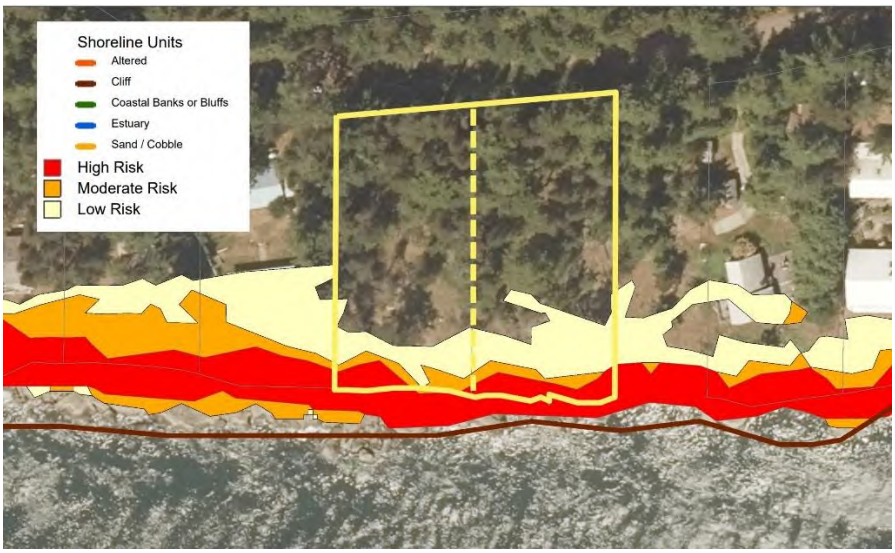
POLICY/REGULATORY

Official Community Plan Designations	**R - Rural** in the Saturna Island Official Community Plan No. 70 **Bluffs Development Permit Area**  *Bluff DPA*

Land Use Bylaw	**Rural Residential Zone** in the Saturna Island Land Use Bylaw No. 119,2 2018  *Orthozoning*
Other Regulations	N/A
Covenants	N/A
Bylaw Enforcement	N/A

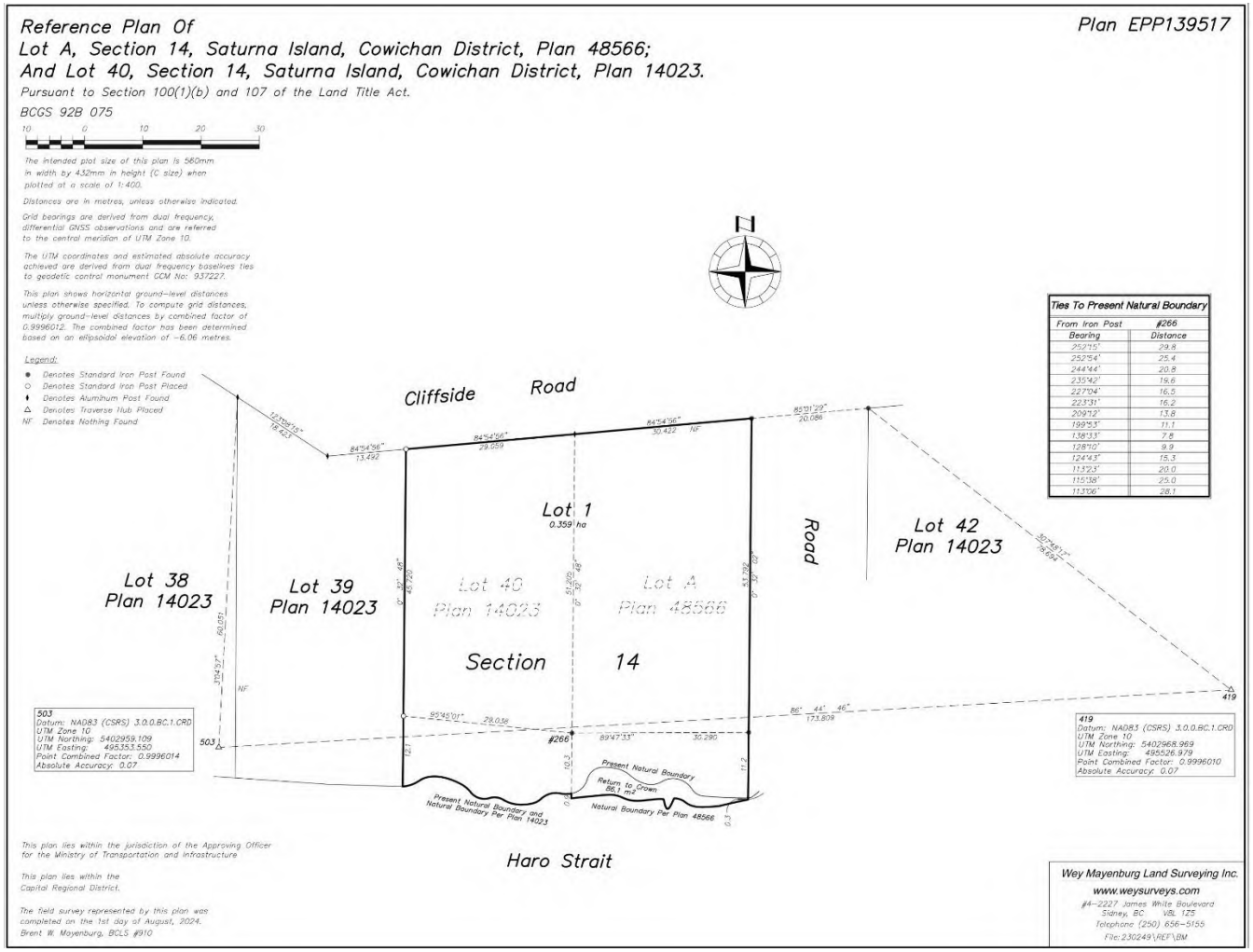
SITE INFLUENCES

Islands Trust Conservancy	The application has no considerations for the Islands Trust Conservancy
Regional Conservation Strategy	This application has no considerations for the Regional Conservation Plan.
Species at Risk	None listed - confirmed by Biologist's Report
Sensitive Ecosystems	 *Sensitive Ecosystem Mapping*

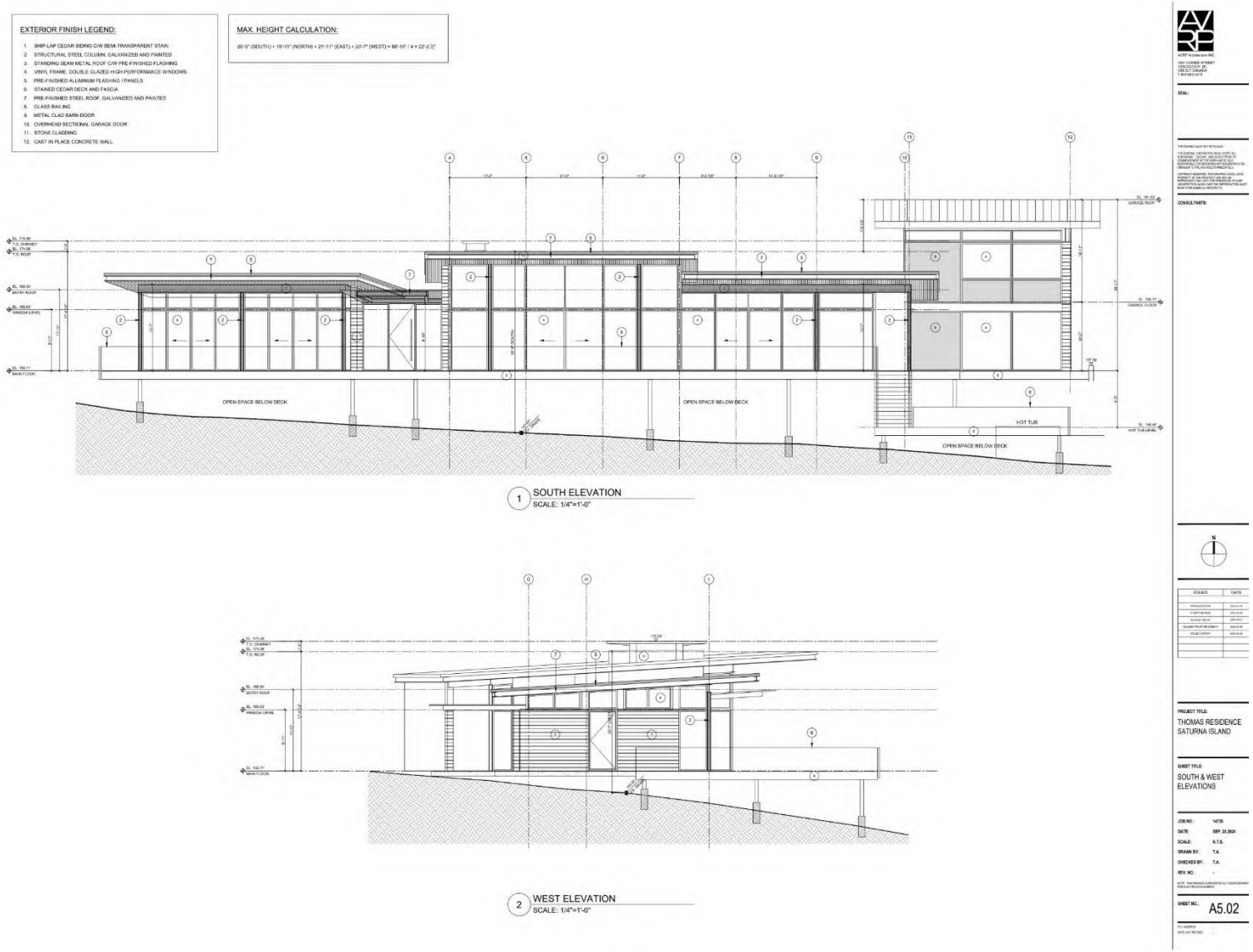
Hazard Areas	 *Steep Slope Hazard and Shoreline Mapping*
Archaeological Sites	Archaeological Potential on property (See report under 'First Nations')
Climate Change Adaptation and Mitigation	GHG emission changes are linked to allowable density on the property and will not change with approval of the DP
Shoreline Classification	Cliff (see 'Hazard Areas' – above)

ATTACHMENT 2 – PLANS & PHOTOGRAPHS

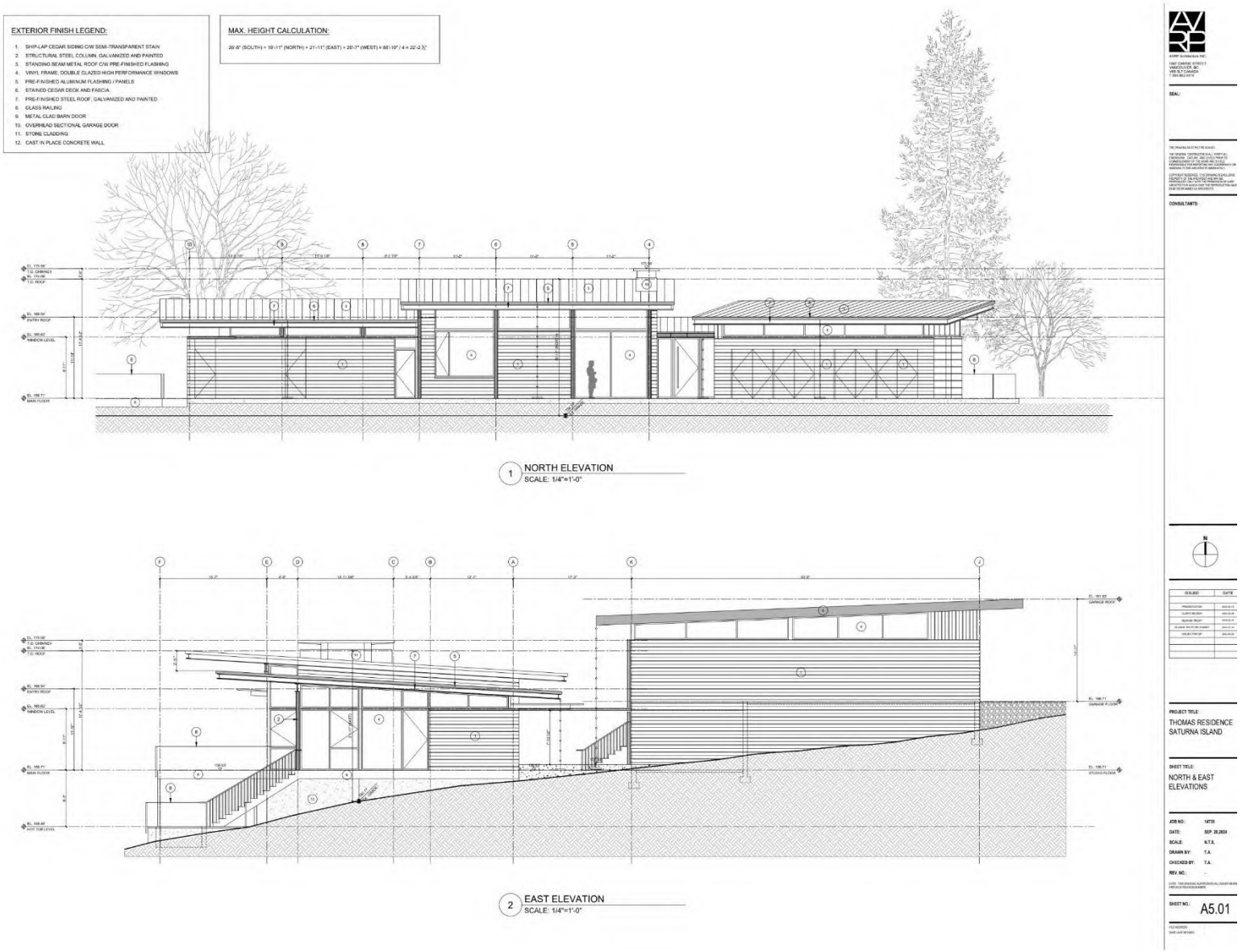
2.1 SURVEY PLAN (CONSOLIDATION PLAN TO BE REGISTERED)



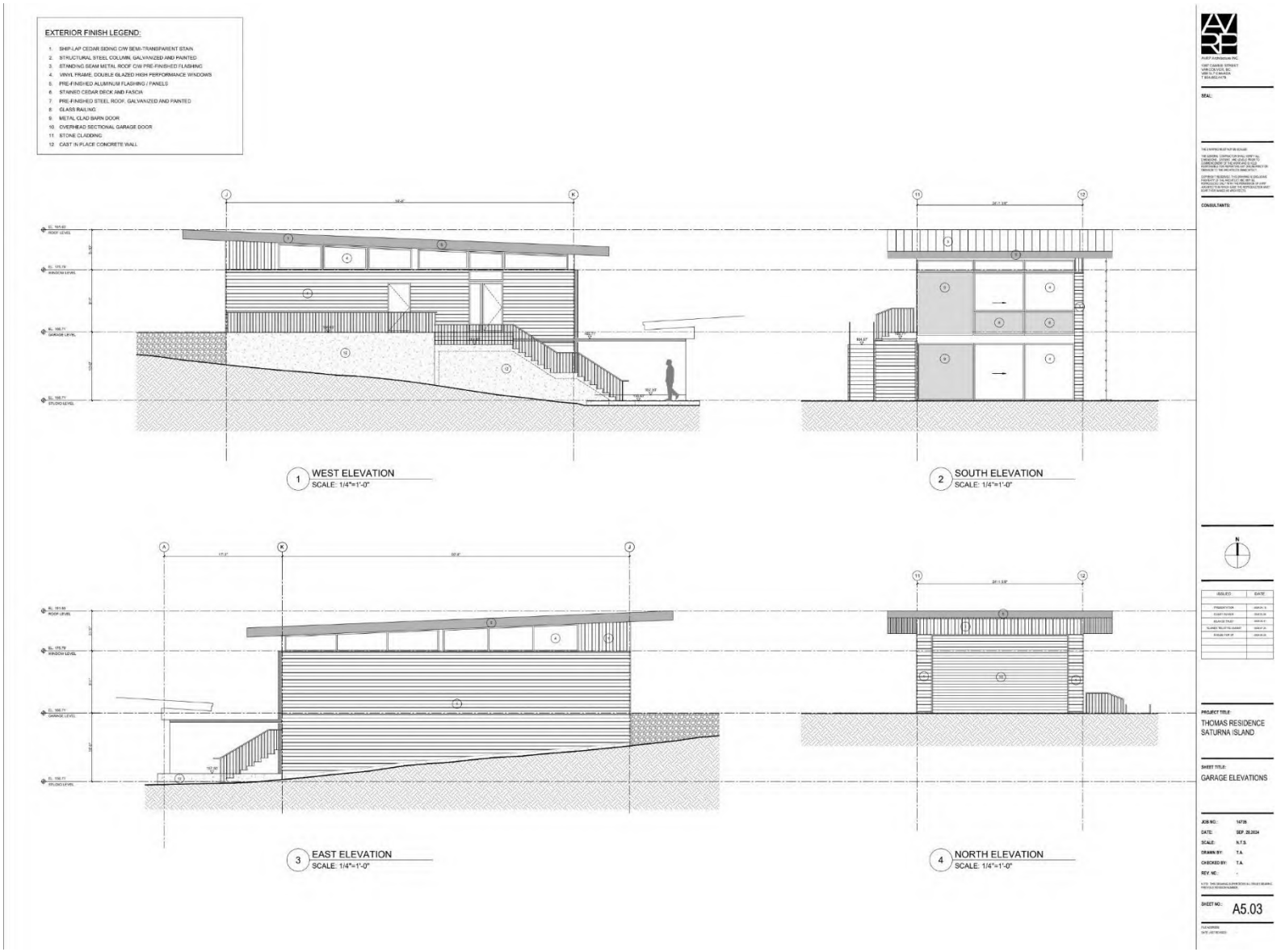
2.2 ELEVATIONS 1 OF 3



2.2 ELEVATIONS 2 OF 3



2.2 ELEVATIONS 3 OF 3 (ATTACHED GARAGE)



ARCHITECTURE

November 29th, 2024

Islands Trust

Re: Development Variance Project Narrative
180 & 182 Cliffside Road
Saturna, BC

The proposed development at 180 and 182 Cliffside Road, comprising a single-family seasonal residence and accessory garage, has been designed to respect the ecological sensitivity of its location within the Bluffs Ecosystem Development Permit Area (DPA). A key component of this design is the inclusion of an elevated deck, which contributes to a minor exceedance of the allowable site coverage by 4%. This narrative explains why the deck is a critical feature of the project and how it aligns with the environmental and functional goals of the site, warranting consideration for a development variance.

Rationale for the Elevated Deck

The deck is integral to the design for several reasons, both functional and ecological:

- **Minimal Environmental Impact**: The elevated design avoids extensive hardscaping, such as patios or paved terraces, that would require substantial land alteration. Instead, the deck allows for vegetation to grow beneath it, preserving the natural ground cover and reducing erosion risks.
- **Improved Hydrology**: Constructed with 6-inch boards spaced ¼ inch apart, the deck allows water to pass through directly to the ground, maintaining natural drainage patterns and minimizing runoff. This design effectively acts as a permeable surface, unlike traditional hardscapes, which exacerbate water accumulation and require additional drainage solutions.
- **Preservation of Sensitive Ecosystems**: By lifting outdoor living spaces off the ground, the deck protects the site's fragile ecosystems, including the unique bluff terrain. This approach minimizes soil compaction and disturbance, fostering ecological resilience.

Variance Justification

The deck area has been thoughtfully designed to achieve minimal visual and physical intrusion while providing necessary functional space for seasonal family use. Its inclusion results in a 4% site coverage overage, but this is offset by significant ecological and practical benefits:

1. Hardscaping alternatives, such as concrete or pavers, would not only increase environmental impact but also fail to align with the sustainable ethos of the Saturna Island Official Community Plan.
2. The deck offers a low-profile, visually discrete addition to the home, ensuring that the development integrates harmoniously with the natural surroundings.
3. It represents a creative solution to maximizing outdoor usability without compromising the site’s ecological integrity.

T 604 662 4479
F 604 662 4079

1067 Cambie Street
VANCOUVER BC
V6B 5L7 CANADA

Alignment with the Intent of the Bylaw

While the deck technically increases site coverage, its design aligns with the broader intent of the Bylaw: to minimize the impact of development on sensitive lands. By prioritizing an elevated, permeable, and ecologically sensitive structure over impervious ground-level hardscaping, the deck supports the preservation goals outlined in the Bluffs Ecosystem DPA guidelines.

Conclusion

The proposed variance to site coverage is minor in scale but vital to the project's environmental and functional integrity. The elevated deck serves as a thoughtful response to the site's challenges, balancing family needs with ecological preservation. We respectfully request that the variance be granted, recognizing the deck as a solution that embodies sustainable development principles while maintaining the natural beauty and integrity of Saturna Island.

With Kind Regards,

Tomasz Anielski

Principal

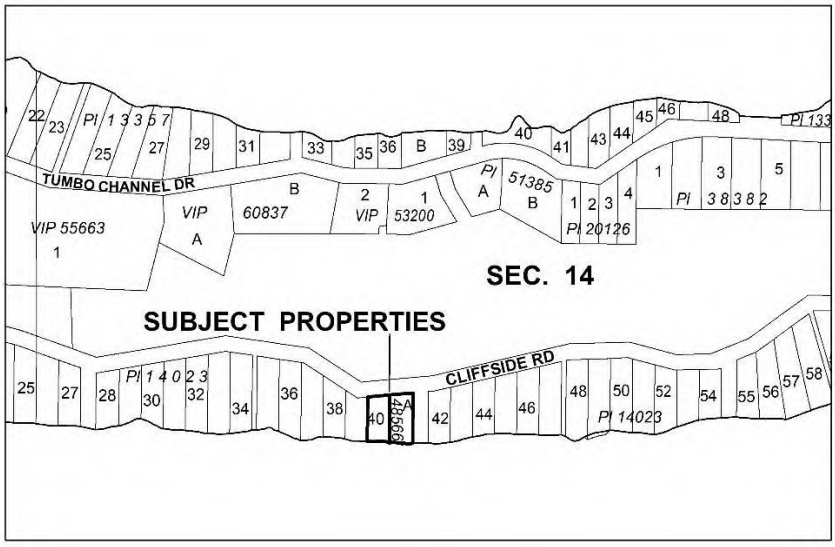
NOTICE
PLDVP20240324
SATURNA ISLAND LOCAL TRUST COMMITTEE

NOTICE is hereby given pursuant to Section 499 of the *Local Government Act* that the Saturna Island Local Trust Committee will be considering a resolution allowing for the issuance of a Development Variance Permit. The proposed permit is attached and would vary the Saturna Island Land Use Bylaw No. 119, 2018 as follows:

- A variance to increase the maximum permitted lot coverage from 20% to 24.5% to allow the construction of a dwelling on a consolidated parcel of the existing two.

Note: if approved, in order for the permit to be valid, the two properties must be legally consolidated and registered with the Land Titles Office as a single parcel.

The properties are located at **180** and **182 Cliffside Road** and are legally described as Lot 40, Section 14, Saturna Island, Cowichan District, Plan 14023 (PID: 004-454-006) and Lot A, Section 14, Saturna Island, Cowichan District, Plan 48566 (PID: 013-995-839) respectively. The general location of the subject properties is shown on the following sketch:



A copy of the proposed permit may be inspected at the Islands Trust Office, 200 - 1627 Fort Street, Victoria, B.C. V8R 1H8 between the hours of 8:30 a.m. to 4:30 p.m. Monday to Friday inclusive, excluding statutory holidays, commencing **December 27, 2024** and continuing up to and including **January 7, 2025**.

For the convenience of the public only, and not to satisfy Section 499 (2) (c) of the *Local Government Act*, additional copies of the Proposed Permit may be inspected at various Notice Boards on Saturna Island, BC, commencing **December 27, 2024**.

Enquiries or comments should be directed to Phil Testemale, Planner 2 at (250) 405-5170, for Toll Free Access, request a transfer via Enquiry BC: In Vancouver 660-2421 and elsewhere in BC 1-800-663-7867; or by fax (250) 405-5155; or by email to: southinfo@islandstrust.bc.ca before 4:30 p.m., **January 7, 2025**.

The Saturna Island Local Trust Committee may consider a resolution allowing for the issuance of the permit during the regular business meeting starting at **11:30 a.m., January 16, 2025**, at the **Saturna Recreation & Cultural Centre, 104 Harris Road** on Saturna Island.

All applications are available for review by the public. Written comments made in response to this notice will also be available for public review.

Jas Chonk, Deputy Secretary

Islands Trust

SATURNA ISLAND LOCAL TRUST COMMITTEE
DEVELOPMENT VARIANCE PERMIT
PLDVP20240324

To: Bronwen Thomas
c/o Tomasz Anielski, AVRP Architecture Inc.

1. This Development Variance Permit applies to the land described below:

   Lot A, Section 14, Saturna Island, Cowichan District, Plan 48566
   (PID: 013-995-839); and,

   Lot 40, Section 14, Saturna Island, Cowichan District, Plan 14023
   (PID: 004-454-006)

2. Saturna Island Land Use Bylaw 119, 2018 is varied as follows:

   a) Subsection 4.1.6 which states that on lots less than 0.4 hectare (one acre) in area, lot coverage for buildings and structures shall not exceed 20% is varied to permit a maximum lot coverage for buildings and structures of 24.5%.

   The development shall be consistent with Schedule 'A' attached to and form part of this permit.

3. This permit is not a building permit and does not remove any obligation on the part of the permittee to comply with all other requirements of the "Saturna Island Land Use Bylaw 119, 2018" including, but not limited to, the legal consolidation of the two parcels into a single parcel, and to obtain other approvals necessary for completion of the proposed development, including approval of the Capital Regional District and Ministry of Transportation and Infrastructure.

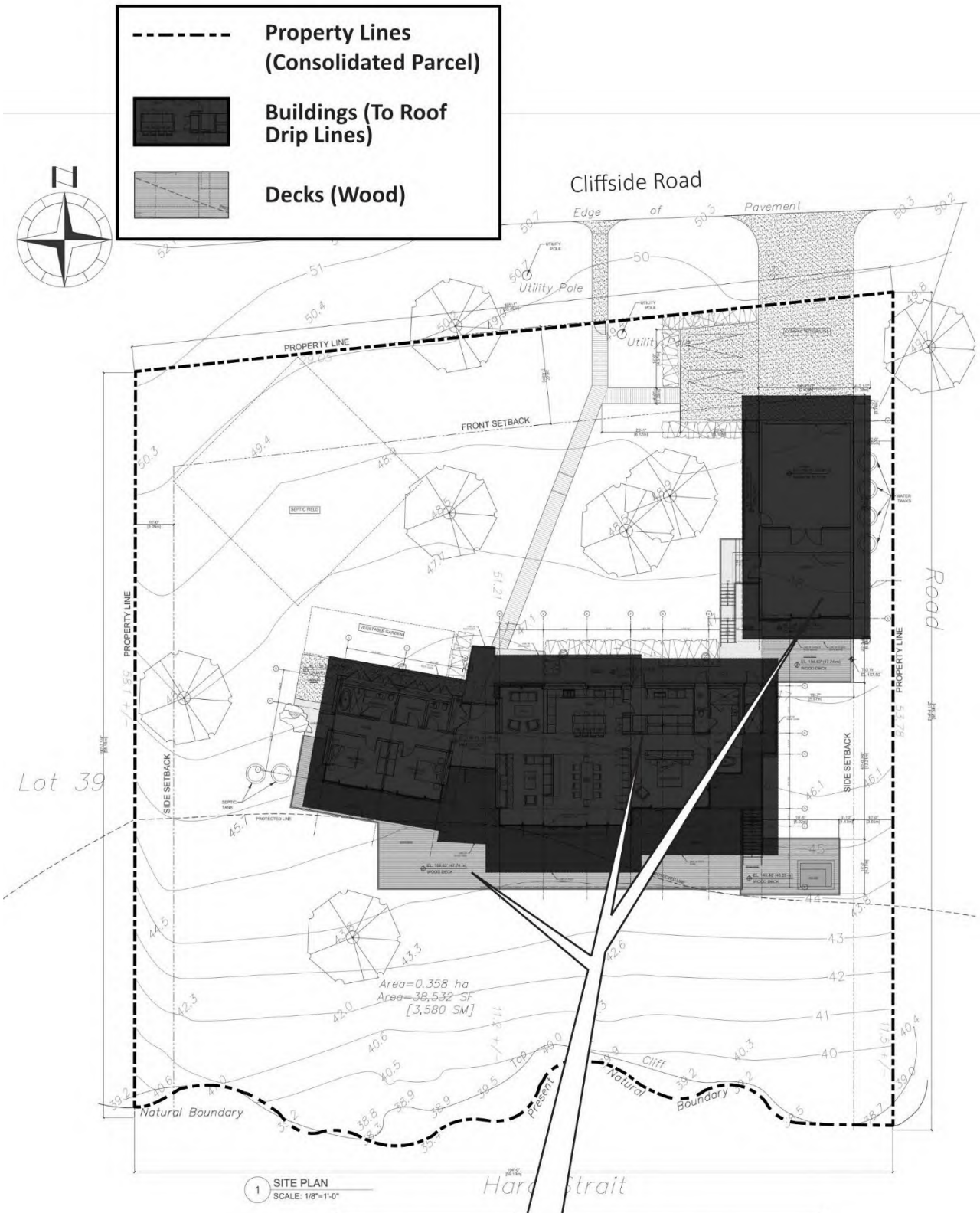
AUTHORIZING RESOLUTION PASSED BY THE SATURNA ISLAND LOCAL TRUST COMMITTEE THIS ##TH DAY OF MONTH, 2025.

_____
Deputy Secretary, Islands Trust

_____
Date of Issuance

IF THE DEVELOPMENT DESCRIBED HEREIN IS NOT COMMENCED BY THE #TH DAY OF MONTH, 2027, THIS PERMIT AUTOMATICALLY LAPSES.

SCHEDULE 'A'



Lot Coverage for buildings and structures is varied from a maximum of 20% to **24.5%**

BYLAW REFERRAL FORM

Suite 200, 1627 Fort Street
Victoria, B.C. BC V8R 1H8
Ph: (250) 405-5151
Fax: (250) 405-5155
southinfo@islandstrust.bc.ca
www.islandstrust.bc.ca

Island: North Pender Island Local Trust Area **Bylaw No.:** 235 **Date:** December 16, 2024

You are requested to comment on the attached Bylaw for potential effect on your agency's interests. We would appreciate your response within 30 days. If no response is received within that time, it will be assumed that your agency's interests are unaffected.

APPLICANTS NAME / ADDRESS:

Not applicable

PURPOSE OF BYLAW:

The purpose of draft Bylaw No. 235 is to make amendments to the North Pender Island Official Community Plan No. 171 to update Raptor and Heron Nest Development Permit Area (DPA) mapping and associated provisions.

The current Raptor Nest DPA provisions were adopted in 2008 based upon surveys conducted by local volunteers. Nest trees were mapped with assistance of Islands Trust staff. An update of wildlife trees is required as new nests are established and older ones abandoned. In addition, DPA provisions have been reviewed and updates proposed based on most recent 2013 provincial guidelines for raptor conservation.

For ease of reference and review, attached are both a redline version of draft Bylaw No. 235 with proposed revisions in track changes, and a clean version that does not include track changes.

GENERAL LOCATION:

North Pender Island Local Trust Area

LEGAL DESCRIPTION:

Multiple parcels

SIZE OF PROPERTY AFFECTED:	ALR STATUS:	OFFICIAL COMMUNITY PLAN DESIGNATION:
N/A	N/A	N/A

OTHER INFORMATION:

Additional project information, including associated project staff reports, mapping and draft Bylaw No. 235 is available at: https://islandstrust.bc.ca/island-planning/north-pender/projects/

Please fill out the Response Summary on the back of this form. If your agency's interests are *"Unaffected"*, no further information is necessary. In all other cases, we would appreciate receiving additional information to substantiate your position and, if necessary, outline any conditions related to your position. Please note any legislation or official government policy which would affect our consideration of this Bylaw.

BSmith

(Signature)

Name: Brad Smith

Title: Island Planner

Contact Info: Tel: 250-405-5194
Email: bsmith@islandstrust.bc.ca

PLEASE TURN OVER

This referral has been sent to the following agencies:

Federal Agencies
Parks Canada

Regional Agencies
Capital Regional District – Building Inspection
Capital Regional District – Planning & Protective Services

Provincial Agencies
Ministry of Municipal Affairs
Ministry of Water, Land and Resource Stewardship – Wildlife Branch

Adjacent Local Trust Committees and Municipalities
Mayne Island Local Trust Committee
Saturna Island Local Trust Committee
South Pender Island Local Trust Committee
Salt Spring Island Local Trust Committee

Non-Agency Referrals
Pender Islands Parks and Recreation Commission
Islands Trust Conservancy
Pender Islands Conservancy

First Nations
Cowichan Tribes
Halalt First Nation
Lyackson First Nation
Malahat First Nation
Pauquachin First Nation
Penelakut Tribe
Semiahmoo First Nation
Snuneymuxw First Nation
Stz'uminus First Nation
Ts'uubaa-asatx Nation (Lake Cowichan)
Tsartlip First Nation
Tsawout First Nation
Tsawwassen First Nation
Tseycum First Nation
WSANEC Leadership Council

BYLAW REFERRAL FORM
RESPONSE SUMMARY

☐ **Approval Recommended for Reasons Outlined Below**

☐ **Approval Recommended Subject to Conditions Outlined Below**

☐ **Interests Unaffected by Bylaw**

☐ **Approval Not Recommended Due to Reason Outlined Below**

North Pender Island Local Trust Area	235
(Island)	(Bylaw Number)
(Signature)	(Name and Title)
(Date)	(Agency)

STAFF REPORT

File No.: Minor Housing Amendments Review Project

DATE OF MEETING:	January 16, 2025
TO:	Saturna Island Local Trust Committee
FROM:	Robert Kojima, Regional Planning Manager Southern Team
COPY:	Brad Smith, Island Planner
SUBJECT:	Minor Housing Amendments Review Project – Draft Bylaw No. 143

RECOMMENDATIONS

1. **That the Saturna Island Local Trust Committee receives draft bylaw No. 143, cited as "Saturna Island Land Use Bylaw No. 119, 2018, Amendment No. 1, 2024", and directs staff to initiate referrals.**

2. **That the Saturna Island Local Trust Committee directs staff to prepare a staff report that provides potential options for bylaw amendments to increase zoning flexibility for housing on Saturna Island based on the framework of the Islands Trust Housing Toolkit and similar approaches being taken in other Local Trust Areas.**

REPORT SUMMARY

The purpose of this staff report is to update the Saturna Island Local Trust Committee (LTC) on the Minor Housing Amendments Review Project and to present draft Bylaw No. 143 for consideration of next steps.

The recommendations above are supported as:

- Moving forward with draft Bylaw No. 143 will allow for progress to be made on project objectives 1 and 2 while further community engagement can occur in exploring more flexible housing options;
- Proceeding with draft bylaw No. 143 will facilitate First Nations and agency referrals and further public input to identify any issues or concerns prior to consideration of first reading; and,
- The Islands Trust toolkit is well developed and being applied in other Local Trust Areas (LTAs), and this work can help inform the LTC on what options may be available to increase flexibility for housing.

BACKGROUND

The LTC has been working on the Minor Housing Amendments Review Project since May 2023. The scope includes:

1) Reviewing Schedule C of the LUB and assessing establishment of cistern requirements across the LTA;
2) Reviewing Schedule E for secondary suites and update with new provincial saltwater intrusion mapping;
3) Reviewing Multiple Family Residential (MFR) zoning restrictions and associated OCP policies.

Staff are now seeking direction on next steps for draft Bylaw No. 143 that addresses items 1 and 2, above. Staff are also seeking direction to proceed with analysis of potential options for more flexible housing as per item 3.

ANALYSIS

Regulatory

Bylaw No 143

If adopted, draft Bylaw No. 143 would result in the following changes to the Saturna Island Land Use Bylaw No. 119 (LUB):

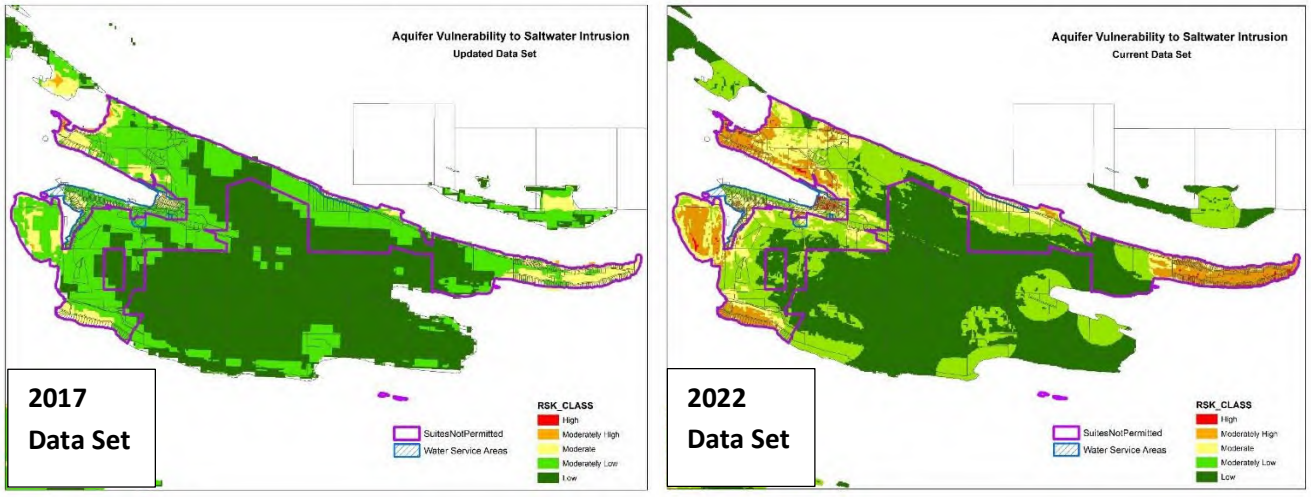
1) A minimum cistern capacity of 21820 litres (4800 gallons) would be required on Saturna Island for any new construction of a residence or visitor accommodation unit, or any addition to a residence or visitor accommodation unit that exceeds 11.6 square metres (125 square feet) of floor area. Currently, this requirement only applies in the East Point Water Management Area as depicted in Schedule C.
2) References to 'rainwater' would be expanded to 'freshwater' to be consistent with terminology used by the Senior Freshwater Specialist and being adopted in other Trust Areas.
3) Areas where secondary suites are permitted would be expanded to include some of those properties where updated saltwater intrusion data moves them from the moderate or higher risk category to moderately low or lower risk. This would be reflected in a new Schedule E map that shows these parcels no longer cross-hatched and thus permitted to have a secondary suite.

   As currently drafted, and despite some parcels in these areas moving into the lower risk category for saltwater intrusion, the updated Schedule E does not include any parcels where secondary suites would be permitted in either the East Point Water Management Area or within the Saturna Beach Strata Corporation. This is consistent with the current Schedule E map, as further described below.

Schedule E Mapping Considerations

Figure 1. shows the existing and new 2022 provincial saltwater intrusion data layers for Saturna Island. The new data set does have more areas in the low and moderately low categories. However, the data is also not as fine a scale as the original data set as can be seen by the larger block polygons in the 2022 mapping image. Given this much more granular mapping scale, the new data may not be as accurate or precise in some instances at the site-specific individual parcel level than the 2017 data.

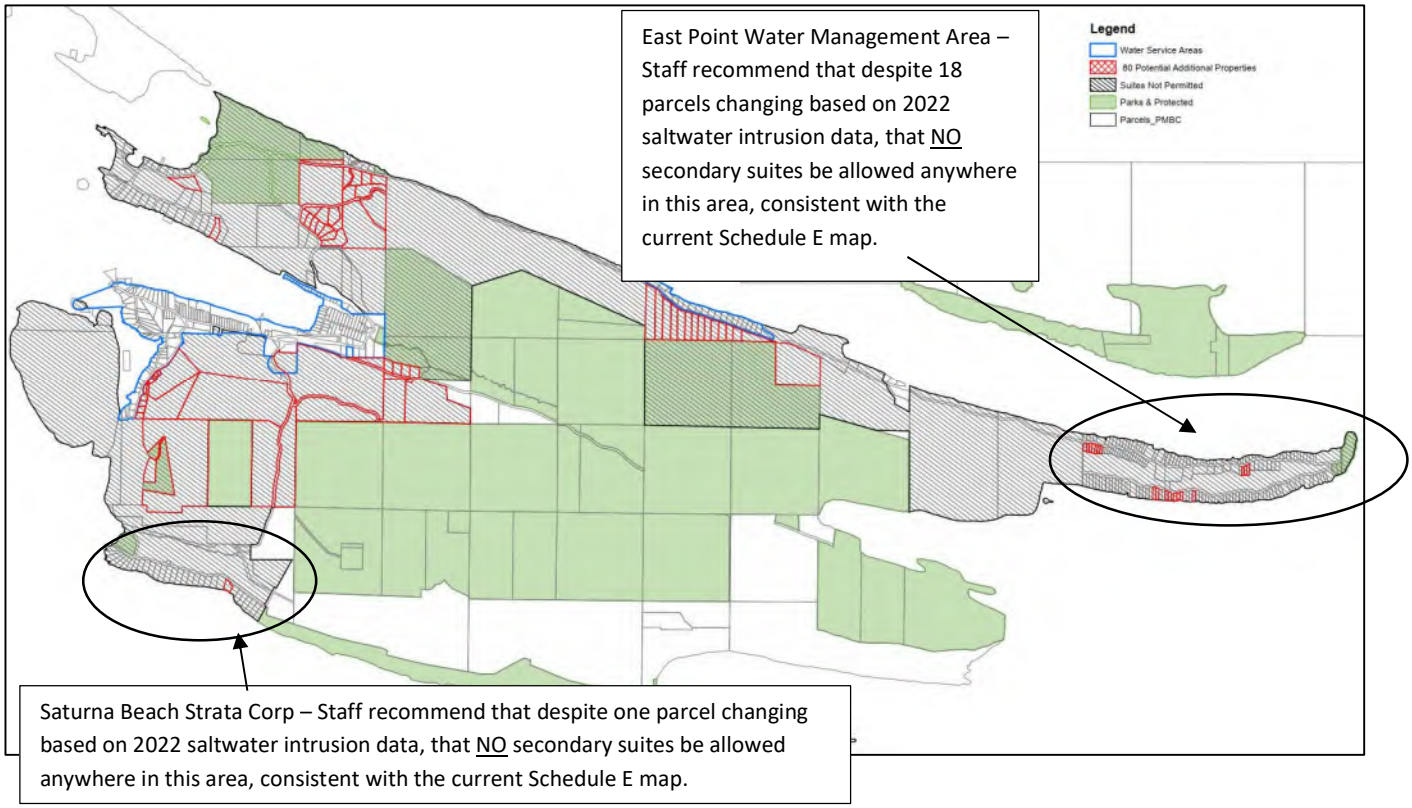
Figure 1. 2017 and 2022 Saltwater Intrusion Mapping, Saturna Island



As shown outlined in red in figure 2, a total of 80 parcels have been identified where the new 2022 saltwater intrusion data moves that parcel entirely within low or moderately low risk categories, which then could potentially allow them to have a secondary suite, based on this parameter alone.

In the East Point Water Management Area, there are 18 parcels where the new data sites them entirely within low or moderately low risk categories. However, given the significant known water issues in the area, and to ensure fairness within the local community, staff have not included these parcels in the updated schedule E map, and thus secondary suites would still not be permitted anywhere in the East Point Water Management Area. The one parcel located within the Saturna Beach Strata Corporation has also not been included for the same reasons.

Figure 2. Parcels Identified that are entirely within low or moderately low risk categories based on 2022 data

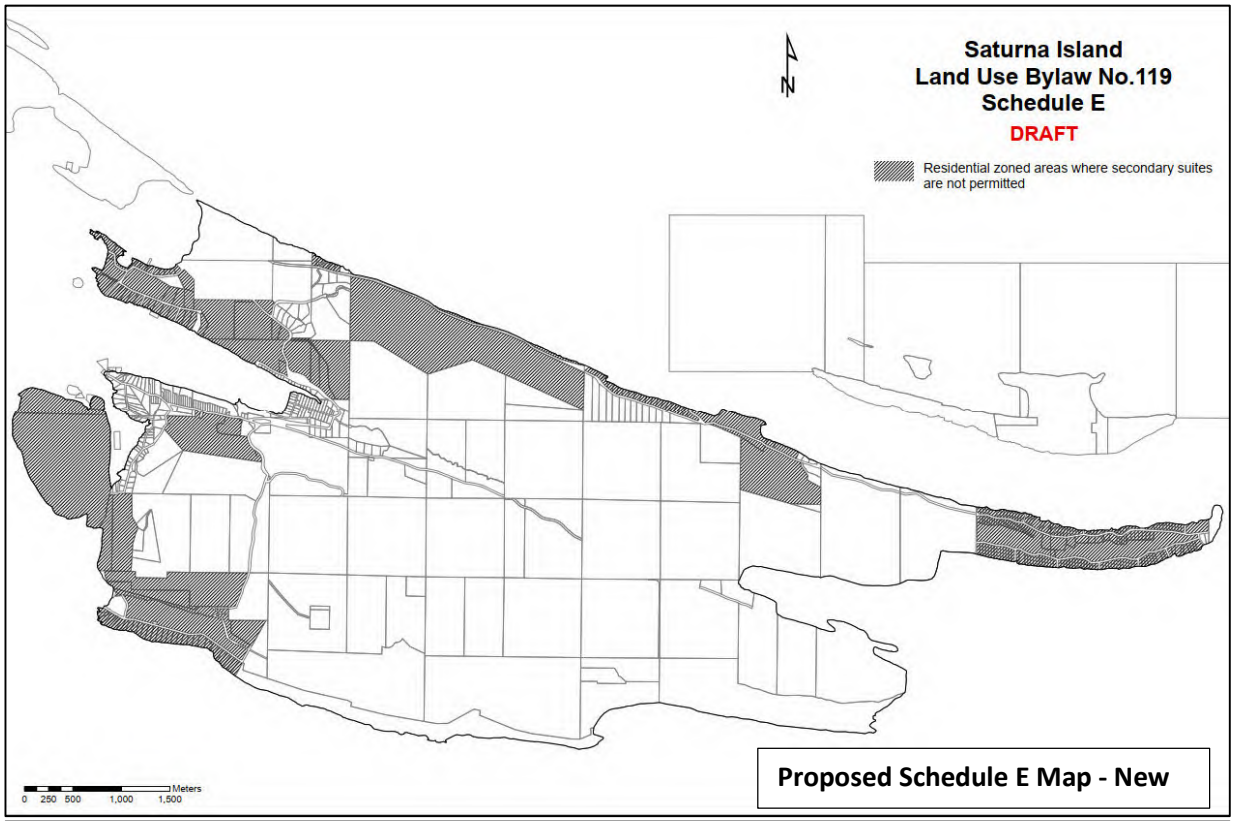


As such, the amended Schedule E map (Figure 3) includes a total of 61 additional parcels where secondary suites would now be permitted (ie. All of the parcels in red in Figure 2 other than those located in the East Point Water Management Area or the Saturna Beach Strata Corporation).

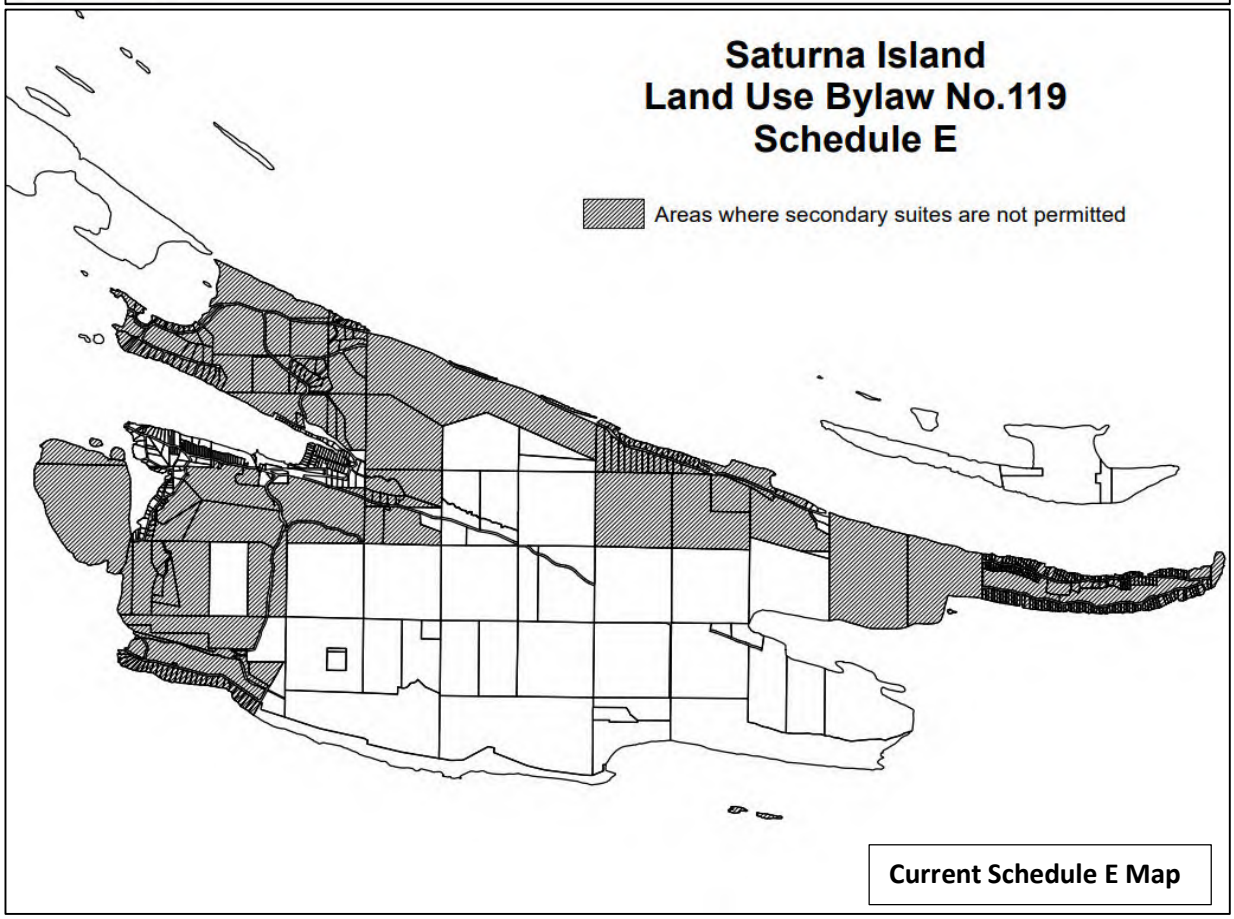
For clarity, staff have also adjusted the map legend to only include residential zoned properties where secondary suites are not permitted and subsequently removed the cross-hatching from all designated parks and First Nation reserves.

Note: Currently, the Schedule E map depicts areas where suites are not permitted. Staff are of the view that this information may present itself better if the map were to show areas where secondary suites are permitted, rather than not. If the LTC is interested in this alternative approach, staff will bring revised maps forward at the next meeting for consideration. This work would not impact timing of bylaw referrals as there would be no changes to the underlying data, only how it is being presented.

Figure 3. Proposed New Schedule E Map and Current Map for Comparison



Proposed Schedule E Map - New



Current Schedule E Map

Islands Trust Policy Statement

Staff are of the view that draft Bylaw No. 143 is not contrary to or at variance with Islands Trust Policy Statement (ITPS) policies, in particular with respect to policies related to ecosystem protection and preservation, stewardship of freshwater resources, and growth and development.

If the LTC decides to proceed, the ITPS policy checklist will be presented to LTC for review and consideration in a future staff report when the draft bylaws are presented for 1st reading.

Official Community Plan

The proposed amendments initiated by draft Bylaw No. 143 are generally consistent with or not in conflict with the policies of the OCP, including natural environment, residential and water supply policies.

Options for Flexible Zoning

While the initial scope of the project was to review MFR zoning only, community and LTC discussion has led to a broader consideration of potential zoning amendments to increase housing flexibility. The Islands Trust toolkit is well developed and provides a good starting point for exploring those options. Work underway in other LTAs, based on the Housing Toolkit framework, are also well advanced and could help inform the LTC of potential options that could be applied to Saturna Island.

As such, staff are recommending that the LTC direct staff to prepare a report that provides potential options for bylaw amendments to increase zoning flexibility for housing on Saturna Island, based on the framework of the Islands Trust Housing Toolkit and similar approaches being taken in other Local Trust Areas.

Consultation

First Nations Engagement

Staff have sent an early engagement letter to all identified First Nations with an invitation to engage and participate in the project. To date, no responses have been received.

Should LTC proceed with draft Bylaw No. 143, bylaw referrals will be sent the same group of First Nations.

Agency Referrals

Staff will refer draft Bylaw No. 143 to the following:

- CRD, Planning and Protective Services
- CRD, Building Inspection
- CRD Water Quality Division (in respect of Lyall Harbour-Boot Cove Water System)
- Island Health
- Ministry of Water, Land and Resource Stewardship – Water Management Branch
- Mayne Island Local Trust Committee
- South Pender Island Local Trust Committee
- North Pender Island Local Trust Committee

The LTC could direct staff to complete additional referrals not on this list.

Statutory Requirements

In this case, as there are no OCP amendments, and consistent with *Local Government Act* s. 464 (2), the LTC could decide to not hold a public hearing. However, notice would need to be given prior to first reading.

If the LTC decides to hold a public hearing, this would occur after draft bylaws have received at least first reading. Public hearing notice would be posted as per statutory and bylaw requirements in advance of a public hearing.

At this time, staff recommend that a final draft bylaw be brought back to the LTC at the April meeting following completion of bylaw referrals, and the LTC can then decide whether to hold a public hearing or not. If the LTC decides to not hold a public hearing, staff will give notice of first reading for the July meeting. At that July meeting, the LTC could then give first, second and third readings and send to Executive Committee for approval prior to final adoption.

Rationale for Recommendation

The recommendations on page 1 are supported as:

- Moving forward with draft Bylaw No. 143 will allow for progress to be made on project objectives 1 and 2 while further community engagement can occur in exploring more flexible housing options;
- Proceeding with draft bylaw No. 143 will facilitate First Nations and agency referrals and further public input to identify any issues or concerns prior to consideration of first reading; and,
- The Islands Trust toolkit is well developed and being applied in other LTAs, and this work can help inform the LTC on what options may be available to increase flexibility for housing.

ALTERNATIVES

The LTC may consider the following alternatives to the staff recommendation:

1. **Request further information**

   The LTC may request further information prior to making a decision. Recommended wording for the resolution is as follows:

   That the Saturna Island Local Trust Committee request that...

2. **Not proceed with a separate amending bylaw for water storage and secondary suite provisions**

   The LTC may decide not to proceed with a separate bylaw and instead consider all bylaw amendments in one package including any proposed changes to MFR zoning or flexible housing options.

3. **Not Proceed with the Project**

   The LTC may decide to not proceed with the project.

4. **Receive for information**

   The LTC may receive the report for information.

NEXT STEPS

With direction from LTC, staff will initiate bylaw referrals and prepare a staff report with options for more flexible zoning in relation to housing.

Submitted By:	Brad Smith, Island Planner	January 7, 2025
Concurrence:	Robert Kojima, Regional Planning Manager	January 8, 2025

1. Draft Bylaw No. 143
2. Secondary Suite Public Engagement Map
3. Draft Schedule E Map – High Resolution

DRAFT

SATURNA ISLAND LOCAL TRUST COMMITTEE
BYLAW NO. 143

A BYLAW TO AMEND SATURNA ISLAND LAND USE BYLAW NO. 119, 2018

The Saturna Island Local Trust Committee, being the Local Trust Committee having jurisdiction in respect of the Saturna Island Local Trust Area under the *Islands Trust Act,* enacts as follows:

1. Citation

   This bylaw may be cited for all purposes as "Saturna Island Land Use Bylaw No. 119, 2018, Amendment No. 1, 2024".

2. Saturna Island Local Trust Committee Bylaw No. 119, cited as "Saturna Island Land Use Bylaw No 119, 2018," is amended as follows:

   2.1 Section 2.17 – Water Storage, is amended by:
   i) deleting the words "in the water management area depicted on Schedule C";
   ii) replacing the word "rainwater" with the word "freshwater".

   2.2 Section 2.18 – Secondary Suites, Subsection 2.18.5 is amended by deleting the words "as having moderate to high aquifer vulnerability depicted".

   2.3 Section 15.1, Subsection 15.1.13 "floor area" is amended by replacing the word "rainwater" with the word "freshwater".

   2.3 Schedule "C" – Eastpoint Water Management Area, is deleted in its entirety and replaced with 'Reserved'.

   2.4 Schedule "E" – Secondary Suites Map, is deleted in its entirety and replaced by Schedule "E" - Secondary Suites Map dated *INSERT DATE,* attached to and forming part of this bylaw.

3. SEVERABILITY

   If any provision of this Bylaw is for any reason held to be invalid by a decision of any Court of competent jurisdiction, the invalid provision must be severed from the Bylaw and the decision that such provision is invalid must not affect the validity of the remaining provisions of the Bylaw.

READ A FIRST TIME THIS _____ DAY OF _____ 20____

PUBLIC HEARING HELD THIS _____ DAY OF _____ 20____

[public hearing date should be consistent with chronology and can be after first or second reading; ***If two public hearings, only indicate the date of the last one]***

READ A SECOND TIME THIS _____ DAY OF _____ 20____

READ A THIRD TIME THIS _____ DAY OF _____ 20____

APPROVED BY THE EXECUTIVE COMMITTEE OF THE ISLANDS TRUST THIS
_____ DAY OF _____ 20____

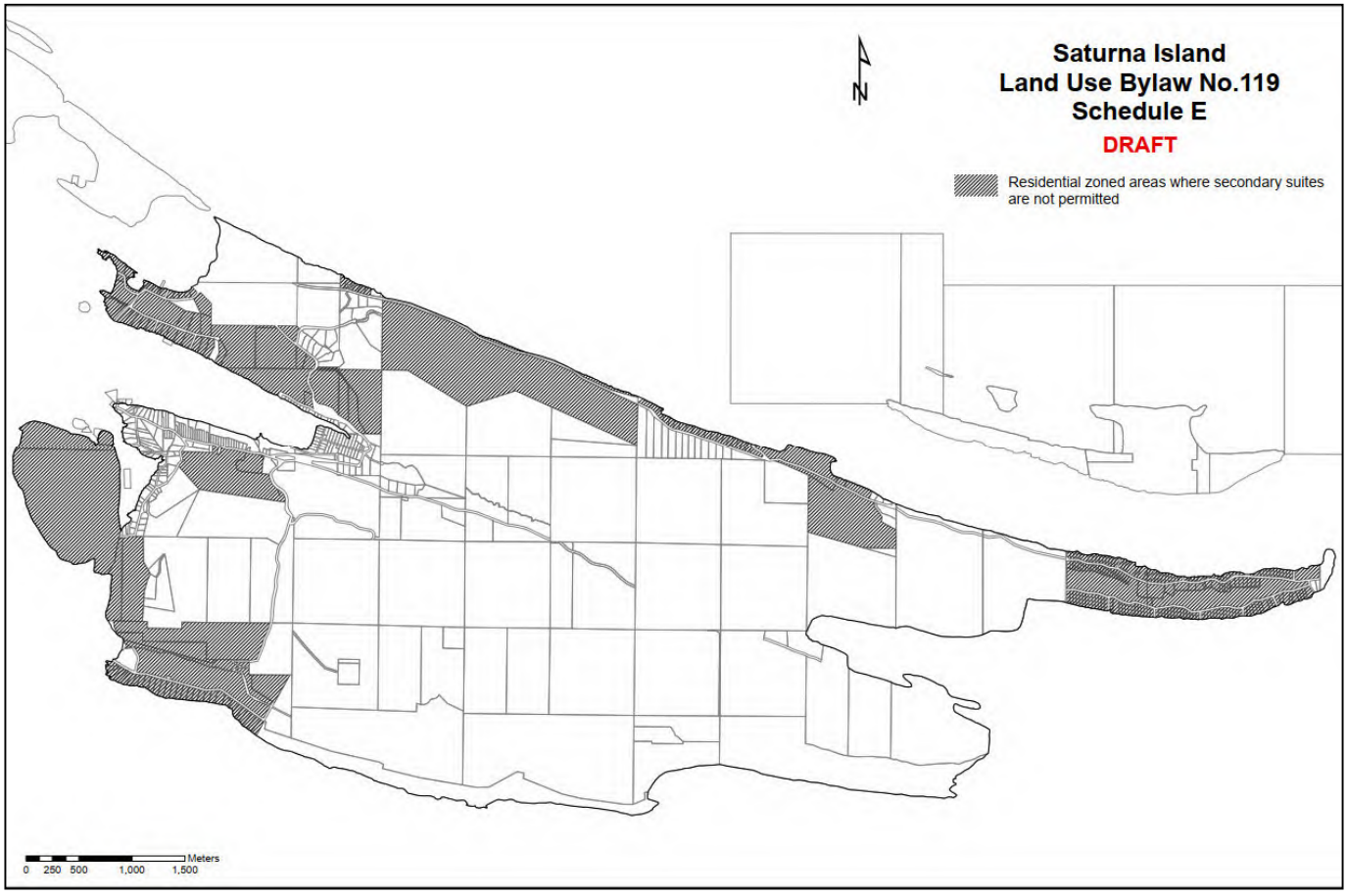
ADOPTED THIS _____ DAY OF _____ 20____

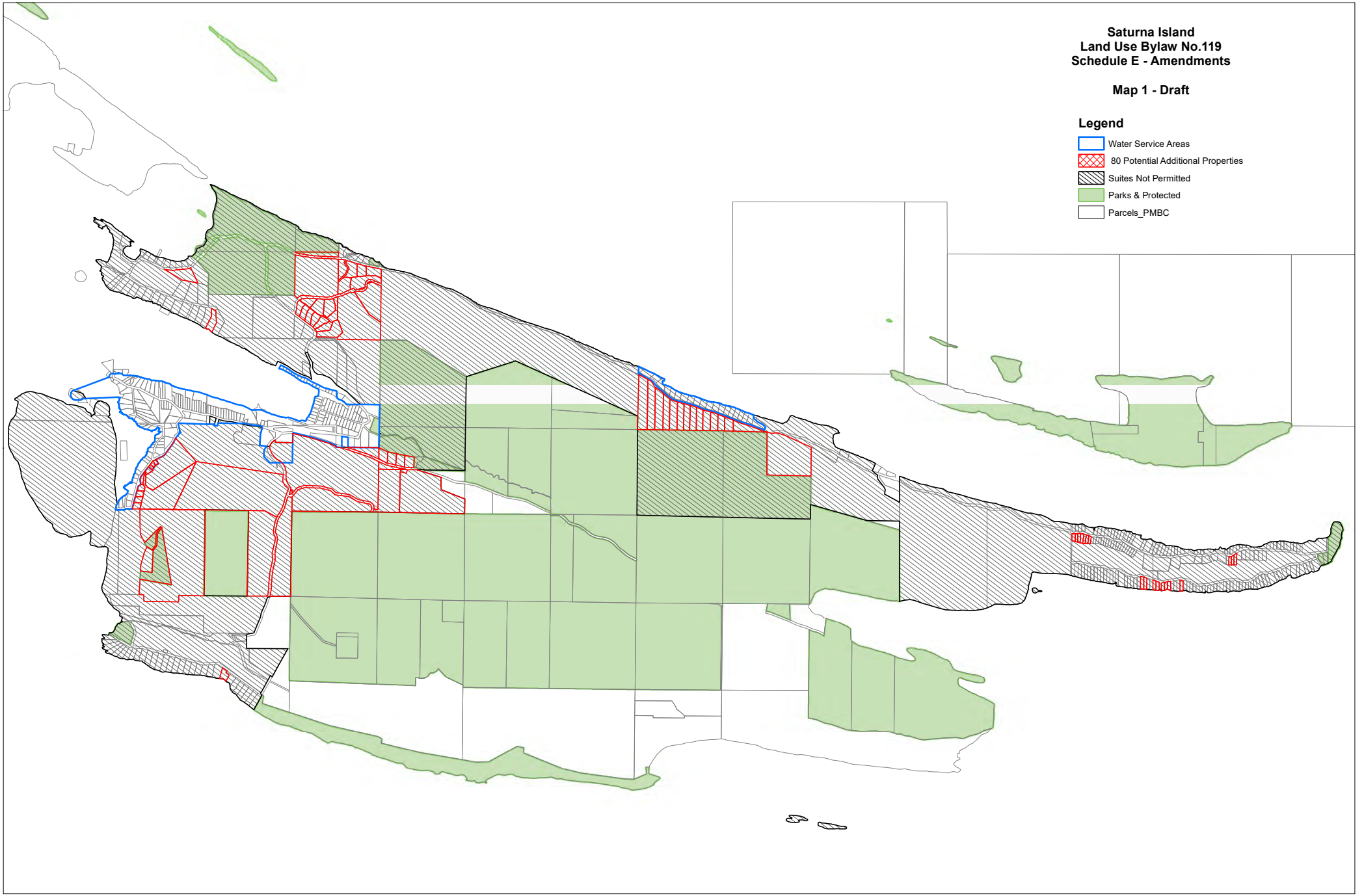
_____ _____

CHAIR SECRETARY

SATURNA ISLAND LOCAL TRUST COMMITTEE
BYLAW NO. 143

Schedule E - Secondary Suites Map




Saturna Island
Land Use Bylaw No.119
Schedule E - Amendments
Map 1 - Draft
Legend
Water Service Areas
80 Potential Additional Properties
Suites Not Permitted
Parks & Protected
Parcels_PMBC

Saturna Island
Land Use Bylaw No.119
Schedule E

DRAFT

Print Date: January 8, 2025

Follow Up Action List

Active Projects Report

Saturna Island

1. *Minor Project - Minor housing amendments review project*	Responsible	Dates
Activity:	Brad Smith Robert Kojima	Rec'd: 23-May-2024

Future Projects Report

Saturna Island

1. *Groundwater Sustainability Project*	Responsible	Date Received
Phase 1 report pending completed LTC direction to defer proceeding with consideration of implementation		

2. *Shoreline policy review*	Responsible	Date Received
		23-May-2024

Islands Trust

LTC EXP SUMMARY REPORT F2025

Invoices posted to Month ending November 2024

660 Saturna	Invoices posted to Month ending November 2024	Budget	Spent	Balance
65000-660	LTC "Trustee Expenses"	100.00	161.84	-61.84
LTC Local				
65200-660	LTC - Local Exp - LTC Meeting Expenses	790.00	1,333.56	-543.56
TOTAL LTC Local Expense		790.00	1,333.56	-543.56
Projects				
73001-660-4135	Saturna Minor Housing Review	2,000.00	250.00	1,750.00
TOTAL Project Expenses		2,000.00	250.00	1,750.00

Standing Resolutions Log

Saturna Island

Resolution Number	Action	Date
2024-015 (Standing)	**Carried**	**15-Feb-2024**

Southern Resident Killer Whale Management Measures Review - Supported

That Saturna Island Local Trust Committee fully supports the implementation of the following measures for the recovery of Southern Resident killer whales in the waters of the Saturna Island Local Trust Area:
a) that commercial whale watching boats be regulated and or licensed to mirror the regulatory regime established in the adjacent waters of Washington State.
b) the continuation of annual interim measures by the Government of Canada including recreational and commercial salmon fishing closures, interim sanctuary and speed restricted zones, and avoidance
requirements whereby vessels are prohibited from approaching any killer whale at a distance of less than 400-metres, or impeding the path of an individual or group;
c) efforts by the Government of Canada to develop longer-term and permanent measures, and integrate the annual interim measures into existing management processes; and,
d) large commercial vessel speed reduction initiatives as part of the Southern Resident killer whale 2019 conservation agreement signed between Canada and shipping industry stakeholders.

Standing Resolutions Log

Saturna Island

Resolution Number	Action	Date
2023-008 (Standing)	**Carried**	**16-Feb-2023**
16.5 Bylaw notification requirements on Saturna that it be resolved that Clause 2 in Saturna Local Trust Committee Bylaw 30 - A Bylaw to Authorize Inspection of Alleged Infractions Against Regulations - is replaced on an interim basis with the wording of Clause 14.1 from Saturna Local Trust Committee Bylaw 119 - Land Use Bylaws amalgamated. This clause reads 'The Island Trust Bylaw Enforcement Officer or any other person designated by the Saturna Island Local Trust Committee to administer this Bylaw is authorized to enter, at any reasonable time and after having given two-weeks prior notification to the occupier, upon any property that is subject to regulation under this Bylaw, for the purpose of determining whether the regulations are being observed.' This Standing Resolution will remain in place until such time a review of Bylaw No. 30 and Bylaw No. 119 Section 1.4 'Inspection and Enforcement' can be reviewed and re-enacted through public process embodying Bylaw Enforcement Best Practices outlined in the 2022 Ombudsperson of British Columbia report concerning Local Government Bylaw Enforcement Policy and Practice. Amended on February 15, 2024 (15.4) - Amend standing resolution 2023-008 by replacing changing all references of '24 hours' to 'two-weeks'.		
2021-007 (Standing)	**Carried**	**21-Oct-2021**
14.4 Potable rain water catchment systems That the Saturna LTC endorses the use of potable rain water catchment systems as proof of adequate potable water for residential subdivision, subject to the withholding of temporary or final occupancy permits until such catchment systems are in place.		
2019-036 (Standing)	**Carried**	**09-May-2019**
13.2 Unlawful Short-Term Vacation Rental Enforcement Policy - Staff Report that the Saturna Island Local Trust Committee only authorize enforcement against unlawful short term vacation rentals, unless one of the following circumstances exists: 1. There is more than one complainant from the immediate neighbourhood; 2. The complaint is made by a representative of an improvement district and it concerns overuse of water; 3. The complaint concerns use of a common driveway servicing at least two separate lots; 4. There is a written complaint by owners or residents in the immediate neighbourhood about bona fide nuisance issues such as noise or parking congestion related to the STVR.		

Standing Resolutions Log

Saturna Island

Resolution Number	Action	Date
2019-017 (Standing)	**Carried**	**09-May-2019**
7.1 Follow-up Action List Dated May 2019 that Saturna Local Trust Committee no longer wishes to receive bylaw referrals from adjacent local trust committee areas unless the planner deems it in the interest of the LTC to review and comment on a specific referral.		
2019-011 (Standing)	**Carried**	**17-Jan-2019**
13.2 Unlawful Dwelling Policy that the Saturna Island Local Trust Committee directs staff to take enforcement action against unlawful dwellings only if one of the following conditions exists: There is a complaint from an immediate neighbour; or there is a referral from an agency responsible for health and safety issues that is doing concurrent enforcement. Nothing in this enforcement policy should be interpreted as giving permission to violate the Land Use Bylaw and the Saturna Island Local Trust Committee may change this policy at any time and may give direction to expand enforcement activities at any time.		

Islands Trust

Standing Resolutions Log

Saturna Island

Resolution Number	Action	Date
2018-050 (Standing)	**Carried**	**04-Oct-2018**

- Proposed or amended licenses for non-medical cannabis retail establishments require an application to the local trust committee.
- The application process shall comprise a public consultation component, which includes at least one notification to neighbours, one public meeting, posting of public notices and one advertisement in a local periodical.
- The public consultation process shall be determined by the local trust committee after initial review of the proposal.
- However, as a minimum, the local trust committee will mail or otherwise deliver a notice to all owners and residents of properties within a 500 metre radius of the subject property where the establishment is proposed at least 10 days before adoption of a resolution providing comment on the application. The required notice shall include the following information:

o Name of the applicant and a description of the proposal in general terms
o The location of the proposed establishment and the subject site
o The place where, and date and time when, both a public meeting will be held and a resolution of the local trust committee considered.
o The name and contact information of the Islands Trust planning staff member who can provide copies of the proposed or amended license application
o How public comments may be submitted to the local trust committee.

2012-011 (Standing)	**Carried**	**09-Feb-2012**

It was Moved and Seconded that where a Liquor Control and Licensing Branch Special Occasion License referral relates to a property where Saturna Island Land Use Bylaw No. 78, 2002 permits public assembly uses, such as halls, recreation facilities or restaurants, and where there have been no issues related to parking or past complaints for the preceding three years, planning staff may approve the Special Occasion License without referral to the Local Trust Committee. All other Special Occasion License referrals are to be referred to the Local Trust Committee for consideration

Islands Trust

Standing Resolutions Log

Saturna Island

Resolution Number	Action	Date
2011-000 (Standing)	**Carried**	**22-Jun-2011**
It was Moved and Seconded that the Saturna Island Local Trust Committee adopt a Standing Resolution to direct staff to place the in camera minutes on the agenda when there is a need to close the meeting or at least once a year.		
2009-009 (Standing)	**Carried**	**25-Feb-2009**
It was Moved and Seconded that the Saturna Island Local Trust Committee draft minutes be adopted by Resolution without meeting within 30 days of the meeting and posted to the website.		
2007-016 (Standing)	**Carried**	**16-May-2007**
Travel Trailer or Camper It was Moved and Seconded that staff be directed to not take enforcement action against property owners when a travel trailer or camper is located on a lot when: - The travel trailer or camper is being used for recreational purposes by the owners of the lot and; - The travel trailer or camper is being used intermittently and for short periods not exceeding two months. Not withstanding this direction, staff is to take action to prevent the recreational use of travel trailers or campers on inappropriately zoned land if: - The travel trailer or camper is being used as a second residence or; - The trailer or camper is situated within the setbacks for a structure or; - There are serious safety issues, unsightliness, noise, or health problems related to the use or; - A complaint based on the above three items is received from a person who owns neighboring property. Nothing in this direction should be interpreted by a property owner as giving permission to violate the Land Use Bylaw and the Saturna Island Trust Committee may change this policy at any time and may give direction to enforce the Bylaw at any time.		

HIGHLIGHTS OF ISLANDS TRUST CONSERVANCY NOVEMBER 19TH, 2024 BOARD MEETING

NOTE: For more detail on Islands Trust Conservancy meetings, including meeting minutes, please visit https://islandstrust.bc.ca/whats-happening/meetings-and-events/

1. ORGANIZATION UPDATES/TEAM

- Chair Smith provided a reminder that there will be an election for Chair and Vice Chair in January 2025, and advised she will be stepping down as Chair.
- The ITC Board and ITC staff reported on the highlights of attending the Salish Sea Conservation Forum on Galiano Island on October 18th, 2024.

2. STRATEGIC PLANNING/ADMINISTRATION

- The ITC Board adopted the proposed board meeting schedule from January 2025 to March 31st, 2026. Staff were directed to schedule the following ITC board meeting dates: January 21st, May 27th, October 7th, November 18th, 2025 and January 20th, 2026 as electronic meetings, and list the Victoria office board room as the public meeting location. Three in-person meetings will be held on March 18th and July 22nd, 2025, and March 17th, 2026.
- The ITC Board approved an increase of $7,582 to its proposed 2025-26 Salaries and Benefits budget (Islands Trust Contribution) due to an error in its earlier submission relative to the amount available from the Environment and Climate Change Canada Contribution Agreement for Salaries and Benefits in 2025-26. In light of the increasing budget line request, the Board approved reducing the Board's training budget line by $3,000 (originally increased to support education on Indigenous Conserved and Protected Areas). The board directed staff to provide these changes to the Financial Planning Committee and Trust Council.
- The ITC Board will indicate to Financial Planning Committee and Trust Council its supports for the Trust Area Services business case for an Auxiliary Policy Advisor for 2025-26 as this position is critical for ongoing intergovernmental and policy work. The ITC Board requests that a portion of an Auxiliary Policy Advisor position be dedicated to support the Conservancy's engagement with First Nations on the development of its next Five Year Plan.
- Trustee Elliott provided an update to the ITC Board from Executive Committee. Items reported include identifying an upcoming Executive Committee meeting on November 20th in preparation for Trust Council's December meeting, welcoming the new Islands Trust Chief Administration Officer, Reuben Bronee, and that the Policy Statement amendment project is proceeding through Committee of the Whole discussions and will go to communities and ITC before it is finalized.

- Trustee Yates reported that no changes to the proposed ITC budget were requested by Financial Planning Committee.
- Trustee Gauvreau provided an update to the ITC Board from Governance Committee including that the Committee is reviewing the Trustee remuneration policy to ensure that Islands Trust is following best practices and is submitting two business cases to Financial Planning Committee for inclusion in the 2025-26 budget; for a full-time Corporate Secretary and for policy assistance. The committee also set its 2025-26 meeting schedule and supported a suggestion to create a governance manual to help organize policies.
- The ITC Board received a Salt Spring Island LTC Planning Referral Notice and discussed how best to review and comment referrals in a timely manner.

3. COVENANT AND PROPERTY ACQUISITIONS

- The ITC Board approved the conservation proposal submitted by Tara Martin to place a NAPTEP covenant on approximately 1 ha of Salt Spring Island, subject to review of First Nations responses and to Ministerial approval, to protect woodlands and herbaceous habitats, maturing dry Douglas-fir forest, and connectivity with adjacent protected areas.

4. COVENANT AND PROPERTY MANAGEMENT

- The ITC Board granted the request of Sallas Forest Strata, Sidney Island, to use an excavator to extract invasive Crataegus monogyna (hawthorn) trees from covenants ES065747 (Dragonfly Pond), ES65743 (Woodpecker Pond), and ES065749 (Kingfisher Pond) and to dispose of the biomass on site by burning. A temporary waiver of certain sections of the covenant was granted, subject to specific terms to allow this work.
- The ITC Board accepted the ITC Natural Area Protection Tax Exemption Program (NAPTEP) Covenant Monitoring Report 2024 and directed staff to address compliance and ecological concerns as identified in the report.
- The ITC Board accepted the ITC Nature Reserve Monitoring Report 2024 and directed staff to address the recommendations as identified in the report.
- The ITC Board approved soil moisture research at Link Island Nature Reserve by the Swift family, subject to First Nations consultation and the covenant holder's approval.
- The ITC Property Management Specialist presented a briefing on Gambier Island Local Trust Committee requesting the use of Squamish language on ITC Nature Reserve signage on Gambier Island.

5. COMMUNICATIONS AND OUTREACH

- The ITC Board directed staff to prepare and submit a letter from the ITC Board to the Minister of Municipal Affairs that reiterates the ITC's desire to undertake meaningful First Nations engagement, explains the ITC's staff capacity challenges, provides the Board's proposed ITC Plan engagement outline, and seeks the Minister's support for the updated timeframe for development and submission of the next ITC Plan.
- The ITC Board requested that Director Frater consider if a portion of the new Trust Area Services Policy Advisor position, supposed by Trust Council in September 2024, can be targeted to assist ITC staff with the Five Year Plan/First Nations Engagement project or if ITC can seek similar funding for an ITC Policy Advisor position for this and other policy requirements.
- The ITC Board requested Chair Smith write a letter on behalf of ITC to Trust Council regarding having not been consulted by Trust Council before the request for a Provincial review was made.
- The ITC Communications Specialist presented a briefing with a Communications and Engagement Strategy for ITC's 35th Anniversary.
- The ITC Strategic Fund Development Specialist advised that the annual holiday appeal will launch this year on Giving Tuesday on Tuesday December 3rd.

Learn more about Islands Trust Conservancy: https://islandstrust.bc.ca/conservancy/

Subscribe for Islands Trust Conservancy updates: https://islandstrust.bc.ca/subscribe/