Schedule A

Village of Lions Bay Official Community Plan Designation Bylaw
No. 408, 2008, Amendment Bylaw No. 525, 2018

10.0 Natural Hazard Assessment Areas

10.0.1 Definitions

"Accessory" means accessory as defined in the *Zoning Bylaw;*

"Buffer" or "Buffer Area" means an area that remains undeveloped in order to protect slope stability or to provide a setback from a natural hazard or riparian area;

"Council" means the Council of the *Municipality*;

"Debris Flood" means a flood of water that carries an unusually large amount of sediment and/or wood debris, and that is often triggered by severe channel and bank erosion or a Landslide dam outbreak;

"Debris Flow" means a fast moving, liquefied and channelized Landslide of mixed and unconsolidated debris that may occur during unusually wet weather on a steep mountain creek with abundant debris sources;

"Defensible Space" means the area around a structure where Fuel and vegetation should be managed to reduce the risk of structure fires spreading to the forest or vice versa and to provide safe working space for fire fighters;

"Detailed Assessment" means a detailed, site-specific study and field review to delineate hazard areas and provide quantitative estimates of hazard or risk, the minimum requirements of which Detailed Assessment are set out in this policy described as Schedule A, attached to and forming part of the Municipality's Official Community Plan Bylaw No. 408, 2008, as amended;

“EGBC” means the Engineers and Geoscientists of British Columbia or any replacement or successor professional association;

“Elements at Risk” means anything of social, environmental or economic value, including human lives and well-being that may be affected by a natural hazard;

“Exemption” means an exemption from the requirement for an approval or permit in connection with a given development;

“Fire Resistive Materials” means materials resistant to fire, such as stucco, metal, brick, rock, stone, lumber treated for fire resistance and cementitious products (including hardiplank), but excludes, without limitation, untreated wood, aluminum and vinyl products;

“Fire Retardant Roofing” means Class A and Class B roofing as specified in the Homeowners FireSmart Manual, BC Edition, 2004, Province of B.C., as the same may be amended or replaced from time to time, or such other roofing as may be specified by the Municipality from time to time;

“Freeboard” means a vertical distance typically added to the designated flood level to account for variation in local hydraulic conditions (such as river bend or large boulders in a stream), to allow for wave affects arising from winds, and to address uncertainties inherent in engineering assumptions and calculations, and to introduce a factor of safety to such calculations;

“Fuel” means a combustible material;

“Gross Floor Area” means gross floor area as defined in the Zoning Bylaw;

"Habitable Space" means any room or space within a building or structure, which room or space is or can be used for human occupancy, commercial sales, or storage of goods, personal property or mechanical or electrical equipment (including furnaces);

"Landslide" means a movement of rock, debris or earth down a slope, and can be the result of wet weather, erosion, earthquake or other natural sequences of events and/or human activities; Landslides may be rapid or slow moving, and include landslip, rock falls, rock slumps, rockslides, rock avalanches, avalanches, rock creep, debris falls, debris slides, debris flows, debris floods, debris torrents, mud flows, earth falls, earth slumps, earth slides, earth flows, earth creep, flow slides and subsidence;

"Municipality" means, depending on the context, the municipal corporation of the Village of Lions Bay or all of the land falling within the jurisdictional boundaries of the Village of Lions Bay;

"New Building or Structure" means a building or structure, excluding an Accessory building or structure, that generally contains Habitable Space and that is newly constructed or being constructed, or intended to be constructed, or that is or is being or is intended to be substantially reconstructed, and shall include:

(a) a retaining wall as set out the Zoning Bylaw;
(b) a pool as set out in Building Bylaw No. 234, 1994, as amended; or
(c) an alteration to a residentially zoned building where
    (i) the footprint of the building is to be increased by 25% or more, or
    (ii) the value of the alteration as specified in the applicable building permit is more than 50% of the replacement value of the building, as determined by multiplying the Gross Floor Area of the building by $300;

"New Development" means:

(a) construction of a New Building or Structure requiring a building permit;
(b) construction of a retaining wall over 1.2 meters in height, or a series of terraced retaining walls with a combined height of greater than 1.2 metres;

(c) development requiring a permit under Soil Deposit, Soil Removal and Land Alteration Bylaw No. 510, 2018 (the "Land Alteration Bylaw");
(d) subdivision;
(e) rezoning; or
(f) a temporary use permit for the purpose of short-term rentals;

"Preliminary Assessment" means a preliminary or overview assessment by a Qualified Professional to determine the extent, location or presence of a hazard, the probability of a hazardous event affecting an element at risk, and whether a Detailed Assessment is required;

"Qualified Professional" or "QP" means a professional with appropriate education, training and experience, fully insured and in good standing with the relevant professional association, and means:

(a) for the purposes of the NHAAs 2A, 2B, 2C, 3A, 3B, and 3C, a specialist Professional Engineer or Professional Geoscientist, as appropriate, with experience or training in geotechnical and geohazard assessments, Landslides, river hydraulics and hydrology and, where appropriate, specialist engineering expertise in connection with selection and design of appropriate mitigation works; and

(b) for the purpose of NHAA 4, a Registered Forest Professional qualified by training or with at least two years' experience in the assessment, fuel management prescription development and mitigation of wildfire hazards in British Columbia;

"Ravine" means a narrow, steep-sided valley that is commonly eroded by running water and has a ravine sidewall slope gradient greater than 3:1;

"Top of Bank" means:

(a) for a floodplain area contained in a Ravine, the point closest to the boundary of the active floodplain of a stream where a break in the slope of the land occurs such that the grade beyond the break is flatter than 3:1 at any point for a minimum distance of 15 metres measured horizontally from the break; and

(b) for a floodplain area not contained in a Ravine, the edge of the active floodplain of a stream where the slope of the land beyond the edge is flatter than 3:1 at any point for a minimum distance of 15 metres measured horizontally from the edge;

"Top of Ravine Bank" means the first significant break in a Ravine slope where the break occurs such that the grade beyond the break is flatter than 3:1 for a minimum distance of 15 metres measured horizontally from the break, and the break does not include a bench within the Ravine that could be developed;

"Watercourse" means any natural or man-made depression with well-defined banks and a bed 0.6 metre or more below the surrounding land that serves to give direction to a current of water at least six months of the year, or having a drainage area of two square kilometres or more upstream of the point of consideration;

"Wildfire Mitigation" means any action taken to eliminate or reduce the long-term risk of wildfire; and

"Zoning Bylaw" means the Zoning and Development Bylaw No. 520, 2017. as amended, consolidated or re-enacted from time to time.

10.1 General

10.1.1 Introduction – Purpose and Policy

The technical study by Cordilleran Geoscience titled "The Village of Lions Bay, Natural Hazards Development Permit Area Strategy: Coastal, Creek and Hillslope Hazards", dated January 18, 2018 (the "Cordilleran Report", available from the Village of Lions Bay by request or from the Village of Lions Bay online Reports and Documents Library at lionsbay.ca), identifies land potentially subject to geological natural hazards. The study notes that in Lions Bay, given the steep

terrain and the coastal maritime setting there are a number of natural hazards that may affect the community, including coastal hazards, creek hazards and hillslope hazards. Where the Cordilleran Report references Development Permit Areas (DPAs), this bylaw uses the term Natural Hazard Assessment Areas (NHAAs), but these terms should be considered as synonymous in relation to the physical areas mapped as DPAs in the Cordilleran Report and its technical recommendations.

As described in the Cordilleran Report, a hazard is a phenomenon with the potential to cause harm; it is usually represented by a magnitude and recurrence interval (Table 1).

Cordilleran Report, Table 1: Qualitative hazard frequency categories

Qualitative frequency	Annual return frequency	Probability	Comments
Very high	>1:20	>90% in 50 years	Hazard is well within the lifetime of a person or typical structure. Clear fresh signs of hazard are present.
High	1:100 to 1:20	40% to 90% in 50 years	Hazard could happen within the lifetime of a person or structure. Events are identifiable from deposits and vegetation, but may not appear fresh.
Moderate	1:500 to 1:100	10% to 40% in 50 years	Hazard within a given lifetime is possible, but not likely. Signs of previous events may not be easily noted.
Low	1:2500 to 1:500	2% to 10% in 50 years	The hazard is of uncertain significance.
Very low	<1:2500	<2% in 50 years	The occurrence of the hazard is remote.

Consequence (Table 2) is a product of factors, including whether a given hazard will reach a site, whether Elements at Risk (e.g., houses/people) will be present when the site is affected by the hazard, how vulnerable the Elements at Risk are to the hazard affecting the site, and the value of the Elements at Risk or the number of persons exposed.

Cordilleran Report, Table 2: Simplified consequence assessment

Consequence	Description
Very High	Direct impact with extensive structural damage; loss of life & limb.
High	Direct or indirect impact with some potential for structural damage; loss of life & limb.
Moderate	Indirect debris impact. No structural damage but damage to houses and property.
Low	Minor property damage only.
Very Low	Virtually no damage.

The product of the factors Hazard Frequency and Hazard Consequence equals Hazard Risk.

No activity is free of risk, and the concept of safety embodies risk tolerance. In Canada and BC there is no legislated guidance for risk tolerance to geohazards, and the term "safe" has not been defined. In considering risk tolerance, an important concept, and one accepted by the Village of Lions Bay (the "Municipality") is that risk of loss of life from natural hazards should not add substantially to the combined risk of loss of life to which one is typically exposed (e.g., driving, health, recreation, etc). For reference, the risk of injury and death from driving in Canada is approximately 1:1000 and 1:10,000 per annum, respectively (Transport Canada 2011).

The Municipality wishes to set acceptable levels of risk tolerance with respect to New Development within the Village in the circumstances identified in the Report. Quoting from the Landslide Risk Policy of the District of North Vancouver, "tolerable and acceptable risks are somewhat different: tolerable risks can be tolerated in order to realize some benefit, but they are not negligible, and should be kept under review and reduced further if possible. In contrast, acceptable risks are considered broadly acceptable to the public and efforts to further reduce risks are not warranted."

As an example, the levels of risk tolerable and acceptable to the District of North Vancouver are in accordance with the risk thresholds set out in Table 11 below.

Cordilleran Report, Table 11: Landslide risk policy, District of North Vancouver

Type of Application	1:10,000 + ALARP	1:100,000	FOS >1.3 (static)	FOS >1.5 (static)
Building Permit (<25% increase to Gross Floor Area)	X		X	
Building Permit (>25% increase to gross Floor Area and/or retaining walls >1.2m)		X		X
Re-zoning		X		X
Sub-division		X		X
New Development		X		X

The ostensible rationale for differing thresholds (1:10,000 vs 1:100,000) is that for any form of New Development (substantial addition (>25%), new building, rezoning, sub-division, new development) the extra involuntary risk posed by a hazard should be much less than for existing development (existing building, or addition <25%) on the premise that risk avoidance through development elsewhere in the municipality is an option. Nevertheless, 1:100,000 could be considered a very high threshold for Lions Bay. The Municipality is substantially built out and there are very few options within the Village for risk avoidance through location choice. This means that hazards may need to be mitigated through other means, such as reinforced or raised foundations, siting considerations within a parcel, design considerations for Habitable Space within a structure, rockfall fencing, and other methods of reducing risk.

In the circumstances, the Municipality considers that the level of risk tolerance for New Development ought to consider the scale of such development in comparison to generally accepted levels of risk tolerance for existing development, as indicated in the first line of Table 11. If New Development is within a smaller scope as described in the first two types of application in Table A below, then it is reasonable to set a safety standard which is generally appropriate for existing

development (i.e., 1:10,000 plus ALARP). Typically, as noted in the Cave (1993) Report from the Fraser Valley Regional District, such smaller scale development is in the nature of infill or extension of existing development which may already be subject to the same hazard. Accordingly, balancing concerns for safety with economic, social and political considerations, the levels of risk tolerable and acceptable to the Village of Lions Bay in respect of New Development is in accordance with the risk thresholds set out in Table A below and as expanded upon in the text following Table A.

Table A: Risk Tolerance Thresholds for New Development, Village of Lions Bay

Risk tolerance thresholds in accordance with development type:

Type of Application	1:10,000 + ALARP	1:100,000	*FOS >1.3 (static)	*FOS >1.5 (static)
New Development not requiring subdivision or rezoning	X		X	
Subdivision and/or rezoning to create 4 or fewer fee simple or strata parcels (including the original parcel)	X		X	
Subdivision and/or rezoning to create 5 or more fee simple or strata parcels (including the original parcel)		X		X

* Ratios denote annual probability of individual loss of life per the calculation set out in section 10.4.2 of this bylaw

* FOS means Factor of Safety, generally in relation to engineered slopes and Ravine sidewall stability

+ ALARP means As Low As Reasonably Practicable

For a risk to be ALARP, it must be possible to demonstrate that the cost involved in reducing the risk further would be grossly disproportionate to the benefit gained. In Lions Bay, this principle of mitigation is to be applied across all Natural Hazard Assessment Areas (NHAAs), particularly where the level of hazard uncertainty is significant. Qualified

Professionals will be responsible for indicating that all methods to reduce risk to As Low As Reasonably Practicable have been considered or implemented.

The Municipality specifically and explicitly chooses *not* to set a risk tolerance threshold in respect of existing development in Lions Bay. The risk tolerance policy set out herein is in respect to New Development only, as defined above, howsoever triggered or required. The Municipality's risk tolerance thresholds for both the annual probability of individual loss of life and the Factor of Safety should be considered by the Qualified Professional and the Municipality for any New Development in NHAAs 2A, 2B, 2C, 3A, 3B, and 3C. Risk tolerance for New Development in NHAAs 1 and 4 is in accordance with the guidelines and requirements in each of those Natural Hazard Assessment Areas.

The goal of the NHAA boundary delineation is to categorise natural hazards by landform type and/or process domain and create a natural hazard planning framework to provide a consistent basis for managing natural hazard risks. The Cordilleran Report identifies potential hazards and assesses the potential reach of these hazards. The likelihood or magnitude of possible hazards is not explicitly estimated, as that is the role and responsibility of site specific studies to be undertaken by property owners wishing to develop their land, or to be undertaken by senior government as further work recommended in the Cordilleran Report.

Additionally, a Community Wildfire Protection Plan was prepared for the Village of Lions Bay in 2007 by B.A. Blackwell and Associates (the "Blackwell Report") and it forms the basis for the Wildfire Natural Hazard Assessment Area, along with other Wildfire Mitigation best practices.

The following sections outline the NHAA framework for natural hazard areas in the Village of Lions Bay, based on the hazards identified and assessed in the Cordilleran and Blackwell reports. A generalized, process-based approach to NHAA delineation is used, with four main categories:

NHAA 1, Coastal Zone Hazards (flooding and erosion);
NHAA 2, Creek Hazards (alluvial fans; Ravines, small creeks);
NHAA 3, Slope Hazards (Open-slope failures, rockfall, and seismic slope stability); and
NHAA 4, Wildfire Hazard

Coastal zone hazards (NHAA 1) include flooding and erosion from a combination of processes including tides, storm surge, wave action and sea level rise. Creek hazards include residual Debris Flow hazards on creeks that have flood control works (NHAA 2A - Alberta, Harvey and Magnesia Creeks) and flooding, Debris Flow and channel avulsion on Upper Bayview Creek (NHAA 2B), and channel and slope hazards associated with creek Ravines (NHAA 2C). Three categories of slope hazard have been identified – open slope failures (NHAA 3A), rockfall hazards (NHAA 3B) and terrain with slopes >30% (NHAA 3C). All land within the Village of Lions Bay is included in the wildfire hazard area (NHAA 4), but particular attention should be given to areas within the residential-wildland interface.

In determining the NHAA boundaries for the hazard categories, it is recognized that there is uncertainty in the extent of influence of possible hazards. Therefore, NHAA boundaries were drawn conservatively so as not to exclude terrain that could be affected by the range of magnitudes considered within future studies. While boundaries are drawn from high-resolution LIDAR-derived mapping products, for proposed development purposes, surveys and professional assessment(s) may be needed to confirm lot layout, natural features, and setback recommendations on a site-specific basis (e.g., top of Ravine vs. setbacks).

10.1.2 Designation of Natural Hazard Assessment Areas

Under the authority of section 473 (1) (d) of the *Local Government Act*, the areas outlined on Maps 3-9 are designated as Natural Hazard Assessment Areas as follows:

NHAA 1, Map 3: Coastal Zone Hazards (flooding and erosion);
NHAA 2, Maps 4, 5, and 6: Creek Hazards (alluvial fans; Ravines, small creeks);
NHAA 3, Maps 7, 8, and 9: Slope Hazards (Open-slope failures, rockfall, and seismic slope stability); and
NHAA 4, Wildfire Hazard (all land within the boundaries of the Village of Lions Bay).

10.1.3 Activities that Require a Natural Hazard Assessment

1. In a Natural Hazard Assessment Area, there shall be no New Development permitted unless an Exemption applies under section 10.1.4 or the owner first obtains a Natural Hazard Assessment and a permit or approval from the Municipality.

2. The Municipality may impose in an approval or permit, any condition permitted by law in order to ensure compliance with the guidelines set out in this document.

3. Where a parcel is designated as being within more than one type of NHAA, a single natural hazard assessment report may suffice, provided that the guidelines for all applicable NHAAs are addressed in the assessment report.

10.1.4 Exemptions

The following activities are exempt from the requirement to obtain natural hazard assessment:

1. public works, services and maintenance activities carried out by, or on behalf of, the Village of Lions Bay, and approved by the CAO;

2. non-structural repairs or renovations, including roof and other exterior repairs or replacements which do not require a building permit;

3. construction of an Accessory building of less than 10 square metres as permitted by the Zoning Bylaw;

4. alteration of land which constitutes routine maintenance of existing landscaping and lawn areas, or construction of Minor Works; Minor Works means the removal or deposit of soil or alteration of land where:

    (i) at any point the depth of the soil removed or deposited does not exceed 1.2 meters;
    (ii) the unrestrained slope of the filled or excavated surface does not exceed three (3) horizontal to one (1) vertical (30%);
    (iii) retaining walls associated with the work do not exceed a height of 1.2 meters measured from the natural ground elevation; and
    (iv) for deposit of soil, the slope of the existing ground does not exceed thirty percent (30%) at any point or, where the existing ground is filled, the underlying natural ground surface does not exceed thirty percent (30%) at any point;

5. habitat creation, streamside restoration or similar habitat enhancement works in accordance with Village of Lions Bay bylaws and a plan approved by the CAO;

6. planting of vegetation, provided that within 10 metres of the Top of Bank or Top of Ravine Bank, or within 10 metres of any part of a building containing a dwelling, the vegetation should not exceed 9 metres in height at maturity;

7. setbacks may be reduced where coastal zone or riparian area regulation setbacks would preclude development on a lot provided that reports by QPs be supplied to support any Exemption and/or variance; or

8. emergency procedures to prevent, control or reduce erosion, or other immediate threats to life and property provided they are, to the extent possible in the circumstances, undertaken in accordance with the provincial *Water Act* and *Wildlife Act* and the Federal *Fisheries Act*, and are reported immediately to the Municipality.

10.1.5 Expectations for professional scope and reporting

1. All professional reports pertaining to NHAAs should be consistent with applicable qualified professional practice guidelines and their various report requirements, and provincial regulations (as updated from time to time), including but not exclusive to the list below:

    i. Flood Hazard Area Land Use Management Guidelines (WLAP 2004; amended January 1, 2018);
    ii. Guidelines for Legislated Landslide Assessments for Residential Developments in BC (2008, 2010);
    iii. Guidelines for Legislated Flood Assessments in a Changing Climate in BC (2012, 2017);
    iv. Riparian Areas Regulation;
    v. BC Building Code; and
    vi, Worksafe BC.

2. Where applicable, a report by a Qualified Professional should include the following:

    i. Report name and date;
    ii. Client information;
    iii. QP’s information (training, experience, insurance);
    iv. Property information (legal and civic);
    v. Description of development proposal;

vi. Review of relevant Village of Lions Bay bylaws and other statutory requirements;

vii. Review of background information (site-specific and overview archived & provided by the Village of Lions Bay and others);

viii. Description of geologic and geomorphic setting;

ix. Description of field work conducted on and, if required, beyond the proposed development;

x. Identification of natural hazards or other hazards identified in background reports and field work. Includes also a description of all potential hazards and rationale for excluding some;

xi. Provides site plan and other mapping required to show hazards affecting, minimum scale ~1:5000-1:10,000;

xii. Provides maps, illustrations and diagrams to illustrate risk scenarios referred to in the Report;

xiii. For all hazards, separate and in aggregate, analyses of the georisk affecting the proposed development and evaluation against the Village of Lions Bay safety policy;

xiv. Discusses the effect of changed conditions to slope stability caused by the project, by future potential natural factors or land-use (fire, forestry) or climate change;

xv. Discusses uncertainties and describes any residual risk that would remain;

xvi. Provides technically justified siting constraints or protective measures, as required;

xvii. States whether all methods to reduce risk to As Low As Reasonably Practicable (ALARP) have been considered or implemented;

xviii. Provides implementation steps for the identified structural mitigation works (in terms of design, construction and approval). Where protective works are recommended, the report must identify where follow up field verification is required to ensure conformance to design.

xix. States that “the land may be used safely for the use intended” with siting constraints, protective measures or restrictive covenant, as stipulated in the report.

xx. Provides permission to Village of Lions Bay to include the Report in the online geo-hazard report library (as background information, not for other parties to rely on);

xxi. Acknowledges that report may be attached to covenant registered on title to the property;

xxii. Provides time limitation or condition statement to describe extent the Village of Lions Bay may rely on the Report for development approvals, and when resubmittal is recommended;

xxiii. Provides an assurance statement (after APEGBC 2010, 2012);

xxiv. Signed and sealed by coordinating qualified registered professional.

3. For sites located within multiple hazard NHAAs, a coordinated approach will be required to ensure recommended prescriptions do not conflict and the overall project objectives are successfully met.

4. Where a report by a QP identifies protective works or measures to mitigate hazard(s) affecting a lot, those works or measures must not transfer risk to any other lots.

5. Where an owner has provided a natural hazard assessment report by a QP, the CAO or the Approving Officer may direct that the report be peer reviewed by a QP selected and retained by the Municipality. The peer review will be completed at the owner's expense and the owner must pay the invoice for same within 30 days of the invoice date. If the invoice amount is not paid when due, the CAO, at his or her discretion, may direct the Public Works Manager, the Building Inspector or a Building Official to issue a Stop Work Order Notice in respect of any Soil Deposit and Removal or Land Alteration Permit or Building Permit, as the case may be. The unpaid invoice amount may be deducted from a security deposit paid in respect of any development on or subdivision of the parcel.

6. Where a Preliminary Assessment only has been provided by an owner, the Municipality may require a Detailed Assessment to be provided by the owner at the owner’s cost, whether the QP has recommended one or not.

10.1.6 Registration of Covenants as to Use and Indemnification

A covenant as to use and indemnification, in wording satisfactory to the Municipality and in accordance with Provincial enactments, will be required to be placed on the land title for all approvals and permits in NHAAs 1, 2A, 2B, 2C, 3A, 3B and 3C where the QP has specified conditions in his or her report in order for the land to be used safely for the use intended. The covenant shall include the report of the QP as a schedule.

10.1.7 Conditions and Requirements

All development must comply with the conditions and requirements that may be imposed by the Municipality following the review of QP reports as identified in this section.

10.1.8 Council Reconsideration

If a building inspector is authorized to issue a building permit in accordance with the conditions specified in a QP's report but refuses to do so, the Council may, on application of the parcel owner within 30 days of the building inspector's decision being conveyed to the property owner in writing via email or letter, direct the building inspector to issue the building permit subject to the requirements of the QP's report after reconsideration in accordance with section 35 (5) of Council Procedures Bylaw No. 476, 2015, as amended.

10.2 NHAA 1 – Coastal Zone Hazards (Map 3)

10.2.1 Justification

Ocean front land in the Village of Lions Bay is subject to hazards such as flooding of low-lying terrain, erosion and instability of oceanfront slopes. Coastal zone hazards are expected to be exacerbated over the coming decades by sea level rise. NHAA 1 is intended to designate sites that should be assessed by a qualified registered professional to address coastal flood hazards, but does not preclude development. For Coastal Zone Hazards, year 2100 high water mark (HWM), and site specific factors such as wave effects, storm surge, shoreline erosion, shore face stability and associated setbacks should be considered.

10.2.2 Extent

NHAA 1 extends from the existing natural boundary of the sea to a height of 8 metres CGD (Canadian Geodetic Datum) and is outlined on Map 3. The 8 metre level is conservatively selected to represent a potential future Flood Construction Level (FCL). NHAA 1 includes all lots fronting the ocean within the Village of Lions Bay.

10.2.3 Background

In the Village of Lions Bay, many steep slopes into the sea are rock controlled or are fill slopes below the railway line. These are not a stability concern for residential development. Most residential lots on surficial materials are located on bouldery debris fan deposits of Magnesia, Alberta and Harvey Creeks, and while the shorefronts may be steepened to 70-80% by wave attack, the sea scarp is not tall (<6 m) and materials are coarse and relatively resistant to erosion at the timescale of the life of a structure (e.g., 100-years).

The sites most vulnerable to erosion are those low-lying areas at the south end of Brunswick Beach Road, where housing has been developed on a gravel tombolo that has linked a small rock outcrop with the mainland. The beach gravels forming the tombolo stand just above the HWM, being formed by storm waves, and the terrain between the north and south facing beaches is slightly lower, just at the high water mark (HWM). Future breaching and erosion of these beach ridges places all these low-lying areas at risk.

10.2.4 Guidelines and Requirements

1. Within NHAA 1, New Development applications shall include a coastal flood hazard assessment prepared by a qualified registered professional to define the year 2100 shoreline position and the derived flood construction level, appropriate setback and any necessary mitigation work. Determination of the Year 2100 flood construction level shall follow the Ausenco Sandwell "Combined Method" as referenced in the Flood Hazard Area Land Use Management Guidelines. The FCL is determined as the sum of:

    - Allowance for future sea level rise to the year 2100;
    - Allowance for regional uplift, or subsidence to the year 2100;
    - Higher high water large tide (HHWLT);
    - Estimated storm surge for the Designated Storm with an annual exceedance probability of 1:200, or 1:500 as per the Ausenco Sandwell method referenced in the Flood Hazard Area Land Use Management Guidelines;
    - Estimated wave effects associated with the Designated Storm; and
    - A minimum Freeboard of 0.6 metres. However, because the Combined Method assumes the Designated Storm occurs in conjunction with a high tide; the Freeboard may be reduced from 0.6 m to 0.3 m for situations where the full FCL may be difficult to achieve.

2. Provincial guidance refers to a 15 m ocean setback, while Village of Lions Bay applies a 7.5 m coastal setback (subject to potential variations down to 4.5 m in Brunswick Beach). Siting could be further constrained by consideration of potential erosion. A factor of safety analysis may also be required to support foundation design and determine building setbacks from escarpment crests.

3. A report by a Qualified Professional in NHAA 1 shall include recommendations for any structural measures required to achieve the FCL or protect against coastal flood hazard (e.g. engineered fill or foundations or coastal bank protection or building envelope design).

4. Where a lot does not have sufficient area to accommodate a dwelling under these siting conditions, a variance may be needed to relax setback requirements. This will be determined on a site by site basis, and a report by a QP would be required to support any variance.

10.3 NHAA 2 - Creek Hazards

10.3.1 Justification

In the Village of Lions Bay, NHAA 2, Creek Hazards include consideration of flooding, Debris Floods and Debris Flows from large creeks with existing Debris Flow hazard mitigation (Magnesia, Alberta, Harvey), unmitigated creeks (upper Bayview) and Ravine hazards arising from deeply channelized unmitigated creeks and escarpment slope instability (parts of Battani and Rundle). Small creeks captured in part by the residential drainage network of ditches, culverts and storm sewers (upper School Yard Creek) are addressed in the NHAA 3C - Slopes >30%.

10.3.2 NHAA 2A- Mitigated Debris Fans

10.3.2.1 Justification

Design of mitigation for Harvey, Alberta and Magnesia Creek hazards in the 1980s was based on an estimation of the largest volume that could reasonably occur during the life of each structure (the "Design Event"). However, present day standards need to consider 500 to 2450 year return periods, especially given potential earthquake triggering, and multiple failure mechanisms could lead to larger volumes than the Design Event for each creek. This is supported by recent reviews of small, steep watersheds with areas of 1-7 square kilometres.

10.3.2.2 Extent

NHAA 2A is shown on Map 4 and includes land on the formerly active portion of the Magnesia Creek fan and the composite Alberta/Harvey Creek fans that could be affected should existing mitigation structures become overwhelmed by a large, rare event.

10.3.2.3 Guidelines and Requirements

1. For debris fan hazards in NHAA 2A, a description of the magnitude and frequency of the hazards, and risk assessment, including evaluation against life safety thresholds established by the Village of Lions Bay is required.

2. At a minimum, until residual risk is better understood by detailed study, and as per development on alluvial fans (WLAP 2004, 2018), house foundations should be designed to withstand Debris Flood impacts with the top of concrete steel reinforced foundations established a minimum of 1 m above finished grade, with foundations protected from scour, and by mitigating the possibility of water ingress by lift. This involves the establishment of a flood construction level for Habitable Space a minimum of 1 m above finished grade, or the design should include measures to prevent water ingress. For example on the downslope side there could be openings such as doors or garage doors as long as the ground is contoured to prevent water ingress.

10.3.3 NHAA 2B - Upper Bayview Creek Fan

10.3.3.1 Justification

NHAA 2B is vulnerable to Debris Flow and stream flooding including channel shifting (avulsion). Should the historically diverted Upper Bayview creek channel jump its banks, then the flow could further erode the gullies downslope, causing similar instability and impacts to lots downslope as those experienced during development in 1972. Channel blockage at the point of the 1972 diversion could redirect the creek back into its natural channel, thereby affecting housing at the fan apex. Moreover, a Debris Flow could directly impact several houses near the apex. In either of these scenarios, water and debris could spread throughout the NHAA in unpredictable ways.

10.3.3.2 Extent

NHAA 2B captures the entire Upper Bayview Creek fan including areas vulnerable to flooding and slope instability in case of misalignment of the diverted channel as outlined on Map 5.

10.3.3.3 Guidelines and Requirements

1. For the Upper Bayview Creek fan, a description of the magnitude and frequency of the hazards, and risk assessment, including evaluation against life safety thresholds established by the Village of Lions Bay.

2. Until comprehensive mitigation of the Upper Bayview fan hazard is in place, the Village of Lions Bay will require Debris Flood and Debris Flow assessment by a qualified registered professional, with consideration for earthquake triggered Landslides from slopes above, failure of excessive and irretrievable road spoil sites, open-slope slides, misaligned drainage and local instability caused by misdirected water.

3. At a minimum, as per development on alluvial fans (WLAP 2004, 2018), house foundations should be designed to withstand Debris Flood impacts with the top of concrete steel reinforced foundations established a minimum of 1 m above finished grade, with foundations protected from scour, and by mitigating the possibility of water ingress by lift. This involves the establishment of a flood construction level for Habitable Space a minimum of 1 m above finished grade, or the design should include measures to prevent water ingress. For example on the downslope side there could be openings such as doors or garage doors as long as the ground is contoured to prevent water ingress.

10.3.4 NHAA 2C – Ravines

10.3.4.1 Justification

Ravines are landforms associated with creeks that have become incised into bedrock or thick deposits of surficial material. Typically, there is an abrupt slope break from adjacent terrain onto a steep erosional slope that may be susceptible to Landslides. At the toe of slope there may or may not be a floodplain between the toe and the creek's natural boundary. Since Ravines are inherently associated with creeks, they also encompass creek hazards.

10.3.4.2 Extent

Land within 30 metres of Ravine crests is included within NHAA 2C. This NHAA captures Battani and Rundle Creeks, and the Ravines upstream of fan apices on Magnesia, Alberta and Harvey Creeks.

10.3.4.3 Guidelines and Requirements

1. For land within 30 metres of Ravine crests in NHAA 2C, a description of the magnitude and frequency of the hazards, and risk assessment, including evaluation against life safety thresholds established by the Village of Lions Bay.

2. A QP's report shall include the following:

    a. a recommendation of required setback from the Ravine crest, and a demonstration of suitability for the proposed use;

    b. a field definition of the required setback from the top of a Ravine or other steep slope;

    c, where building sites are located within Ravines, a Landslide assessment will be required for Ravine slopes affecting the site, and to establish FCLs and other measures based on flood, Debris Flood and Debris Flow from affecting creeks; and

    d. the required setback to Top of Bank and recommendations relating to construction design requirements for the above development activities, on-site storm water drainage management, on-site sewage disposal and other appropriate land use recommendations.

    e. seismic slope stability assessments will be required to assess foundation stability.

10.4 NHAA 3 - Slope Hazards

10.4.1 Landslide Safety Policy

For all Landslide hazards, the Village of Lions Bay adopts a Landslide safety policy that employs Landslide risk assessment for upslope hazards potentially affecting a site, and seismic slope stability for foundation soils, engineered slopes and adjacent slopes as determined relevant by the Qualified Professional. Risk assessments may be qualitative or quantitative in nature, but the QP must satisfy the Municipality that the risk tolerance thresholds for both annual probability of individual loss of life and Factor of Safety set out in Table A of section 10.1.1 of this bylaw have been met. As part of the risk assessment approach, a minimum Landslide magnitude to consider is the 1:500-year event, but larger events up to the 1:2450-year earthquake triggered Landslide should be considered where deemed appropriate by the QP. Reference shall be made to the Cordilleran Report and to the risk tolerance thresholds adopted by the Village of Lions Bay and set out in Table A of section 10.1.1 of this bylaw.

The risk of annual probability of loss of life to an individual is calculated in accordance with the following equation:

$R = P_H * P_{S:H} * P_{T:S} * V * E$, where:

- P_H = the annual probability of the Landslide occurring;
- $P_{S:H}$ = the spatial probability that the Landslide will reach the individual most at risk;
- $P_{T:S}$ = the temporal probability that the individual most at risk will be present when the Landslide occurs;
- V = the vulnerability, or probability of loss of life if the individual is impacted; and
- E = the number of people at risk, which is equal to 1 for the determination of individual risk.

Annual Probability of Death for the Individual Most at Risk	Qualitative Descriptor
$>10^{-3}$	Very High (Unacceptable)
$10^{-4} – 10^{-3}$	High (Unacceptable)
$10^{-5} – 10^{-4}$	Moderate (Tolerable)
$10^{-6} – 10^{-5}$	Low (Acceptable)
$<10^{-6}$	Very Low (Acceptable)

Three sub-categories of slope hazards that present a risk to people and property are identified in sections 10.4.2, 10.4.3 and 10.4.4.

10.4.2 NHAA 3A - Open-slope Landslides

10.4.2.1 Justification

Open-slope Landslides (NHAA 3A) typically involve fragmented bedrock, organic debris, and mineral sediment. A typical slide is triggered by rockfall from a bluff, by windthrow of large trees on a steep slope, or by slab failure of a weathered soil veneer. The headscarp failure plane is typically >60%, but sometimes as low as 40%, or less. Typical, or generic steep terrain where Landslide initiation is most likely has 60-120% slope, and is overlain by a veneer/blanket of till/colluvium. The initial slip then impacts timber downslope clearing a swath through the forest, and may be very destructive to infrastructure.

10.4.2.2 Extent

Open-slope Landslide hazard areas within NHAA 3A are identified on Map 7. NHAA 3A extends from Highway 99 upslope to the municipal boundary. Source areas are in moderately steep to steep terrain within and above the Village of Lions Bay, and require identification and field assessment as part of the QP report.

10.4.2.3 Guidelines and Requirements

In NHAA 3A, a report by a QP should consider the following:

1. Applicants will be required to provide a Preliminary Assessment report and may be required to provide a Detailed Assessment report prepared by a QP in accordance with the subsequent guidelines and requirements as applicable.

2. Some background information on potential slope hazards in some areas is available through the Cordilleran Report. The information in the Cordilleran Report should be referenced as part of any geohazard assessment.

3. Potential slope hazard areas should remain free of development, or, if that is not possible, then:
   i. appropriate mitigation measures shall be identified to reduce risk to an acceptable level, and
   ii. conditions (for example conditions relating to the permitted uses, density or scale of building) should be recommended as necessary to reduce potential risk to acceptable levels,

   as determined by a QP in a Preliminary Assessment or Detailed Assessment report for the consideration of the Municipality.

4. For homes at the base of slopes, it is preferable for bedrooms to be constructed on the downslope side of the home.

5. Where applicable, a report by a QP should include the following:

   i. For slope hazards, description of the magnitude and frequency of the hazards, and risk assessment, including evaluation against life safety thresholds established by the Village of Lions Bay.

ii. If required by the risk assessment, then siting constraints and/or design of protective measures. Siting constraints may include consideration of locations to minimize exposure to upslope hazards (local highs; sheltering behind topographic features), and/or the establishment of setbacks from the crests and/or toes of steep slopes. Protective measures may include aspects of foundation design, lift of Habitable Space, barrier walls and other measures. However, protection for a given lot must not transfer risk to other lots.

6. Landslide (open slope or rockfall) risk assessment requires knowledge of a magnitude-frequency model, with reference to event return frequencies that may affect the site, including the 500-year and 2500 year events, or greater return, as considered appropriate by the QP". Stratigraphic and radiometric methods should be considered to estimate historic return periods and gauge Landslide intensity at the site. Such materials/methods may or may not be present or practicably attained from a single lot or group of lots. In lieu of hard data, regional analysis and expert judgment supported by sound geomorphic reasoning must be relied upon.

7. The area included within NHAA 3A has complex micro terrain, with very irregular to hummocky topography, and it is very difficult to predict individual Landslide paths. Thus, while some local topographic features may shelter or protect certain sites, safe sites cannot be predicted using simple rules, and caution is warranted. Landslide modeling by Qualified Professionals using high resolution LIDAR topography would aid defining specific travel paths for various Landslide volumes and rheologies.

8. Open slope Landslide source areas requiring assessment may exist on a parcel or far upslope of a parcel, and field assessment of terrain beyond the parcel is typically required.

10.4.3 NHAA 3B – Rockfall

10.4.3.1 Justification

Rockfall hazard (NHAA 3B) is the falling, bouncing and rolling of detached rock fragments from cliffs and steep slopes. Natural rockfall source areas are readily identified by slope thematic mapping, keying into slope areas with >70% slopes, and especially bluffs with slopes >90%. Rockfall volumes can range from individual blocks to

100s or 1000s of cubic metres of fragmented rock debris. Over time, rockfall material may form a veneer/blanket or apron of material below a source bluff. These deposits are known as scree or talus. Field assessment of the source area is required to characterise rock structure and quantify potential volumes.

10.4.3.2. Extent

The NHAA 3B area is drawn by projecting a 27.5^0 rockfall shadow angle from the base of the rock cliff between Magnesia and Alberta Creeks, and from other smaller scattered bluffs in and above Lions Bay. In the case of the former, since the rock cliff is located high above the Village, and since the cliff is tall and potential rockfall volumes are reasonably large (e.g., 10s – 1000s m^3), the reach of these events extends far downslope, almost reaching the highway in the vicinity of Schoolyard Creek. Elsewhere, the smaller and lower elevation bluffs, result in less extensive reach of potential rockfall. NHAA 3B is outlined on Map 8.

10.4.3.3 Guidelines and Requirements

In NHAA 3B, a report by a QP shall be prepared that includes the following:

1. Applicants will be required to provide a Preliminary Assessment report and may be required to provide a Detailed Assessment report prepared by a QP in accordance with the subsequent guidelines and requirements as applicable.

2. Some background information on potential slope hazards in some areas is available through the Cordilleran Report. The information in the Cordilleran Report should be referenced as part of any geohazard assessment.

3. Potential slope hazard areas should remain free of development, or, if that is not possible, then:
   i. appropriate mitigation measures shall be identified to reduce risk to an acceptable level, and
   ii. conditions (for example conditions relating to the permitted uses, density or scale of building) should be recommended as necessary to reduce potential risk to acceptable levels,

   as determined by a QP in a Preliminary Assessment or Detailed Assessment report for the consideration of the Municipality.

4. For homes at the base of slopes, it is preferable for bedrooms to be constructed on the downslope side of the home.

5. Where applicable, a report by a QP should include the following:

    i. For rockfall hazards, description of the magnitude and frequency of the hazards, and risk assessment, including evaluation against life safety thresholds established by the Village of Lions Bay.

    ii. If required by the risk assessment, then siting constraints and/or design of protective measures. Siting constraints may include consideration of locations to minimize exposure to upslope hazards (local highs; sheltering behind topographic features), and/or the establishment of setbacks from the crests and/or toes of steep slopes. Protective measures may include aspects of foundation design, lift of Habitable Space, barrier walls and other measures. However, protection for a given lot must not transfer risk to other lots.

6. Within NHAA 3B, a rockfall risk assessment is required. Landslide (open slope or rockfall) risk assessment requires knowledge of a magnitude-frequency model, with reference to event return frequencies that may affect the site, including the 500-year and 2500 year events, or greater return, as considered appropriate by the QP. Rockfall modelling should be applied to aid design of protection measures. Protective measures may include scaling, bolting, shot-creting application, fencing, or building fortification as determined by a specialist QP.

8. Rockfall assessments must consider the hazard intensity of fall of individual blocks to the detachment of larger masses up to several thousand m^3, such as the prehistoric Kelvin Grove wedge failure and rockfall located off Kelvin Grove Way, on Lots 48, 60 & 61. Specialist bedrock structure and kinematic analysis may be required to determine potential event volumes.

9. Rockfall source areas requiring assessment may exist on a parcel or far upslope of a parcel, and field assessment of terrain beyond the parcel is typically required.

10.4.4 NHAA 3C - Slopes >30%

10.4.4.1 Justification

Worksafe BC regulation requires a Natural Hazard Assessment Area category based on simple slope class. NHAA 3C is a slope-based hazard assessment area concerned with stability of foundations, excavations, fill slopes, the existence of very local rockfall and/or slide hazards, and with consideration of water control as it affects local stability, erosion and sedimentation.

10.4.4.2 Extent

1. NHAA 3C applies to areas where natural average ground slope is >30%. It is noted that Part 20.78 of the Worksafe BC Occupational Health and Safety (OHS) Regulation (BC Reg. 296/97) states that excavation work must be done in accordance with the written instructions of a Qualified Professional if:
   - (i) the excavation is more than 6 m (20 ft) deep,
   - (ii) an improvement or structure is adjacent to the excavation,
   - (iii) the excavation is subject to vibration or hydrostatic pressure likely to result in ground movement hazardous to workers, or
   - (iv) the ground slopes away from the edge of the excavation at an angle steeper than a ratio of 3 horizontal to 1 vertical.
2. Areas where natural average ground slope is >30%, but which have been filled and paved (for example the tennis courts and school parking areas) are included in NHAA 3C. Small areas of gentle terrain exist along Bayview Road toward Mountain Drive, but most lots encompass some areas of steeper slope. Thus, these areas are included in the NHAA.

10.4.4.3 Guidelines and Requirements

1. Applicants will be required to provide a Preliminary Assessment report and may be required to provide a Detailed Assessment report prepared by a QP in accordance with the subsequent guidelines and requirements as applicable.

2. Some background information on potential slope hazards in some areas is available through the Cordilleran Report. The information in the Cordilleran Report should be referenced as part of any geohazard assessment.

3. Development should minimize any alterations to steep slopes, and the development should be designed to reflect the site rather than altering the site to reflect the development.

4. Terracing of land should be avoided or minimized and landscaping should follow the natural contours of the land.

5. Buildings and structures and landscaping should be located as far as reasonably possible from steep slopes or channel discharge/runoff points at the base of slopes.

6. Potential slope hazard areas should remain free of development, or, if that is not possible, then:
   i. appropriate mitigation measures shall be identified to reduce risk to an acceptable level, and
   ii. conditions (for example conditions relating to the permitted uses, density or scale of building) should be recommended as necessary to reduce potential risk to acceptable levels,

   as determined by a QP in a Preliminary Assessment or Detailed Assessment report for the consideration of the Municipality.

7. Stepped and articulated building forms that integrate and reflect the natural site contours and slope conditions should be used, and large unbroken building masses that are unsuitable for sloped conditions should be avoided.

8. The construction of structures, pathways/trails, driveways, utilities, drainage facilities, septic fields, swimming pools, hot tubs, ponds, landscaping or other uses at or near the top or base of steep slopes should be avoided. A minimum ten metre Buffer Area from the top or base of any steep slope should be

maintained free of development except as otherwise recommended by a QP. On very steep slopes, this Buffer Area should be increased.

9. Vegetation should be maintained and/or reinstated on the slopes and within any Buffer zone above the slopes to filter and absorb water and minimize erosion.

10. No fill, including yard clippings, excavated material, sand or soil, should be placed within ten metres of the top of slopes or along pre-existing drainage channels. This applies to Ravine slopes as well.

11. The base of slopes shall not be undercut for building, landscaping or other purposes except in accordance with the recommendations of a QP and a permit issued in accordance with this bylaw.

12. For homes at the base of slopes, it is preferable for bedrooms to be constructed on the downslope side of the home.

13. Large single plane retaining walls should be avoided, where possible. Where retaining walls are necessary, smaller sections of retaining wall should be used. Any retaining structures 1.2 metres or higher, or a series of terraced retaining walls with a combined height of greater than 1.2 metres, in steeply sloped areas must be designed by a QP.

14. Disturbed slopes should be reinforced and revegetated, especially where gullied or where bare soil is exposed. Planting should be done in accordance with the recommendations of a Certified Horticulturalist, Landscape Architect or qualified registered Professional Forester.

15. Native species, including trees, shrubs and other plants, should be used for any new planting.

16. Any structural mitigation measures must be designed by a QP and confirmation must be received by the Village of Lions Bay that the mitigation measures were implemented as recommended.

17. Water should be diverted away from slopes, yards and structures in a controlled manner and ponding should be avoided near slopes. Small unidentified drainages intercepted by proposed development should be conveyed by structures with adequate capacity (i.e. 200 year flood) and lots should be graded

so that water is directed away from slopes and toward storm drainage systems as indicated in the following guideline.

18. Landscaping; and building, roof, pavement, and other impervious surface drainage should be designed and maintained to shed water away from slopes (especially steep slopes) and shall be connected to a storm drainage system, infiltration pit, or alternative method, recommended by a QP and approved by the Village of Lions Bay.

19. The extent of paved or hard-surfaced areas should be limited, and absorbent or permeable surfaces should be used instead to encourage infiltration where appropriate and reduce runoff.

20. Where applicable, a report by a QP should include the following:

    i. For slope hazards, description of the magnitude and frequency of the hazards, and risk assessment, including evaluation against life safety thresholds established by the Village of Lions Bay.

    ii. If required by the risk assessment, then siting constraints and/or design of protective measures. Siting constraints may include consideration of locations to minimize exposure to upslope hazards (local highs; sheltering behind topographic features), and/or the establishment of setbacks from the crests and/or toes of steep slopes. Protective measures may include aspects of foundation design, lift of Habitable Space, barrier walls and other measures. However, protection for a given lot must not transfer risk to other lots.

    iii. For stability of slopes on or about the proposed development site, assessment of slope failure modes and limiting Factors of Safety, and stability during seismic events. Seismic slope analysis requires comparatively detailed knowledge of subsurface bedrock, soil and groundwater conditions. The required Factor of Safety calculation references many data sources, including (but not limited to):

        a. seismic hazard maps and reports;
        b. ground motion data;

c. seismic Site Class; and

d. modal magnitude values of the design earthquake.

Assessment of shallow groundwater conditions and the anticipated effects of infiltration pits, footing drains, etc., on local slope stability may also be necessary.

21. A report from a QP is required in NHAA 3C for excavations, roads, drainage, fillslopes and foundations. Local rockfall assessment and mitigation may also be required. Evaluation of onsite and nearby municipal drainage structures to identify potential undersizing, blockages and overland flow, and design of buildings to prevent water ingress is also required.

23. If required by the risk assessment, then siting constraints should be assessed and/or design of protective measures undertaken. Siting constraints include the establishment of setbacks from the crests and/or toes of steep slopes. Protective measures may include engineering design of excavated slopes, fillslopes and foundations and other measures.

10.5 NHAA 4 - Wildfire Hazard

10.5.1 Justification

A Wildfire Risk Management System (WRMS) was developed by B.A. Blackwell and Associates in 2007 as part of the Village of Lions Bay Community Wildfire Protection Plan (CWPP). The WRMS identified the core area of the Village as being at moderate to high risk from wildfire. The entire Village of Lions Bay is identified in the CWPP as being a high vulnerability interface area with respect to risk from "spotting". The Community Wildfire Protection Plan noted that public safety, and many of the important values, facilities and structures, may be severely impacted by a major fire in the Village.

10.5.2 Extent

All land within the Village of Lions Bay is designated as NHAA 4.

10.5.3 Guidelines and Requirements

While there are no mandatory requirements for Wildfire Mitigation, the following recommendations are applicable for assessments required under NHAA 4:

1. Consideration should be given to the use of Fire Resistive Materials and construction practices for all subject developments in the Wildfire Natural Hazard Assessment Area:
    - i. Fire Retardant Roofing materials should be used, and asphalt or metal roofing should be given preference;
    - ii. decks, porches and balconies should be sheathed or coated with Fire Resistive Materials;
    - iii. all eaves, attics, roof vents and openings under floors should be screened to prevent the accumulation of combustible material, using 3mm, non-combustible wire mesh, and vent assemblies should use fire shutters or baffles;
    - iv. exterior walls should be sheathed with Fire Resistive Materials;

v. fire-resistive decking materials, such as solid composite decking materials or fire-resistive treated wood, should be used;

vi. all windows should be tempered or double-glazed to reduce heat and protect against wind and debris that can break windows and allow fire to enter the building or structure;

vii. all chimneys and wood-burning appliances should have approved spark arrestors; and

viii. building design and construction should generally be consistent with the highest current wildfire protection standards published by the National Fire Protection Association or any similar, successor or replacement body that may exist from time to time.

2. The following landscape conditions should be considered within 10 metres of a New Building or Structure requiring a building permit:

i. wildfire risk mitigation and landscaping should be designed and installed to protect, conserve and enhance natural features of the site;

ii. if removal of trees or vegetation is recommended by the QP for the purpose of reducing wildfire risk, Village of Lions Bay approval is required, and replacement trees or vegetation may be required by the Municipality; and

iii. where feasible, a Defensible Space of 10 metres should be managed around buildings and structures with the goal of eliminating Fuel and combustible debris, reducing risks from approaching wildfire and reducing the potential for building fires to spread to the forest, and the required Defensible Space may be larger in areas of sloping ground where fire behaviour creates greater risk.

3. For sites located within multiple hazard NHAAs, a coordinated approach should be employed to ensure recommended prescriptions do not conflict and the overall project objectives are successfully met. Risk associated with geohazards should usually take precedence over wildfire risk where potentially conflicting mitigation measures are recommended (e.g. vegetation retention for slope stability would take precedence over vegetation removal for wildfire protection).

4. In addition to the Exemptions listed in section 10.1.4, all development is exempt from the requirement to obtain a Wildfire hazard assessment other than the construction and installation of a New Building or Structure for which a building permit is required.

5. A report from a QP should include an acknowledgement of receipt of the report by the QP dealing with the reporting guidelines and requirements of all other Natural Hazard Assessment Areas, if applicable.

Slope theme and Terrain Legend

- >90%: Bedrock; rockfall & slide hazard
- 70-90%: Till/colluvial veneer, rock; rockfall & slide hazard
- 60-70%: Till/colluvial veneer/blanket, rock; slide hazard
- 50-60%: Till/colluvial blanket, rock
- 30-50%: Till/colluvial blanket, rock
- 0-30%: Debris fans, beach, till/colluvial veneer, rock

PU Potentially unstable, based on slopes >60%
Landform Unit
Terrain polygon line
Escarpment slope

Battani Creek face
Battani Creek
Magnesia Creek fan
Crystal Falls
Catch basin
Magnesia Creek
Magnesia Creek paraglacial fan-delta
Magnesia Quarry
Brunswick Beach Tombolo
Lions Bay face
Paraglacial headscarp
Alberta Creek
Fan
Schoolyard Creek
Arrested rock mass
horst & graben
rock ridge
levee
fillslope
Howe Sound
till ridge
Upper Bayview Creek
Possible sackung
Pipe crossing road bench
talus
Flume
Alberta Creek fan
kame
erosion gullies
1972 diversion
Upper Bayview Creek
Upper Bayview fan
Harvey Creek fan
Catch basin
Harvey Creek
Harvey Creek Paraglacial fan
kame
Rundle Creek
Bluff collapse
Kelvin Grove face
Suspect rock slide
Rockfall
N
200 m
Cordilleran Geoscience
Terrain Specialists

Map 2. Lions Bay Slope Theme and Geomorphic Features Map

DPA 1, includes shore front terrain captured by the 8 m contour elevation above mean sea-level (CGD) .

Slope theme
- >90%
- 70-90%
- 60-70%
- 50-60%
- 30-50%
- 0-30%

DPA 1

Brunswick Beach Tombolo

Howe Sound

DPA 1

8 m contour elevation

N

200 m

Cordilleran Geoscience
Terrain Specialists

Map 3. Lions Bay DPA 1 Coastal hazards

DPA 2A, includes debris fans formed by Magnesia, Alberta and Harvey Creeks. The area potentially affected reflects the fact that existing mitigation on these channels was not designed to a known return period standard, and engineered structures could be overwhelmed by rare events. Measures are required to mitigate residual risk. Conditional area may be removed once pipe crossing grade on left bank is assessed and mitigated.

Slope theme
- >90%
- 70-90%
- 60-70%
- 50-60%
- 30-50%
- 0-30%

DPA 2A

Howe Sound

Pipe crossing road bench

conditional

DPA 2A

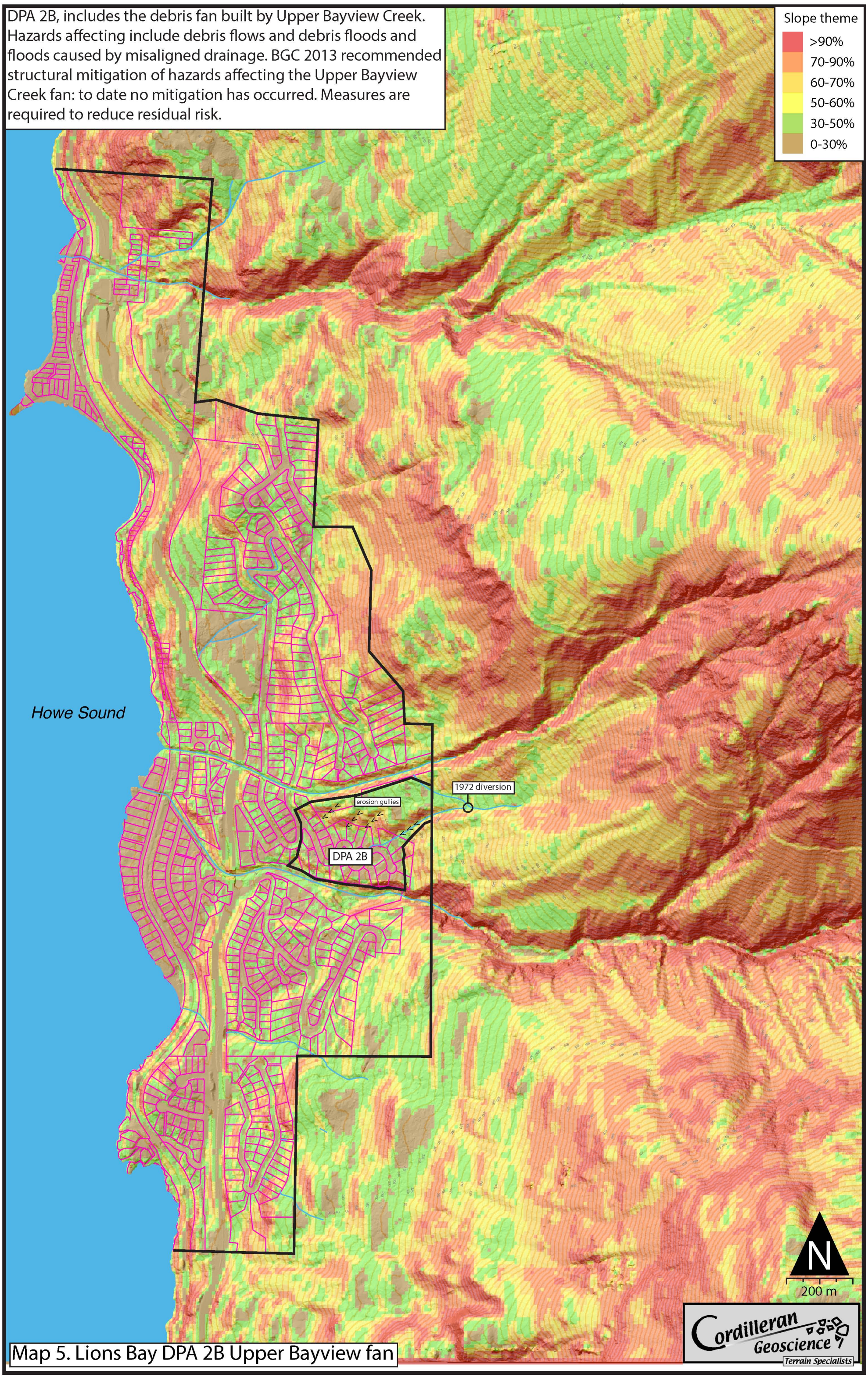
N

200 m

Cordilleran Geoscience
Terrain Specialists

Map 4. Lions Bay DPA 2A Debris fans of mitigated channels

DPA 2B, includes the debris fan built by Upper Bayview Creek. Hazards affecting include debris flows and debris floods and floods caused by misaligned drainage. BGC 2013 recommended structural mitigation of hazards affecting the Upper Bayview Creek fan: to date no mitigation has occurred. Measures are required to reduce residual risk.



Map 5. Lions Bay DPA 2B Upper Bayview fan

DPA 2C includes ravines and terrain within 30 m of the ravine crest. Ravine setbacks can be reduced on a site-specific basis following the advice of a Qualified Professional.

Slope theme
- >90%
- 70-90%
- 60-70%
- 50-60%
- 30-50%
- 0-30%

DPA 2C

DPA 2C

DPA 2C

DPA 2C

Howe Sound

N

200 m

Cordilleran Geoscience
Terrain Specialists

Map 6. Lions Bay DPA 2C Ravines

DPA 3A, includes all terrain vulnerable to open-slope landslide, as predicted by a 20% slope angle projected from potentially unstable terrain, and lying upslope of Highway 99.

PU Potentially Unstable Terrain, based on slope >60%, as identified & assessed by a Qualified Professional.

Slope theme
- >90%
- 70-90%
- 60-70%
- 50-60%
- 30-50%
- 0-30%

PU

DPA 3A

Howe Sound

N

200 m

Cordilleran Geoscience
Terrain Specialists

Map 7. Lions Bay DPA 3A Areas affected by potential open-slope landslides

DPA 3B, includes all terrain vulnerable to rockfall, as predicted by a 50% slope angle projected from potentially unstable, steep (70-90% & >90%) rock terrain located upslope, as identified & assessed by a Qualified Professional.

Slope theme
- >90%
- 70-90%
- 60-70%
- 50-60%
- 30-50%
- 0-30%

DPA 3B

DPA 3B

Rockfall source cliff

Howe Sound

DPA 3B

Bluff collapse

DPA 3B

Rockfall source

N

200 m

Cordilleran Geoscience
Terrain Specialists

Map 8. Lions Bay DPA 3B Areas affected by potential rockfall

DPA 3C, includes all terrain except areas shaded brown.
Larger tracts of <30% terrain are located at Brunswick Point, on Harvey/Alberta Creek fan and at Sweetwater Place.
These areas are exempt (x).

Slope theme
- >90%
- 70-90%
- 60-70%
- 50-60%
- 30-50%
- 0-30%

Howe Sound

X

X

X

DPA 3C

N

200 m

Cordilleran Geoscience
Terrain Specialists

Map 9. Lions Bay DPA 3C Slopes >30% gradient