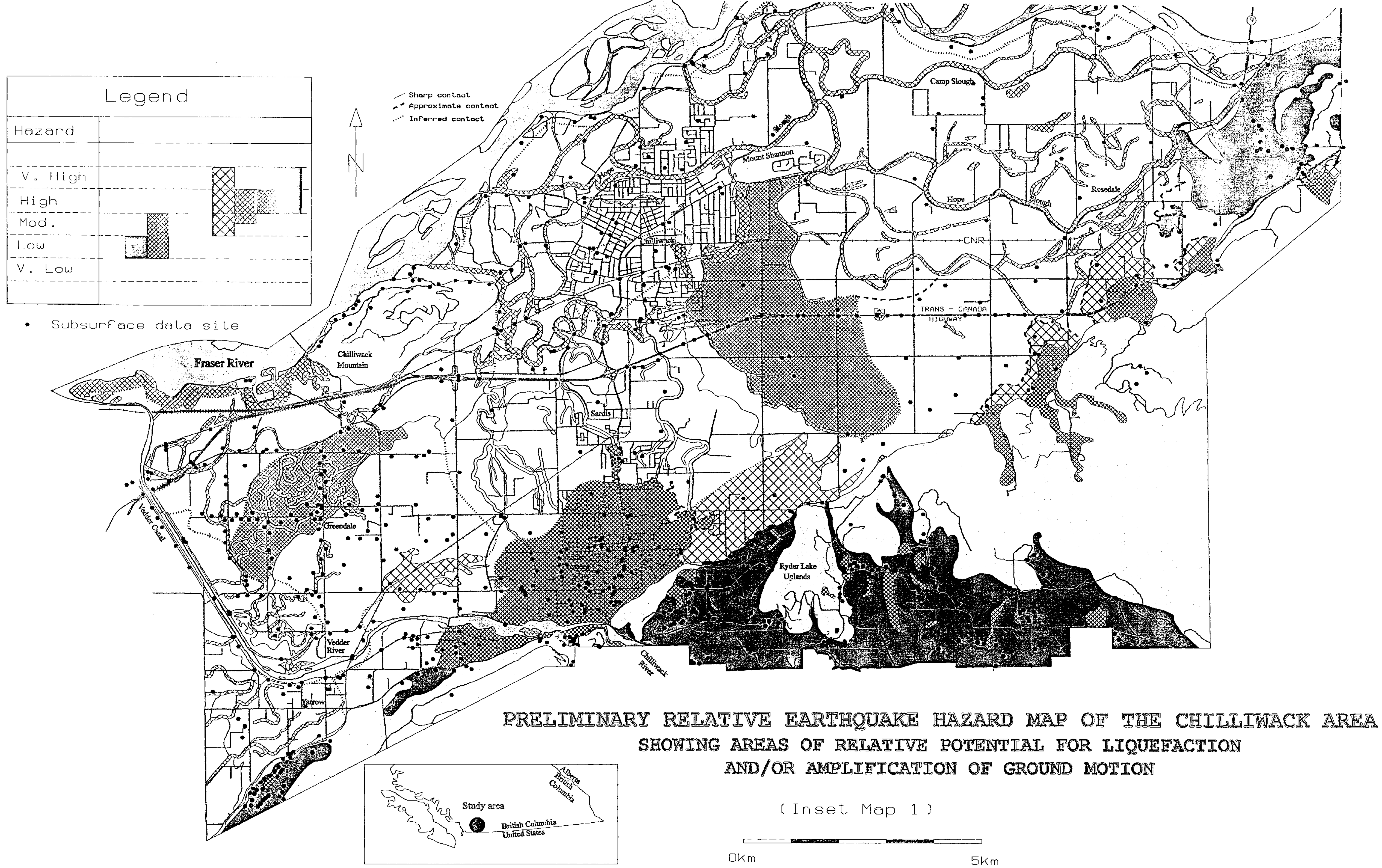
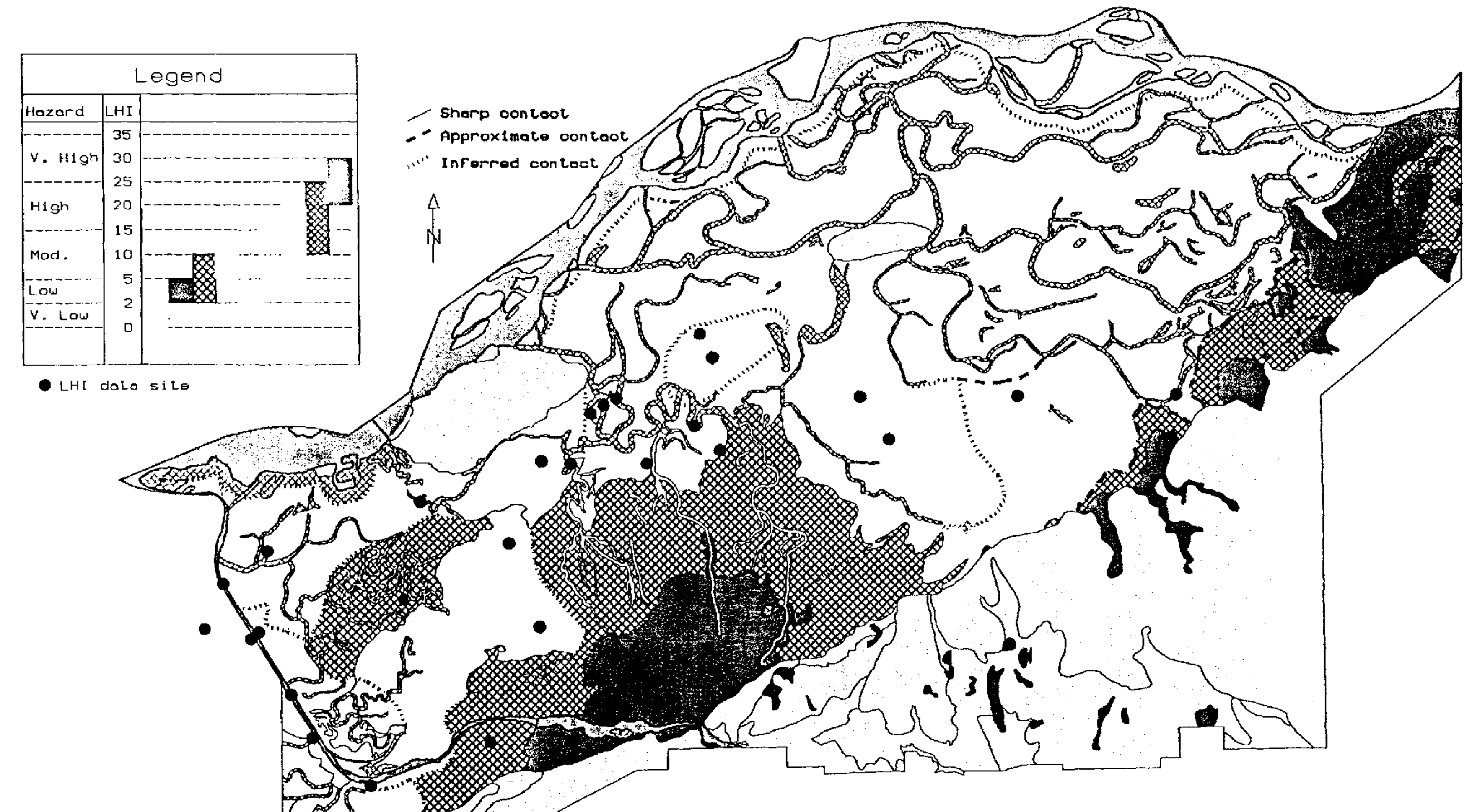


PRELIMINARY RELATIVE EARTHQUAKE HAZARD MAP OF THE CHILLIWACK AREA

SHOWING AREAS OF RELATIVE POTENTIAL FOR LIQUEFACTION AND/OR AMPLIFICATION OF GROUND MOTION

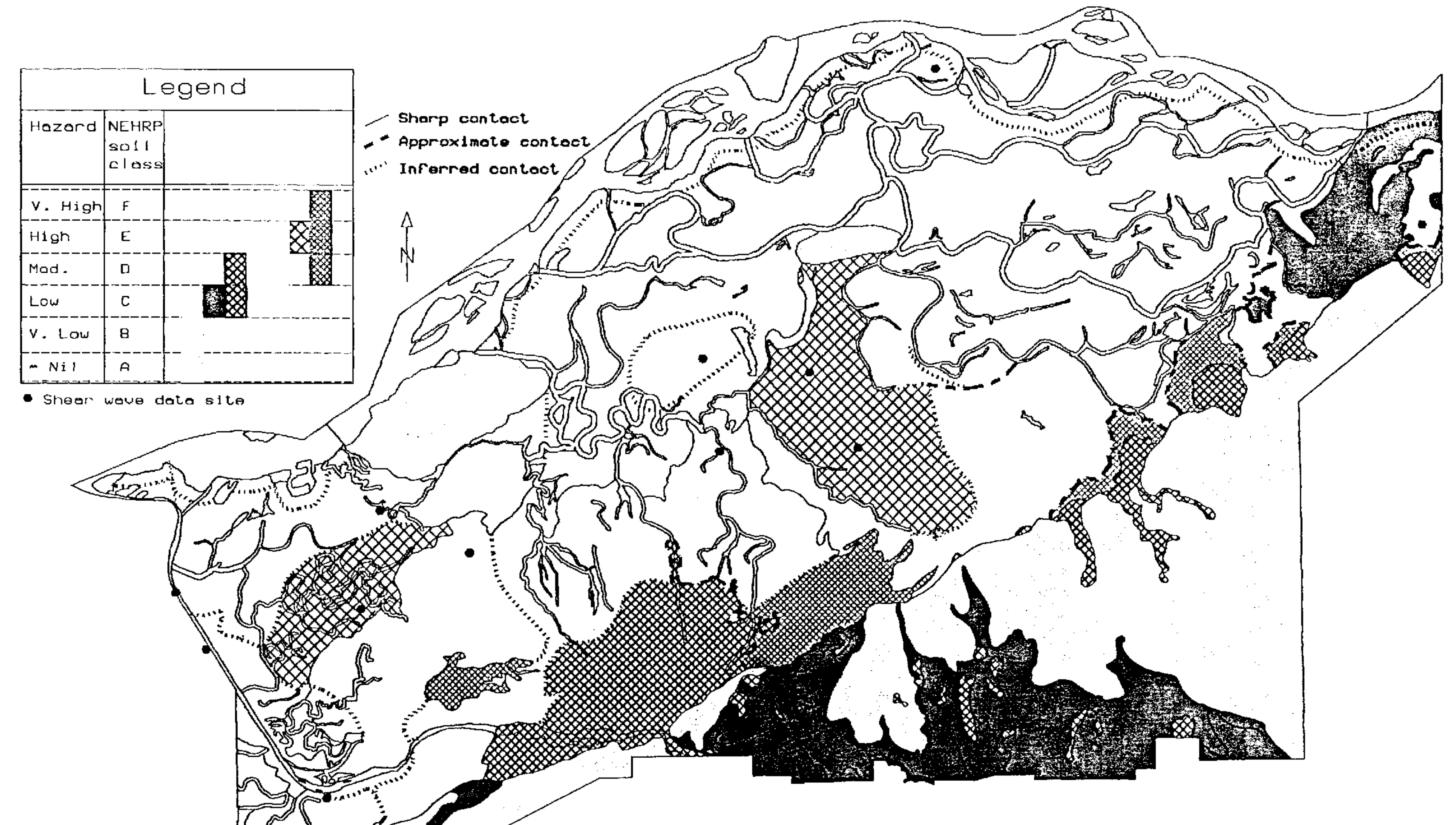
(Inset Map 1)



LIQUEFACTION HAZARD MAP

(Inset Map 2)

0Km 5Km



GROUND MOTION AMPLIFICATION HAZARD MAP

(Inset Map 3)

0Km 5Km

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Victor M. Levson, Patrick A. Monahan, Daniel G. Meldrum, Paul F. Matysek, British Columbia Geological Survey
Alex Sy, Bryan D. Watts, Li Yan, Klohn-Crippen Consultants Ltd.
Robert F. Gerath, Thurber Engineering Ltd. (presently with APEGBC)

INTRODUCTION

Earthquake hazard maps identify the relative potential for ground disturbance during an earthquake due to local geologic conditions. This map (MAP 1) shows areas where the presence of soft or liquefiable soils may result in an increased hazard, compared to other areas with firm or nonliquefiable soils. Although the source and magnitude of earthquakes are difficult to predict, variations in soil behavior and potential surface damage are largely controlled by mappable geologic and geotechnical conditions. Earthquake hazard maps, therefore can be used for mitigative planning in seismically active regions. This map results from a geological and geotechnical study of the Chilliwack region. *The map is intended for regional purposes only, such as landuse and emergency planning and not for site specific hazard evaluations.* Although this map can be used with other criteria to help planners select potential areas for development, avoid geologically vulnerable areas and prioritize seismic upgrading programs, *the map in no way replaces the need for site-specific geotechnical studies* prior to new construction or upgrading of buildings and other facilities such as bridges. The map highlights the need for these studies, especially in areas of high hazard. Although one or more hazards may be included in an earthquake hazard map, only liquefaction and amplification of ground motion hazards are evaluated here. *Other hazards, such as earthquake-triggered landslides, are not included on this map. In addition, the map shows where liquefaction or amplification hazards are expected to be relatively low or high, but no area on the map is entirely free from earthquake-induced ground shaking.* Earthquake hazards can be mapped at different levels of certainty, with the amount, quality and cost of information required, generally increasing with each mapping level (Klohn-Crippen, 1994). For example, liquefaction hazard maps can be grouped into liquefaction susceptibility (level 1), liquefaction potential (level 2) and liquefaction-induced ground displacement (level 3) maps. This map combines level 1 and level 2 procedures and could be augmented (at greater cost and effort) by level 3 hazard assessments.

DEFINITIONS

Liquefaction refers to the transformation that occurs when earthquake shaking (or other disturbances) cause a soil to lose its strength and behave like a liquid. The susceptibility of a soil to liquefaction is dependent on factors such as grain size, density, deposit age and water table depth. Recently deposited, loosely packed, wet granular soils (such as sands) tend to be most susceptible to liquefaction. When a soil liquefies, the amount of surface disturbance depends on the depth and thickness of the liquefiable layer(s), the ground slope and the distance of the site from a free-face such as river bank, toward which the soil may move.

Liquefaction *susceptibility* is dependent on the physical characteristics of the soil and does not account for variations in regional seismicity. However, liquefaction *potential* includes an assessment of the probability of liquefaction actually occurring by accounting for the expected intensity of seismic shaking (based on past records of earthquakes) as well as soil conditions.

Amplification of ground motion refers to an increase in the intensity of ground shaking at a site due to the soil conditions. For example, thick, soft soil deposits often amplify ground motions over and above the seismic motions on firm ground. The effects of resonance, which can increase the intensity of shaking in buildings of different heights, are not considered in this evaluation.

METHODOLOGY

The methodology used included: 1) collection of mainly existing geotechnical test hole and water well data (> 2400 logs from 390 sites, shown on MAP 1 as dots); 2) 1:20,000-scale surficial geology mapping (Levson *et al.*, 1996b); 3) integration of data in a Geographic Information System (Meldrum *et al.*, in press); 4) subsurface geological modeling; 5) production of a Quaternary geology map (reflecting the upper 20 m; Monahan and Levson, in press); 6) assessment of liquefaction susceptibility and liquefaction potential (INSET MAP 2) and ground motion amplification hazards (INSET MAP 3); and 7) development of a combined liquefaction and amplification hazard map. The methods used generally follow those recommended by the Seismic Microzonation Task Group (Klohn-Crippen, 1994). Summaries of the program have been provided by Levson *et al.* (1995, 1996a). The details of the methodologies and references for liquefaction and amplification hazard mapping in the region are provided by Levson *et al.* (in press) and Monahan *et al. (in press), respectively. These methodologies are only summarized briefly here. Reference should be made to these publications for a complete understanding of the procedures used.*

LIQUEFACTION HAZARD MAPPING (INSET MAP 2)

Liquefaction susceptibility of each unit on the Quaternary geology map was estimated based on established correlations between soil types and liquefaction. Liquefaction potential was then quantitatively assessed using a method that accounts for the depth, thickness and density of liquefiable layers and the seismic hazard, based on the National Building Code of Canada (NBCC) seismic model. The results were expressed as a Liquefaction Hazard Index (LHI) and were determined for 59 test holes at 27 different sites. A range of LHI values was assigned to each map unit. For more details see Levson et al. (in press). LHI does not account for lateral ground displacement on slopes and towards free-faces such as a river banks. However, lateral movements are qualitatively considered in this evaluation as areas near the banks of active and semi-active channels, are given a relatively high hazard rating.

GROUND MOTION AMPLIFICATION HAZARD MAPPING (INSET MAP 3)

Potential ground motion amplification has been estimated by comparison of the characteristics of each unit on the Quaternary geology map with soil classes adopted by the U.S. National Earthquake Hazards Reduction Program (Finn, 1996). The hazard for each map unit is expressed as a range to reflect geological variation. For more details see Monahan et al., (in press). The magnitude of ground motion amplification varies with the intensity of firm ground acceleration. For example, in the 1989 Loma Prieta earthquake, firm ground accelerations in the San Francisco Bay area were less than 0.1 g, but at nearby sites on soft soils these accelerations were amplified to more than 0.25 g (Clough et al., 1994). Consequently, the greatest damage occurred in areas underlain by soft soils. However, it has been observed that at very high accelerations (such as 0.5 g) on firm ground, amplification at soft soil sites is negligible. In the Chilliwack region, the peak horizontal, firm-ground acceleration used for design, as required by the NBCC, is approximately 0.2 g. This acceleration has a 10% chance of exceedance in 50 years, or a 475 year return period. The amplification map is based on soils data from the upper 30 metres. The effects of deeper soils that are present in the area but are poorly understood, and the effects of topography on amplification, have not been considered. As noted above, the effects of resonance, which can greatly increase the intensity of shaking for buildings of different heights have not been considered. However, in general, intensified shaking for low buildings could be anticipated where the depth to bedrock is relatively shallow, such as very close to the mountain front. Similarly, intensified shaking for tall buildings could occur where depth to bedrock is deeper.

COMBINING LIQUEFACTION AND GROUND MOTION AMPLIFICATION HAZARDS

A simple, objective approach is used here to combine earthquake-induced liquefaction and ground-motion amplification hazards into one map usable by planners. The approach is conservative in that it reflects the highest rating from either of the two types of hazards. For map units with liquefaction and amplification hazard ratings that span different ranges, the higher ends of the ranges are selected. For example, a map unit with a low to high liquefaction hazard rating and a moderate amplification rating would be presented on this map as a moderate to high hazard (i.e. the composite rating reflects the highest bounding values, in this case the moderate amplification hazard at the bottom end and the high liquefaction hazard at the top end). No attempt is made to add and/or average the two hazards to develop a combined relative hazard rating because the two types of hazards are distinct and are not simply additive. The basic premise behind the map is that a high rating in either type of hazard will result in an overall high earthquake hazard even though the rating in the other type of hazard may be lower. Therefore, if significant damage may result from one type of hazard, such as high amplification of ground motion, this will not be minimized by the possibility that minor liquefaction will occur in the area. Although ground motion amplification may increase the liquefaction hazard, this has been considered in the assessment of liquefaction potential. Furthermore, an increased liquefaction hazard generally does not increase the amplification hazard.

The approach used here has the advantage that other types of earthquake hazards, such as seismically-induced landslides, can also be incorporated. The merits of a non-averaging conservative approach are more obvious in this example. A high landslide hazard rating clearly should not be reduced to reflect a low liquefaction or amplification rating in the same area, as it will matter little to a resident whose house is destroyed by a landslide, for example, that the liquefaction hazard on the property was low!

LIMITATIONS ON MAP USE

This map is regional in scope and indicates general areas where materials susceptible to liquefaction or amplification are likely present. Map unit boundaries are based on geological criteria and on limited borehole information only and, as such, the boundaries between map units are approximate and may change with additional data. The earthquake hazard at any one site may be higher or lower than shown due to geological variations within map units, gradational and approximate map unit boundaries and the regional scale of this map. Furthermore, during an earthquake, ground shaking will occur throughout the map area, even in areas of lower hazard rating, but the hazard in the latter areas will generally not be increased due to liquefaction or amplification. For these reasons, a low hazard rating on this map should not be interpreted as freedom from earthquake hazards. For more information on the technical aspects and limitations of earthquake hazard mapping in the Chilliwack area, reference should be made to the technical maps from which this composite map was made (Levson et al., in press; Monahan, et al., in press).

The map is intended for regional purposes only, such as landuse and emergency planning. In addition, only liquefaction and amplification hazards are evaluated here. Potential effects from other hazards such as earthquake-induced landslides should also be considered in any comprehensive evaluation of earthquake hazards in this area for landuse or emergency planning or any other purpose.

Earthquake hazard maps can not be used to directly predict the amount of damage that will occur at any one site because many other factors such as building design or building height must be considered. However, the maps can be used to estimate the relative hazard due to geological controls. Likewise, earthquake hazard maps can not be used to estimate risk as this is dependent on many other factors such as the number of people present in the area at any one time and the types of facilities that are there. For example, although the earthquake hazard may be high in a farmer's field, the risk of damage is obviously low, compared to the same level of hazard in a developed area of a city.

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Geological Survey Branch
Ministry of Employment and Investment

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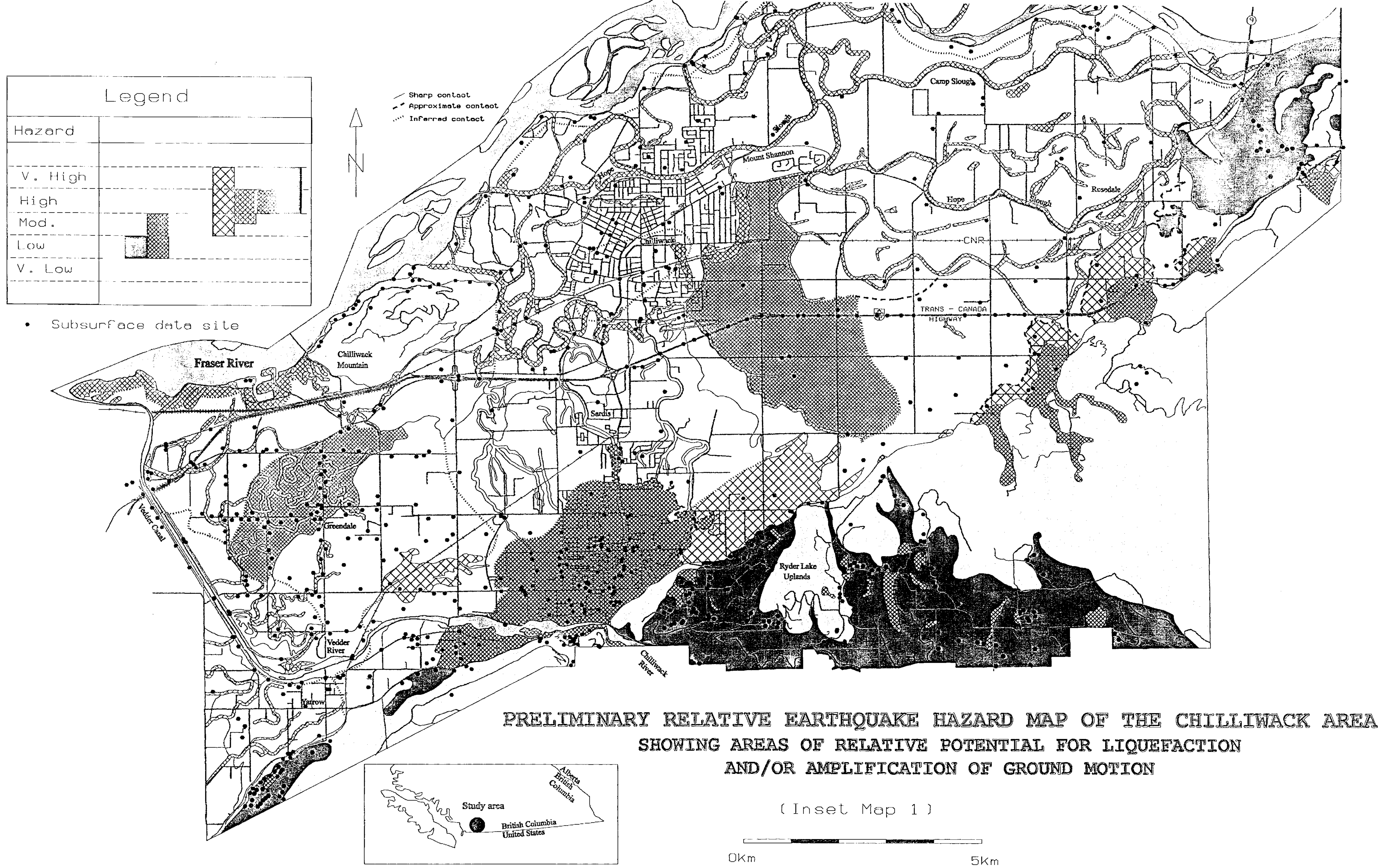

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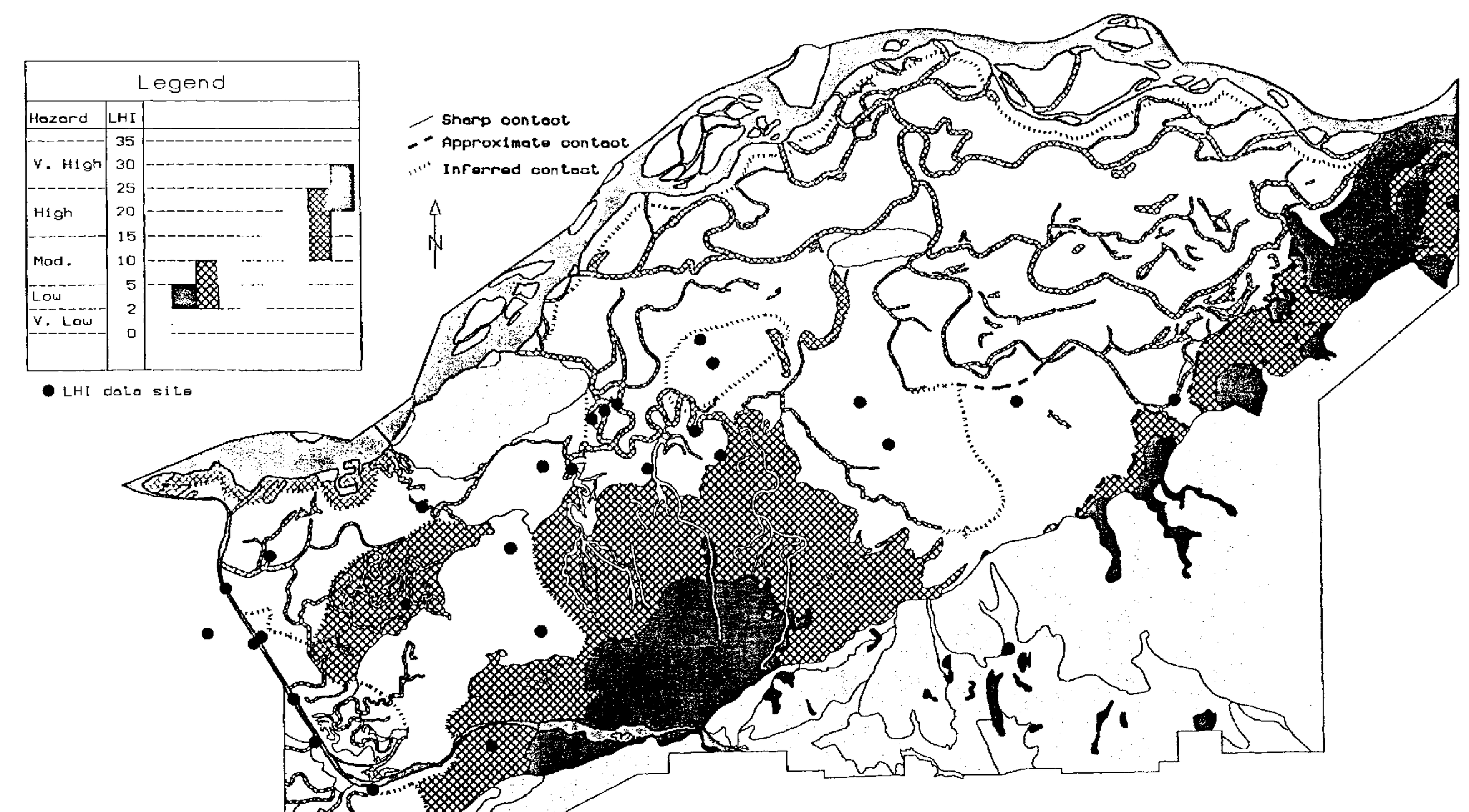

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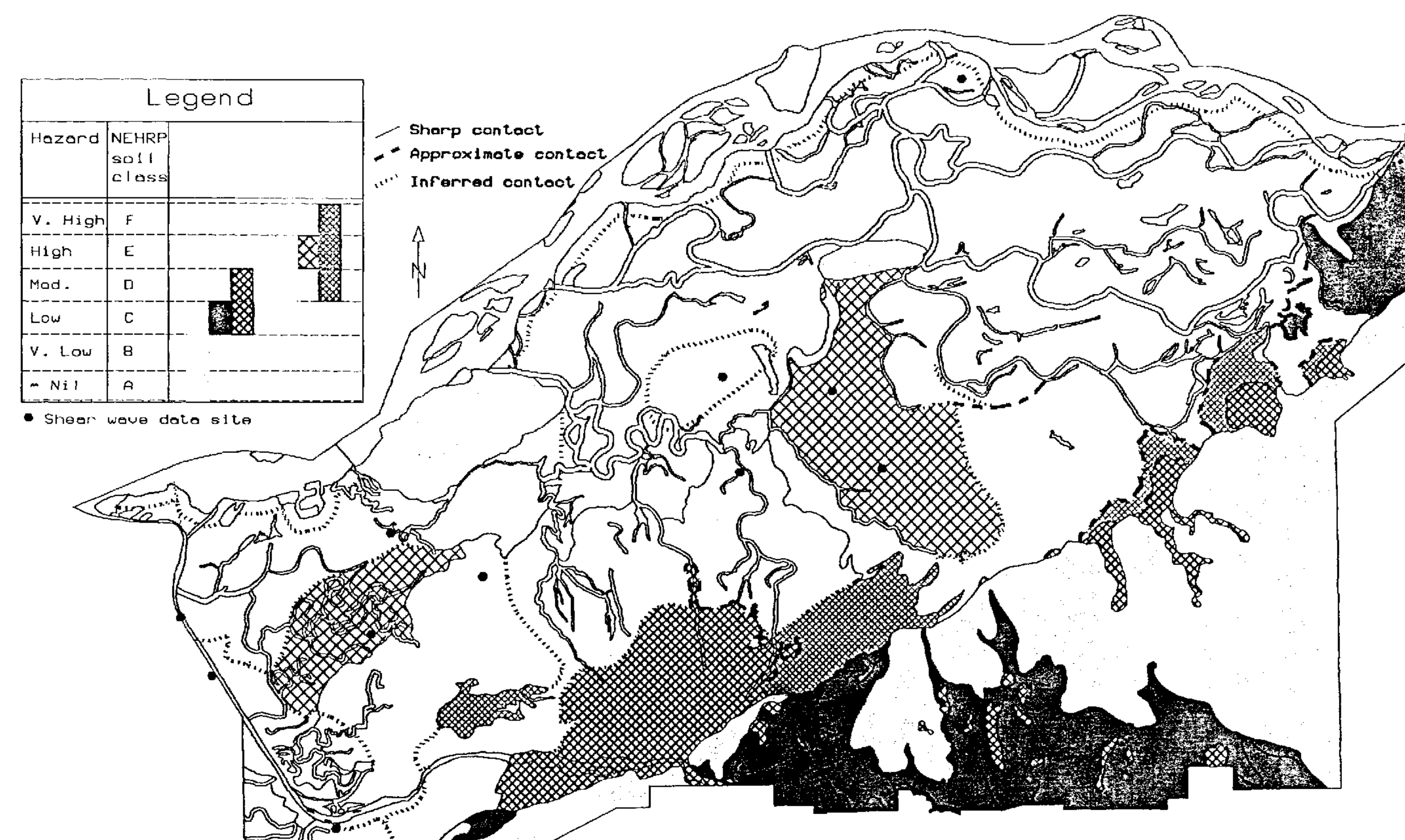

GROUND MOTION AMPLIFICATION HAZARD MAP

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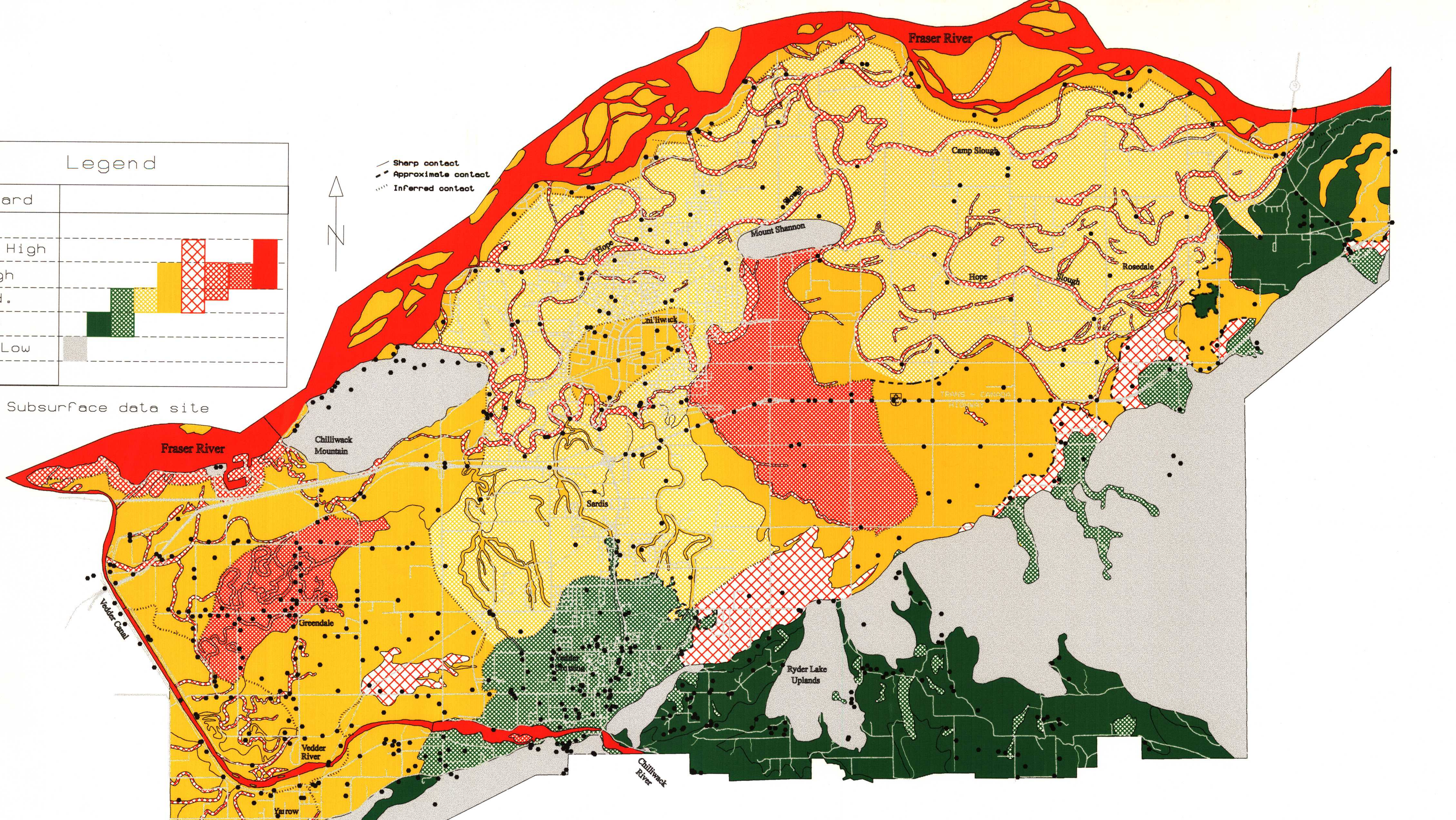

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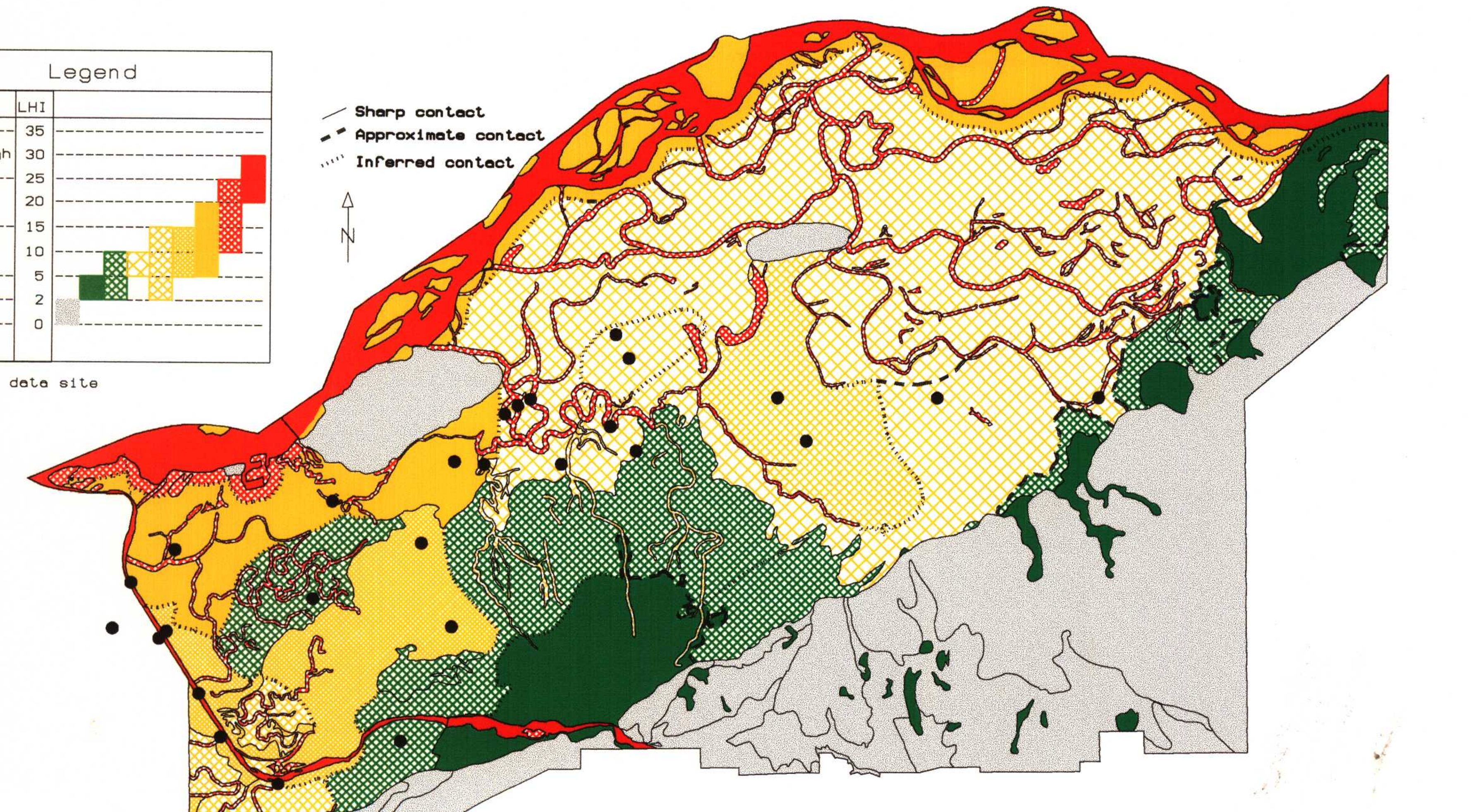

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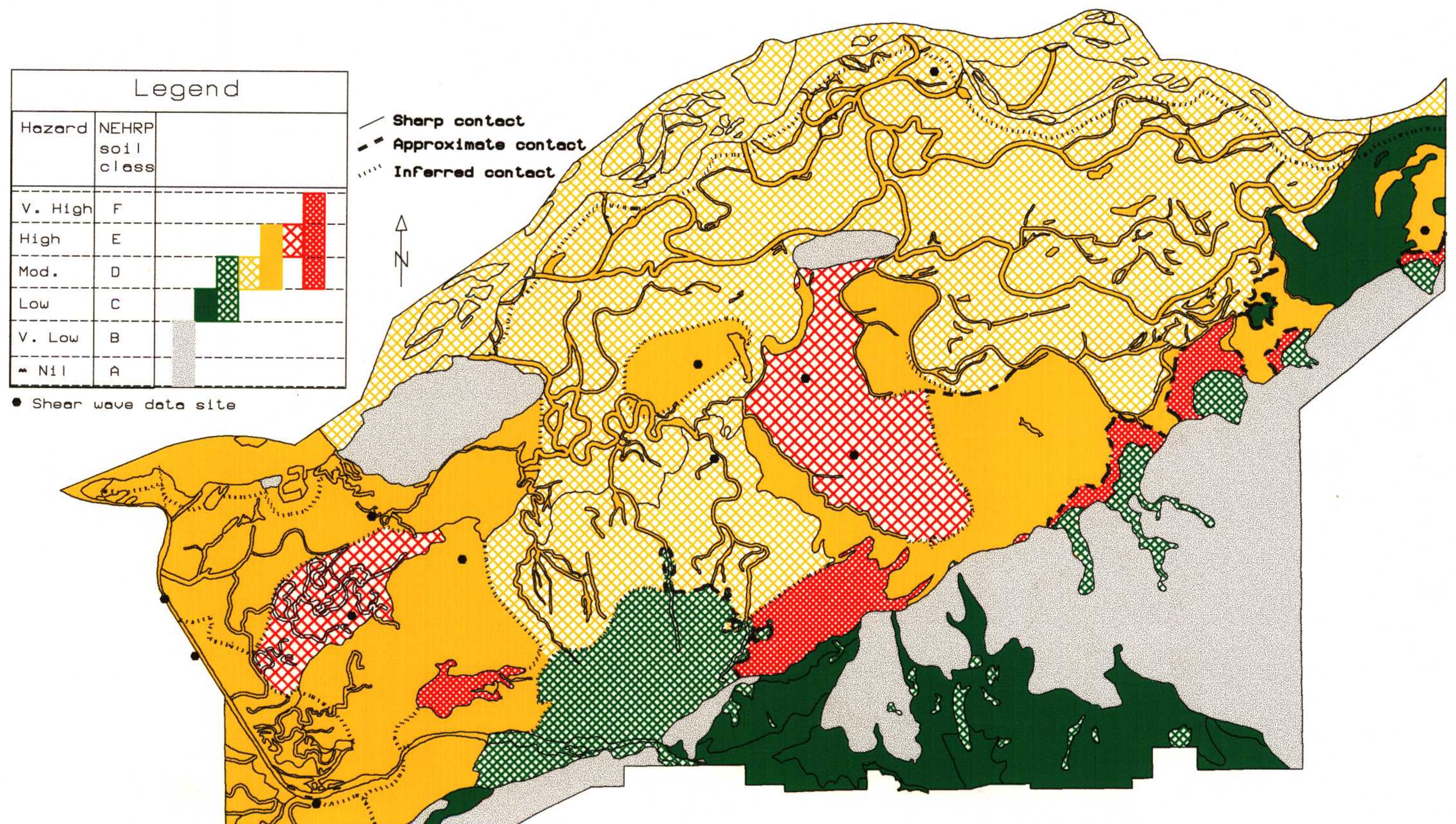

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Robert F. Gerath, Thurber Engineering Ltd. (presently with APEGBC)

INTRODUCTION

Earthquake hazard maps identify the relative potential for ground disturbance during an earthquake due to local geologic conditions. This map (MAP 1) shows areas where the presence of soft or liquefiable soils may result in an increased hazard, compared to other areas with firm or nonliquefiable soils. Although the source and magnitude of earthquakes are difficult to predict, variations in soil behavior and potential surface damage are largely controlled by mappable geologic and geotechnical conditions. Earthquake hazard maps, therefore can be used for mitigative planning in seismically active regions. This map results from a geological and geotechnical study of the Chilliwack region. *The map is intended for regional purposes only, such as landuse and emergency planning and not for site specific hazard evaluations.* Although this map can be used with other criteria to help planners select potential areas for development, avoid geologically vulnerable areas and prioritize seismic upgrading programs, *the map in no way replaces the need for site-specific geotechnical studies* prior to new construction or upgrading of buildings and other facilities such as bridges. The map highlights the need for these studies, especially in areas of high hazard. Although one or more hazards may be included in an earthquake hazard map, only liquefaction and amplification of ground motion hazards are evaluated here. *Other hazards, such as earthquake-triggered landslides, are not included on this map. In addition, the map shows where liquefaction or amplification hazards are expected to be relatively low or high, but no area on the map is entirely free from earthquake-induced ground shaking.* Earthquake hazards can be mapped at different levels of certainty, with the amount, quality and cost of information required, generally increasing with each mapping level (Klohn-Crippen, 1994). For example, liquefaction hazard maps can be grouped into liquefaction susceptibility (level 1), liquefaction potential (level 2) and liquefaction-induced ground displacement (level 3) maps. This map combines level 1 and level 2 procedures and could be augmented (at greater cost and effort) by level 3 hazard assessments.

DEFINITIONS

Liquefaction refers to the transformation that occurs when earthquake shaking (or other disturbances) cause a soil to lose its strength and behave like a liquid. The susceptibility of a soil to liquefaction is dependent on factors such as grain size, density, deposit age and water table depth. Recently deposited, loosely packed, wet granular soils (such as sands) tend to be most susceptible to liquefaction. When a soil liquefies, the amount of surface disturbance depends on the depth and thickness of the liquefiable layer(s), the ground slope and the distance of the site from a free-face such as river bank, toward which the soil may move.

Liquefaction *susceptibility* is dependent on the physical characteristics of the soil and does not account for variations in regional seismicity. However, liquefaction *potential* includes an assessment of the probability of liquefaction actually occurring by accounting for the expected intensity of seismic shaking (based on past records of earthquakes) as well as soil conditions.

Amplification of ground motion refers to an increase in the intensity of ground shaking at a site due to the soil conditions. For example, thick, soft soil deposits often amplify ground motions over and above the seismic motions on firm ground. The effects of resonance, which can increase the intensity of shaking in buildings of different heights, are not considered in this evaluation.

METHODOLOGY

The methodology used included: 1) collection of mainly existing geotechnical test hole and water well data (> 2400 logs from 390 sites, shown on MAP 1 as dots); 2) 1:20,000-scale surficial geology mapping (Levson *et al.*, 1996b); 3) integration of data in a Geographic Information System (Meldrum *et al.*, in press); 4) subsurface geological modeling; 5) production of a Quaternary geology map (reflecting the upper 20 m; Monahan and Levson, in press); 6) assessment of liquefaction susceptibility and liquefaction potential (INSET MAP 2) and ground motion amplification hazards (INSET MAP 3); and 7) development of a combined liquefaction and amplification hazard map. The methods used generally follow those recommended by the Seismic Microzonation Task Group (Klohn-Crippen, 1994). Summaries of the program have been provided by Levson *et al.* (1995, 1996a). The details of the methodologies and references for liquefaction and amplification hazard mapping in the region are provided by Levson *et al.* (in press) and Monahan *et al. (in press), respectively. These methodologies are only summarized briefly here. Reference should be made to these publications for a complete understanding of the procedures used.*

LIQUEFACTION HAZARD MAPPING (INSET MAP 2)

Liquefaction susceptibility of each unit on the Quaternary geology map was estimated based on established correlations between soil types and liquefaction. Liquefaction potential was then quantitatively assessed using a method that accounts for the depth, thickness and density of liquefiable layers and the seismic hazard, based on the National Building Code of Canada (NBCC) seismic model. The results were expressed as a Liquefaction Hazard Index (LHI) and were determined for 59 test holes at 27 different sites. A range of LHI values was assigned to each map unit. For more details see Levson et al. (in press). LHI does not account for lateral ground displacement on slopes and towards free-faces such as a river banks. However, lateral movements are qualitatively considered in this evaluation as areas near the banks of active and semi-active channels, are given a relatively high hazard rating.

GROUND MOTION AMPLIFICATION HAZARD MAPPING (INSET MAP 3)

Potential ground motion amplification has been estimated by comparison of the characteristics of each unit on the Quaternary geology map with soil classes adopted by the U.S. National Earthquake Hazards Reduction Program (Finn, 1996). The hazard for each map unit is expressed as a range to reflect geological variation. For more details see Monahan et al., (in press). The magnitude of ground motion amplification varies with the intensity of firm ground acceleration. For example, in the 1989 Loma Prieta earthquake, firm ground accelerations in the San Francisco Bay area were less than 0.1 g, but at nearby sites on soft soils these accelerations were amplified to more than 0.25 g (Clough et al., 1994). Consequently, the greatest damage occurred in areas underlain by soft soils. However, it has been observed that at very high accelerations (such as 0.5 g) on firm ground, amplification at soft soil sites is negligible. In the Chilliwack region, the peak horizontal, firm-ground acceleration used for design, as required by the NBCC, is approximately 0.2 g. This acceleration has a 10% chance of exceedance in 50 years, or a 475 year return period. The amplification map is based on soils data from the upper 30 metres. The effects of deeper soils that are present in the area but are poorly understood, and the effects of topography on amplification, have not been considered. As noted above, the effects of resonance, which can greatly increase the intensity of shaking for buildings of different heights have not been considered. However, in general, intensified shaking for low buildings could be anticipated where the depth to bedrock is relatively shallow, such as very close to the mountain front. Similarly, intensified shaking for tall buildings could occur where depth to bedrock is deeper.

COMBINING LIQUEFACTION AND GROUND MOTION AMPLIFICATION HAZARDS

A simple, objective approach is used here to combine earthquake-induced liquefaction and ground-motion amplification hazards into one map usable by planners. The approach is conservative in that it reflects the highest rating from either of the two types of hazards. For map units with liquefaction and amplification hazard ratings that span different ranges, the higher ends of the ranges are selected. For example, a map unit with a low to high liquefaction hazard rating and a moderate amplification rating would be presented on this map as a moderate to high hazard (i.e. the composite rating reflects the highest bounding values, in this case the moderate amplification hazard at the bottom end and the high liquefaction hazard at the top end). No attempt is made to add and/or average the two hazards to develop a combined relative hazard rating because the two types of hazards are distinct and are not simply additive. The basic premise behind the map is that a high rating in either type of hazard will result in an overall high earthquake hazard even though the rating in the other type of hazard may be lower. Therefore, if significant damage may result from one type of hazard, such as high amplification of ground motion, this will not be minimized by the possibility that minor liquefaction will occur in the area. Although ground motion amplification may increase the liquefaction hazard, this has been considered in the assessment of liquefaction potential. Furthermore, an increased liquefaction hazard generally does not increase the amplification hazard.

The approach used here has the advantage that other types of earthquake hazards, such as seismically-induced landslides, can also be incorporated. The merits of a non-averaging conservative approach are more obvious in this example. A high landslide hazard rating clearly should not be reduced to reflect a low liquefaction or amplification rating in the same area, as it will matter little to a resident whose house is destroyed by a landslide, for example, that the liquefaction hazard on the property was low!

LIMITATIONS ON MAP USE

This map is regional in scope and indicates general areas where materials susceptible to liquefaction or amplification are likely present. Map unit boundaries are based on geological criteria and on limited borehole information only and, as such, the boundaries between map units are approximate and may change with additional data. The earthquake hazard at any one site may be higher or lower than shown due to geological variations within map units, gradational and approximate map unit boundaries and the regional scale of this map. Furthermore, during an earthquake, ground shaking will occur throughout the map area, even in areas of lower hazard rating, but the hazard in the latter areas will generally not be increased due to liquefaction or amplification. For these reasons, a low hazard rating on this map should not be interpreted as freedom from earthquake hazards. For more information on the technical aspects and limitations of earthquake hazard mapping in the Chilliwack area, reference should be made to the technical maps from which this composite map was made (Levson et al., in press; Monahan, et al., in press).

The map is intended for regional purposes only, such as landuse and emergency planning. In addition, only liquefaction and amplification hazards are evaluated here. Potential effects from other hazards such as earthquake-induced landslides should also be considered in any comprehensive evaluation of earthquake hazards in this area for landuse or emergency planning or any other purpose.

Earthquake hazard maps can not be used to directly predict the amount of damage that will occur at any one site because many other factors such as building design or building height must be considered. However, the maps can be used to estimate the relative hazard due to geological controls. Likewise, earthquake hazard maps can not be used to estimate risk as this is dependent on many other factors such as the number of people present in the area at any one time and the types of facilities that are there. For example, although the earthquake hazard may be high in a farmer's field, the risk of damage is obviously low, compared to the same level of hazard in a developed area of a city.

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Monahan, P.A. and Levson, V.M. (in press): Quaternary Geology Map (Upper 20 Metres), Chilliwack, British Columbia (92G/1 and H/4). British Columbia Ministry of Employment and Investment*, Open File.*

Open File 1996-25
Geological Survey Branch
Ministry of Employment and Investment

BRITISH COLUMBIA GEOLOGICAL SURVEY

PRELIMINARY RELATIVE EARTHQUAKE HAZARD MAP OF THE CHILLIWACK AREA
SHOWING AREAS OF RELATIVE POTENTIAL FOR LIQUEFACTION AND/OR AMPLIFICATION OF GROUND MOTION

Victor M. Levson, Patrick A. Monahan, Daniel G. Meldrum, Paul F. Matysek, British Columbia Geological Survey
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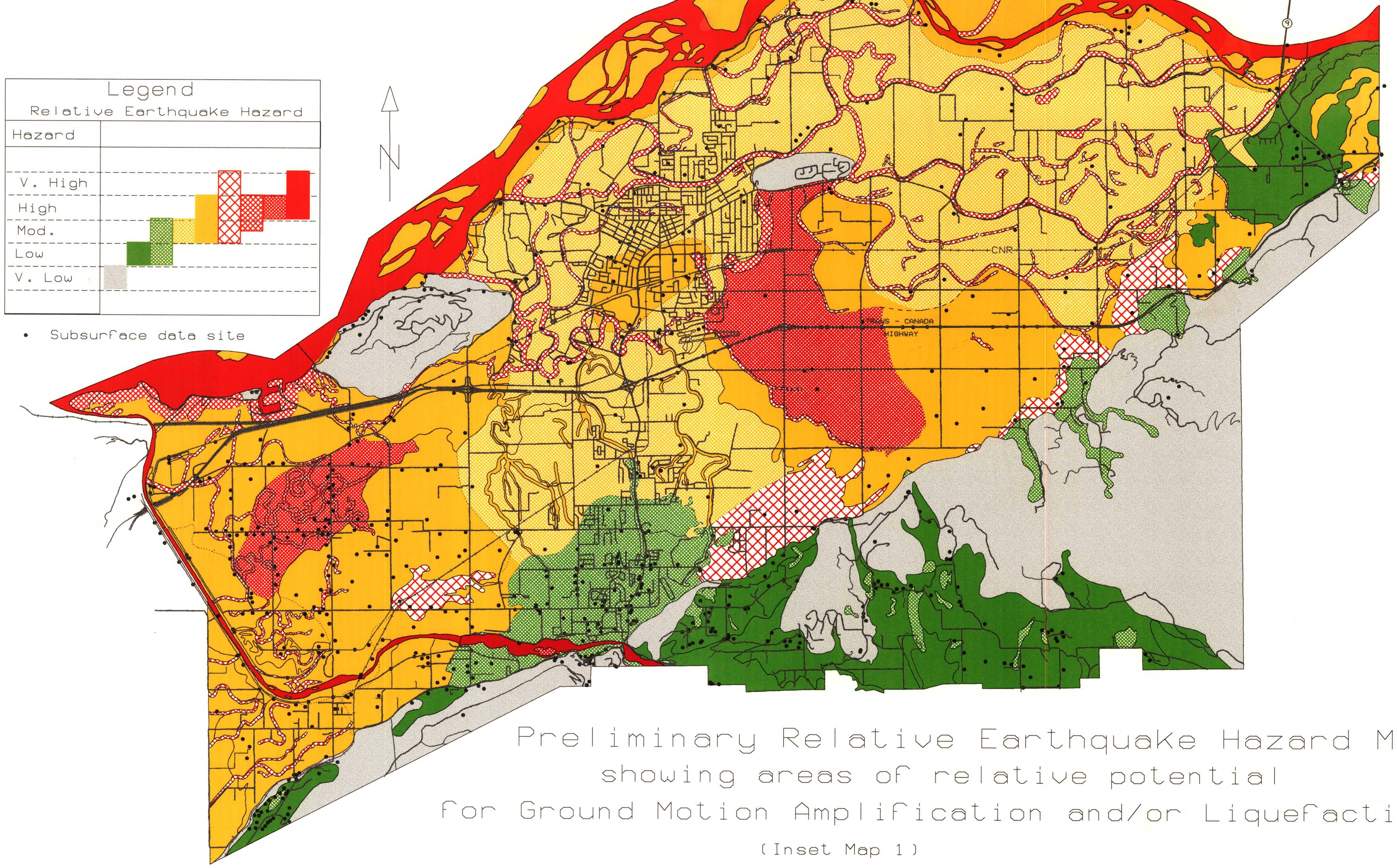
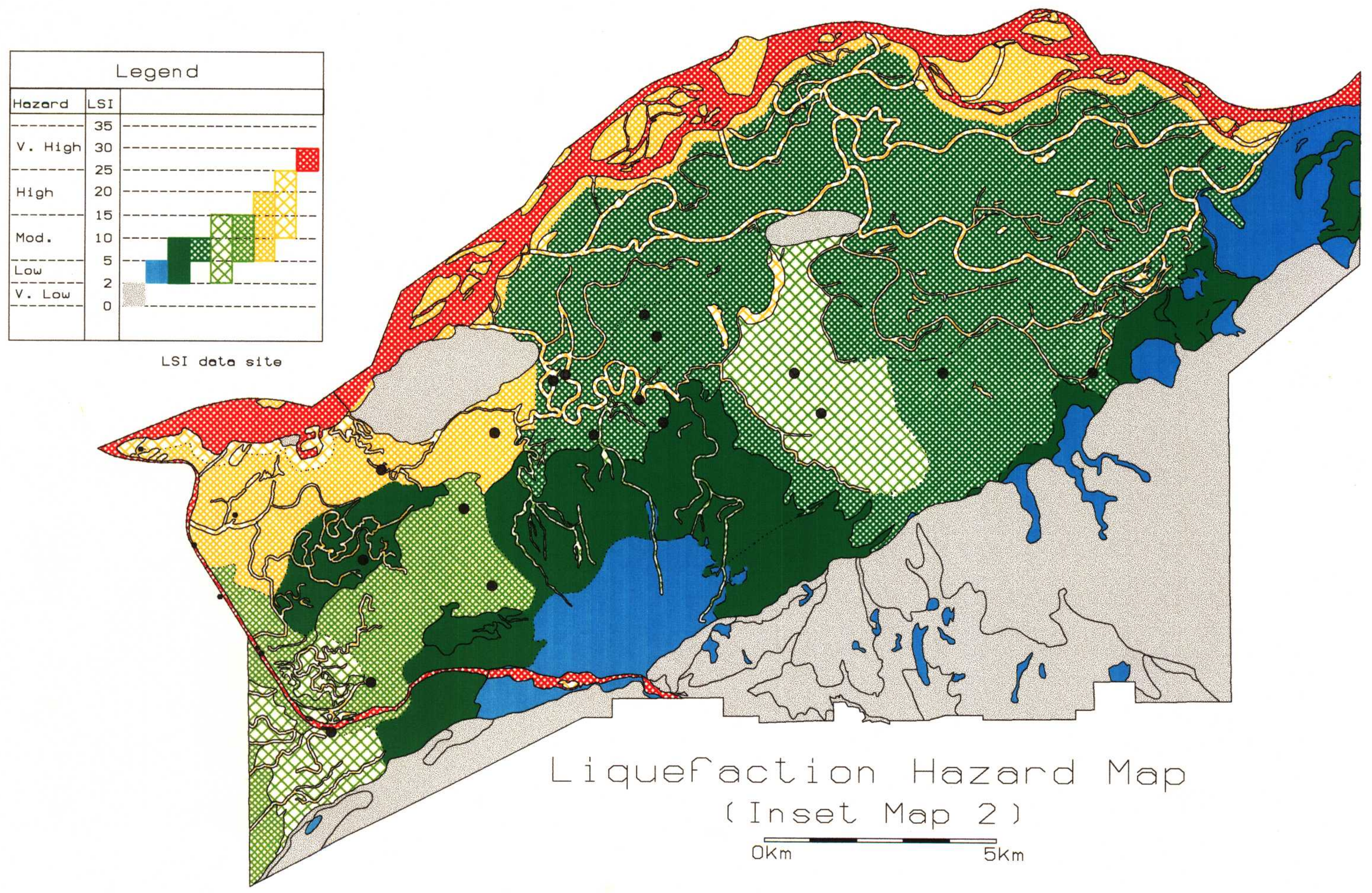


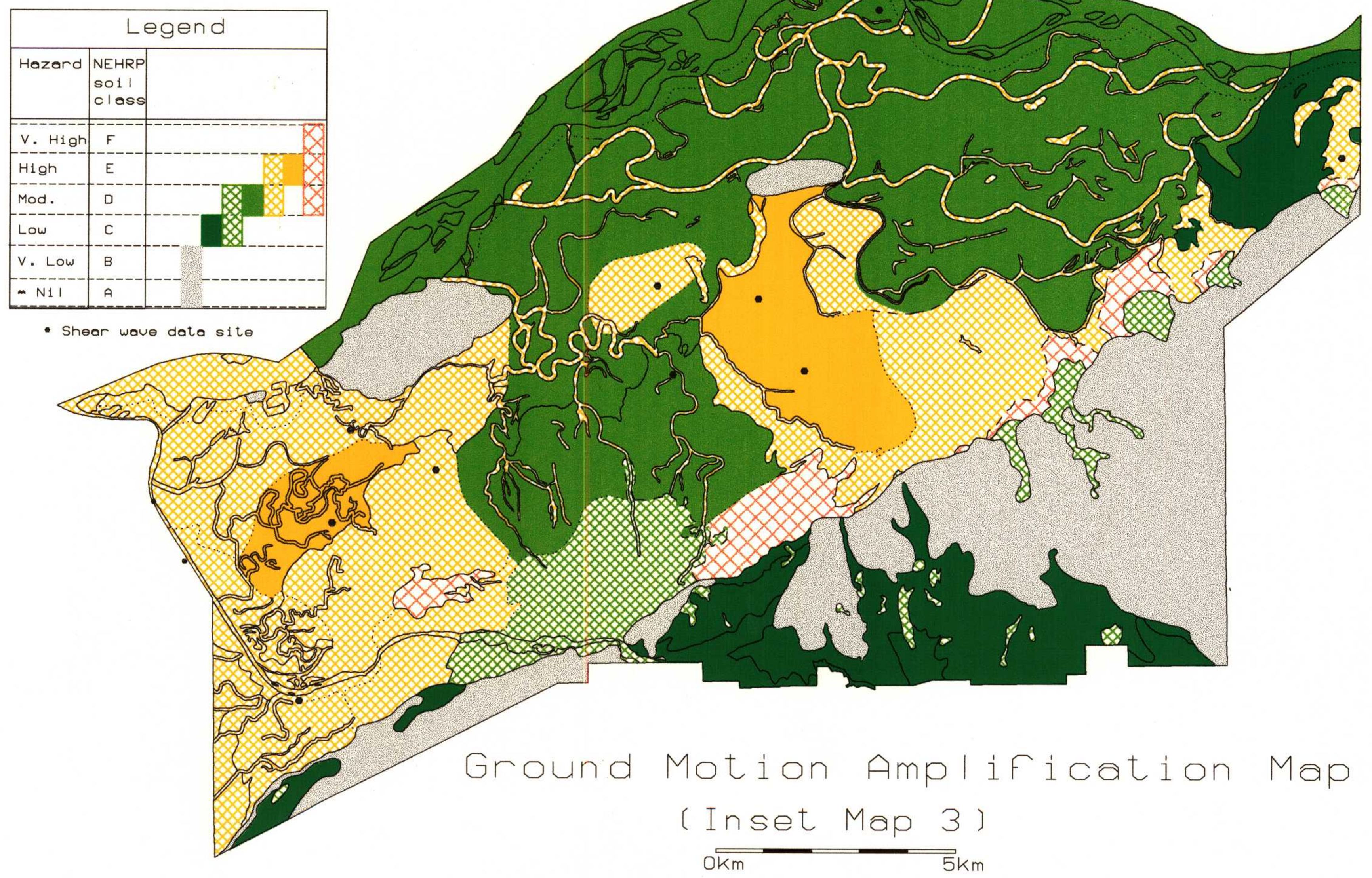
Preliminary Relative Earthquake Hazard Map showing areas of relative potential for Ground Motion Amplification and/or Liquefaction

(Inset Map 1)

0Km 5Km



Liquefaction Hazard Map
(Inset Map 2)



Ground Motion Amplification Map
(Inset Map 3)

INTRODUCTION

Earthquake hazard maps identify the relative potential for ground disturbance during an earthquake due to local geologic conditions. This map shows areas where the presence of soft or liquefiable soils may result in an increased hazard, compared to other areas with firm or nonliquefiable soils. Although the source and magnitude of future earthquakes are difficult to predict, variations in soil behavior and potential surface damage are largely controlled by mappable geologic and geotechnical conditions. Earthquake hazard maps, therefore can be used for mitigative planning in seismically active regions. This map results from a geological and geotechnical study of the Chilliwack region. *The map is intended for regional purposes only, such as landuse and emergency planning and not for site specific hazard evaluations.* Although this map can be used with other criteria to help planners select potential areas for development, avoid geologically vulnerable areas and prioritize seismic upgrading programs, *the map in no way replaces the need for site-specific geotechnical studies* prior to new construction or upgrading of buildings and other facilities such as bridges. The map highlights the need for these studies, especially in areas of high hazard. Although one or more hazards may be included in an earthquake hazard map, only liquefaction and amplification of ground motion hazards are evaluated here.

DEFINITIONS

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METHODOLOGY

The methodology used included: 1) collection of existing and new geotechnical test hole and water well data (> 2400 logs from 390 sites, shown on map 1 as dots); 2) 1:20 000-scale surficial geology mapping (Levson *et al.,* 1996b); 3) integration of data in a Geographic Information System (Meldrum *et al.,* in press); 4) subsurface geological modeling; 5) production of a Quaternary geology map (reflecting the upper 20 m; Monahan and Levson, in press); 6) assessment of liquefaction susceptibility and liquefaction potential (INSET MAP 2) and ground motion amplification hazards (INSET MAP 3); and 7) development of a combined liquefaction and amplification hazard map. The methods used generally follow those recommended by the Seismic Microzonation Task Group (Klohn-Crippen, 1994). Summaries of the program have been provided by Levson *et al.* (1995, 1996a). The details of the methodologies and references for liquefaction and amplification hazard mapping in the region are provided by Levson *et al.* (in press) and Monahan *et al.* (in press), respectively. These methodologies are only summarized briefly here. Reference should be made to these publications for a complete understanding of the procedures used.

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LIMITATIONS ON MAP USE

This map is regional in scope and indicates general areas where materials susceptible to liquefaction or amplification are likely present. Map unit boundaries are based on geological criteria and on limited borehole information only and, as such, the boundaries between map units are approximate and may change with additional data. The earthquake hazard at any one site may be higher or lower than shown due to geological variations within map units, gradational and approximate map unit boundaries and the regional scale of this map. Furthermore, during an earthquake, ground shaking will occur throughout the map area, even in areas of lower hazard rating, but the hazard in the latter areas will generally not be increased due to liquefaction or amplification. **For these reasons, a low hazard rating on this map should not be interpreted as freedom from earthquake hazards**. For more information on the technical aspects and limitations of earthquake hazard mapping in the Chilliwack area, reference should be made to the technical maps from which this composite map was made (Levson *et al.,* in press; Monahan, *et al.,* in press).

The map is intended for regional purposes only, such as landuse and emergency planning. In addition, only liquefaction and amplification hazards are evaluated here. Potential effects from other hazards such as earthquake-induced landslides should also be considered in any comprehensive evaluation of earthquake hazards in this area for landuse or emergency planning or any other purpose.

Earthquake hazard maps can not be used to directly predict the amount of damage that will occur at any one site because many other factors such as building design or building height must be considered. However, the maps can be used to estimate the relative hazard due to geological controls. Likewise, earthquake hazard maps can not be used to estimate **risk** as this is dependent on many other factors such as the number of people present in the area at any one time and the types of facilities that are there. For example, although the earthquake *hazard* may be high in a farmer's field, the *risk* of damage is obviously low, compared to the same level of hazard in a developed area of a city.

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Refer to accompanying text for explanation and for limitations on use.

PRELIMINARY LIQUEFACTION POTENTIAL MAP

CHILLIWACK AREA

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Daniel G. Meldrum,
(B.C. Geological Survey

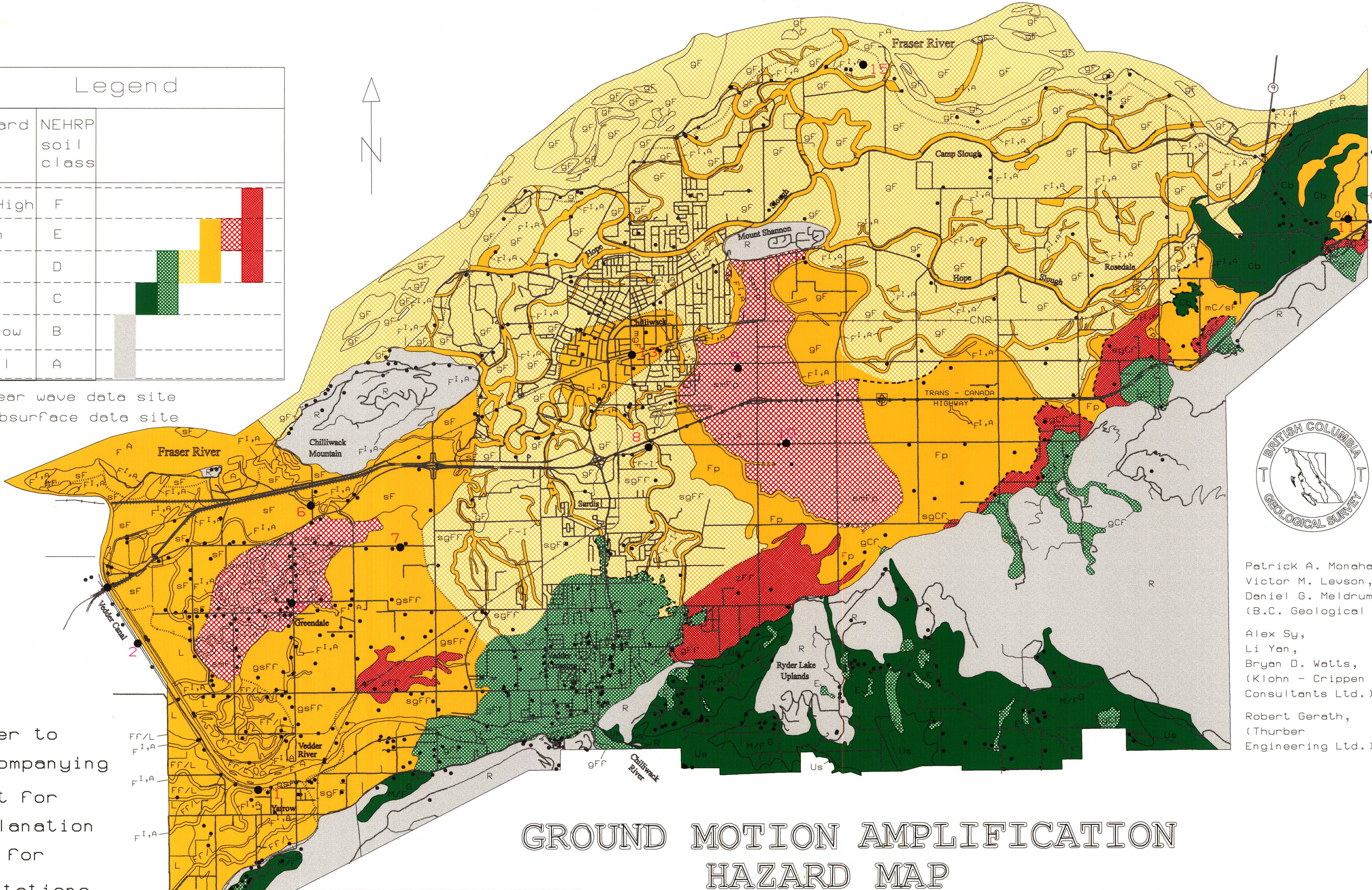
Alex Sy,
Li Yan,
Bryan D. Watts,
(Klohn - Crippen Consultants Ltd.)

Robert Gerath,
(Thurber Engineering Ltd.)

Legend

Hazard	NEHRP soil class	
V. High	F	
High	E	
Mod.	D	
Low	C	
V. Low	B	
≈ Nil	A	

• Shear wave data site
· Subsurface data site



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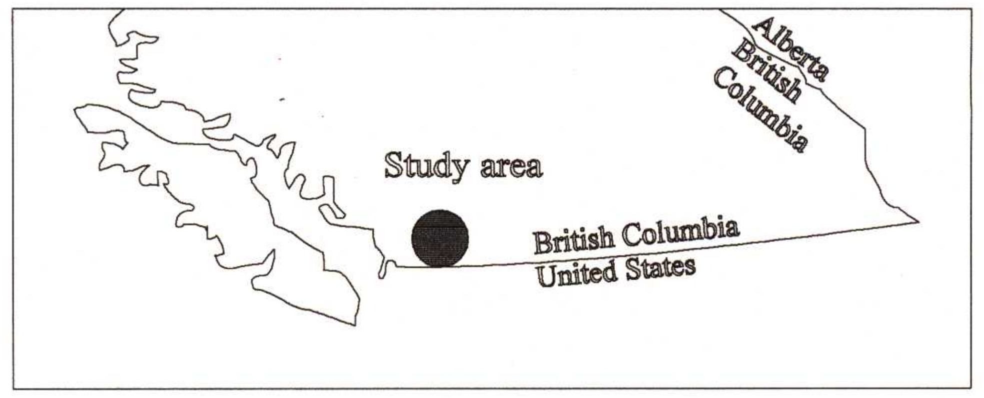
GROUND MOTION AMPLIFICATION HAZARD MAP



0Km 5Km

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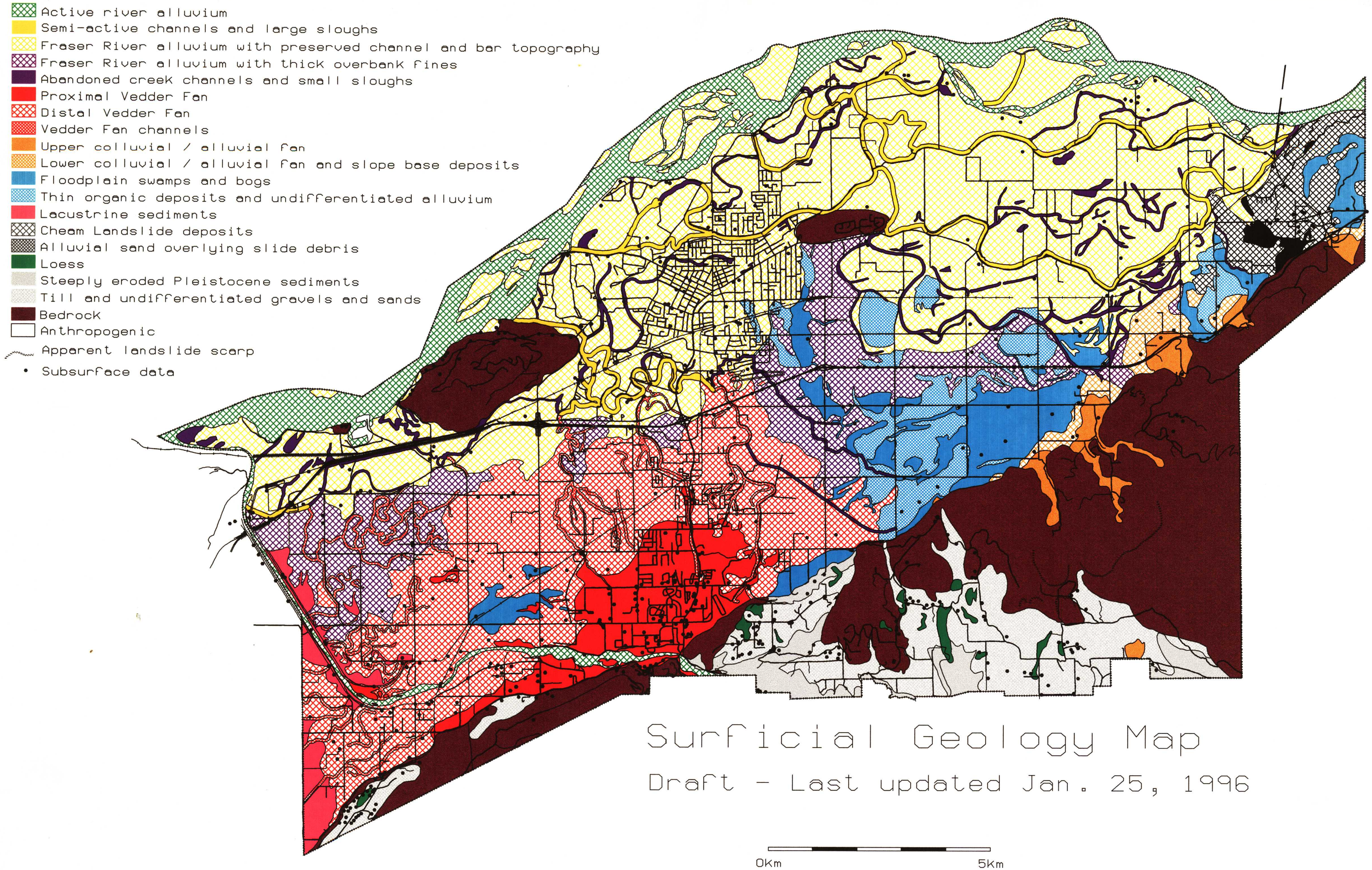

Surficial Geology Map

Draft - Last updated Jan. 25, 1996


Fraser Alluvium
Active River Channels
Semi-active and abandoned channels and sloughs
Gravelly Alluvium
Sandy alluvium
Older gravelly Alluvium
Large Paleo-channel
Alluvium w/ surface fines
Vedder Fan
Upper fan
Gravelly Fan / Gravelly Alluvium
Sand & Gravel Fan
Fan with thick surface fines
Thin Fan / Lacustrine
Fan and minor channels
Lacustrine
Colluvial / Alluvial Fans
Upper Fan
Lower Fan
Colluvium w/ surface fines
Other
Slide debris with interbedded sands and gravels
Fine sediments, organics and marl
Pleistocene till and thin till over outwash
Eroded Pleistocene sediments
Eolian Silt, minor organics and lake sediments
Bedrock
Quaternary Sedimentary Facies
to 20 m depth
Draft - Last Updated Jan. 26, 1996
0Km
5Km