

Adapting to Climate Change

A Risk-based Guide for Local Governments in British Columbia

Volume 2 (Workbook and Case Studies)

Adapting to Climate Change: A Risk-based Guide for Local Governments in British Columbia

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Introduction

This Guide was user-tested in two workshops in British Columbia; one held in Victoria and one in Metro Vancouver for members of regional local governments and representatives of the provincial government..

The purposes of workshops were to:

- Present the risk management process as a tool to facilitate planning for adapting to climate change,
- Consider and understand the projected climate change impacts in British Columbia over the next 20 to 30 years, and
- Test the Guide using selected impacts by the represented communities to determine which adaptation strategies should be considered to reduce the risks to acceptable levels.

The Victoria workshop participants decided to consider the climate impacts in two general areas:

- Sea level rise, and
- Extreme weather events.

The Metro Vancouver workshop participants also decided to consider two aspect of climate change impacts:

- Sea level rise in the lower mainland, and
- Extreme rainfall events.

The case studies and examples included in this volume of the Guide illustrate the use of the risk management process to develop adaptation strategies in these specific areas of climate impacts. They are included below to inform users and assist them as they work through the risk management process.

Because they were developed during time-limited workshops and in a learning environment, the case studies and examples often use very simplified risk scenarios. Nevertheless, the development of the risk management information by the groups illustrate can assist others dealing with similar risk scenarios.

This volume also contains the **Workbook** which contains all the suggested tables and diagrams from Volume 1 in a format that cant be photocopies or copies electronically and used by the risk management team. As suggested in Volume 1, the risk management team should feel free to change the headings and structure of the tables to meet their specific needs.

1. Case Study: Extreme Weather Events in Lower Vancouver island

Members of the Victoria workshop breakout group for sea level rise discussed the risk issues associated with sea level rise in a changing climate about 25 year into the future. The group had about three hours to consider the issue and decided that their work would be very condensed if they were to work through the most important components of the risk management process.

Step 1: Getting Started.

The group discussed the climate projections for their region and considered the following as the risk scenario or likely events flowing from higher salt water levels:

- Higher storm surges,
- Higher high tides,
- Increased exposure to damage from heavy rainfall events
- Increased exposure to damage from on-shore winds,
- Higher waves, and
- A number of general events that included erosion, salt water contamination, infrastructure damages, flooding of buildings, traffic disruptions. Lost habitat, displacement of people, decreased

property values, and loss of public waterfront access,

They considered that the following would be the principal stakeholders who should be involved or informed about the analysis of the problems.

- Waterfront Property Owners,
- Engineering & Public Works,
- Planners,
- First Nations,
- Commercial Interests,
- Health Authority (Regional),
- Ministry of Environment,
- Department of Fisheries,
- Emergency Preparedness,
- Transport Canada,
- Wildlife Services,
- Community Groups and
- Marinas/Port Authorities.

The group decided that it had enough information to move on to the next step.

Step 2: Preliminary Analysis.

The risk scenario for sea level rise was developed and the preliminary estimates of frequency and consequences was made as shown in the table below:

Table 2 Preliminary Assessment

Hazard: Sea Level Rise - 2035

RISK	EVENT OR RESULT	FREQUENCY			CONSEQUENCE			COMMENT or POSSIBLE CONTROL
		1	2	3	1	2	3	
Storm Surges								
High Tides								
Heavy Rain	Urban Flooding, water contamination (sewage-storm), well contamination			X			X	
On-shore Winds	Power outages			X	X			
Higher Waves	Sediment transport, beach erosion, failure of dikes	X		X		X		Dredging activities
GENERAL	Erosion			X			X	
	Salt Water			X			X	

RISK	EVENT OR RESULT	FREQUENCY			CONSEQUENCE			COMMENT or POSSIBLE CONTROL
		1	2	3	1	2	3	
	Contamination							
	Damage to Infrastructure			X			X	
	Flooding of Buildings		X			X		
	Traffic Disruption			X	X			
	Habitat Lost			X		X		
	Displacement of People		X			X		
	Decreased Property Values			X		X		
	Public Waterfront Access			X		X		

The group selected two of the most serious risks for further consideration in the limited time of the workshop in Step 3 and onward..

Step 3: Risk Estimation.

In this step the group considered both extremely high and damaging water levels and heavy and damaging rain events:

Table 3.1: Estimate of Frequency

Probability or Frequency Risk Event	Very Unlikely to Happen	Occasional Occurrence	Moderately Frequent	Occurs Often	Virtually Certain to Occur
Extremely High and Damaging Water Levels					X
Heavy and Damaging Rains					X

Table 3.2 -1 Estimate of Consequences: Extremely High and Damaging Salt Water Levels

Impact Degree	Social factors				Economic factors			Environmental factors			
	Displacement	Health & Safety	Loss of Livelihood	Cultural Aspects	Property Damage	Financial Impact	Impact on Municipal Finances	Air	Water	Land	Eco-systems
Very low			X					X			
Low	X						X			X	
Moderate	X	X		X	X	X	X		X		X
Major											
Very Severe											

Table 3.2 -2 Estimate of Consequences: Heavy and Damages Rains (at the same time as high seas)

Impact Degree	Social factors				Economic factors			Environmental factors			
	Displacement	Health & Safety	Loss of Livelihood	Cultural Aspects	Property Damage	Financial Impact	Impact on Municipal Finances	Air	Water	Land	Eco-systems
Very low			XO					XO			
Low	X						X			X	
Moderate	X	X		XO	X	XO	XO		XO	O	XO
Major	O	O			O						
Very Severe											

Legend X = Extremely High and Damaging Sea Levels
O = Heavy & Damaging Rains

Table 3.3: Stakeholders' Perception of Risks

Climate Factors: (Hazards)	Stakeholders' perception of Risk	High Sea Water Levels	Heavy and Damaging Rains
	Waterfront Property Owners	H	H
	Engineering & Public Works	H	H
	Planners	H	H
	First Nations	H	H
	Commercial Interests	M	L
	Health Sector	L	H
	Ministry of Environment	M	M
	Fisheries	M	M
	Emergency Preparedness		
	Transport Canada		
	Wildlife Services		
	Community Groups		
	Marinas/Port Authorities		

Step 4: Risk Estimation.

Risk Evaluation Matrix

Consequences	Extreme					
	Major					Heavy & Damaging Rain Fall (with raised sea level)
	Moderate					Extremely High Rise in Salt Water Levels
	Low					
	Very Low					
		Very Unlikely	Occasional Occurrence	Moderately Frequent	Occurs Often	Virtually Certain
Frequency						

Step 5: Risk Controls and Adaptation Measures

Table 5: Risk Control and Adaptation Measures

Risk ()	Control or Adaptation Measure	Time Frame	Cost	Effectiveness	Acceptability	Comment / Evaluation
Extremely High and Damaging Sea Levels	Zoning	Opportunistic: short-to-mid term	Low financial cost; high political cost	Only effective for new developments	Difficult	Need Mapping of Hazard Areas, Consider Rezoning, Discussion with other Gov't agencies
	Shore Protection	Long-term	High	Moderate	High in short-term; lower in the long-term	Various techniques & stakeholder consultation
	Abandonment	Opportunistic:	Low to High	Very effective	Difficult in many cases	If large displacement of people were to occur, it would be costly
Heavy & Damaging Rains	NOTE: The group did not have time to complete the table for this risk.					

2. Case Study: Sea Level Rise in the Lower Vancouver island

The breakout group considered only one climate hazard: Extreme weather events out to twenty years in the future.

Step 1: Getting Started

Team Members	Stakeholders
Land Use Planner	Health Authority
Finance / Asset Management	Provincial Reps (MoT, MoE, MCRD)
Engineering	First Nations
Public Information Officer	NGOs & ENGOS
Sustainability Office (TBL)	Neighborhood or Community Associations
Environmental	Chamber of Commerce
Parks Representative	Youth Organization or Council
Social Planner	Utility Companies
Protective Services	Politicians (via Committees)
Facilities Management	Seniors Organizations
Housing Authorities	Tourism Organization
Risk Management	Agricultural Representatives
Human Resources (OH&S rep)	

Step 2: Preliminary Analysis.

Table 2 - Preliminary Risk Assessments

Risk Scenario	Vulnerability	Frequency			Consequence			Comment or control measure
		1	2	3	1	2	3	
Heavy Rain	Water contamination Broken water mains Flooding --Compromised water quality --Septic system overloads			X		X		
Heavy Wind	Power poles and lines Blocked communication		X			X		

Risk Scenario	Vulnerability	Frequency			Consequence			Comment or control measure
		1	2	3	1	2	3	
	lines Trees: loss and clean up Erosion on coasts							
Drought		X				X		
Snow	Transportation routes Communication networks Housing damage Vulnerable populations		X			X		
Extreme heat		X				X		
Extreme cold	Loss of water Vulnerable populations Flooding and erosion	X					X	
Electrical Storms	Forest fires Blocked communication networks		X			X		

Step 3: Risk Estimation.

Step 3 –Risk Estimation
Table 3.1 – Estimates of Frequency of Risks

Frequency	Very Unlikely	Occasional Occurrence	Moderately Frequent	Occurs Often	Virtually Certain
Heavy Rain					X
High Winds			X		
Snow				X	
Extreme Cold		X			
Electrical Storms		X			

The group decided not to consider further the lowest risks from the analysis in table 3.1: drought and extreme heat.

Step 3 –Risk Estimation

Table 3.2 – Estimates of Consequence of Risks

Impact	Social Factors				Economic Factors			Environmental Factors			
	Displacement	Health & Safety	Loss of Livelihood	Cultural Aspects	Property Damage	Financial Impact	Impact on Municipal Functions	Air	Water	Land	Eco-Systems
Very Low								X			
Low			X	X							
Moderate	X						X				
Major		X			X	X				X	
Very Severe									X		X

Risk Scenario: Heavy Rains

Impact	Social Factors				Economic Factors			Environmental Factors			
	Displacement	Health & Safety	Loss of Livelihood	Cultural Aspects	Property Damage	Financial Impact	Impact on Municipal Functions	Air	Water	Land	Eco-Systems
Very Low				X				X			
Low	X						X				X
Moderate		X	X		X	X			X	X	
Major											
Very Severe											

Risk Scenario: High Winds

Impact	Social Factors				Economic Factors			Environmental Factors			
	Displacement	Health & Safety	Loss of Livelihood	Cultural Aspects	Property Damage	Financial Impact	Impact on Municipal Functions	Air	Water	Land	Eco-Systems
Very Low								X	X	X	X
Low			X	X			X				
Moderate	X				X	X					
Major		X									
Very Severe											

Risk Scenario: Extreme Cold

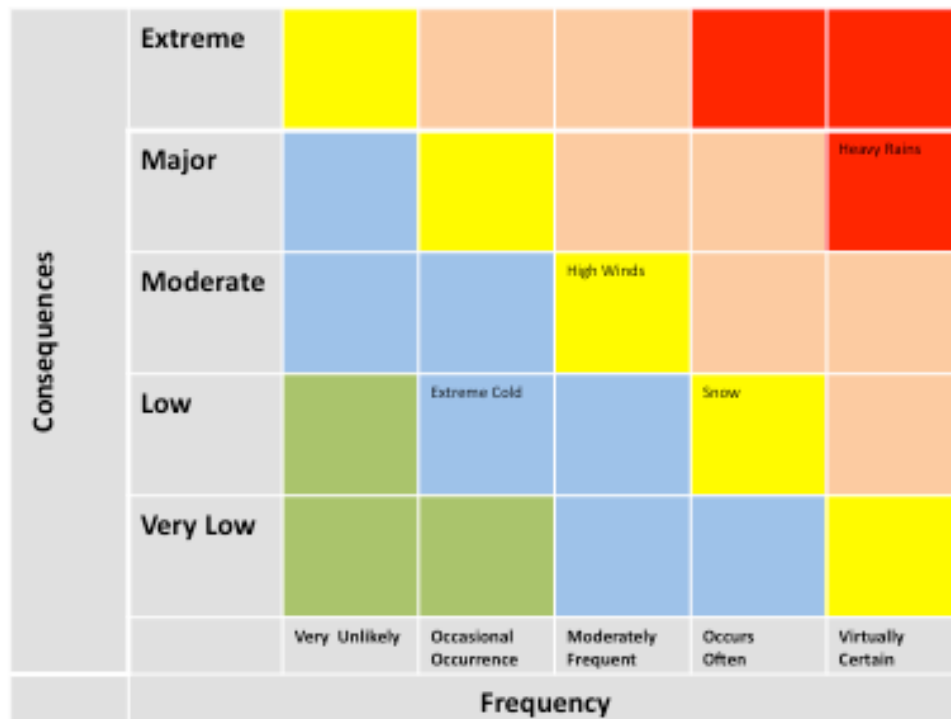
Impact	Social Factors				Economic Factors			Environmental Factors			
	Displacement	Health & Safety	Loss of Livelihood	Cultural Aspects	Property Damage	Financial Impact	Impact on Municipal Functions	Air	Water	Land	Eco-Systems
Very Low	X			X				X			
Low		X	X		X	X			X	X	X
Moderate							X				
Major											
Very Severe											

Risk Scenario: Snow

Table 3.3: Stakeholders' Risk Perception

Climate Factors: (Hazards)	Risk Scenarios - Aspects of Hazards and Risks to Community	Stakeholders and perception of Risk
Extreme weather	Heavy Rains	<i>Utility Companies:</i> infrastructure failure
		<i>Agriculture:</i> loss of business; flooding of property; damage to livestock
		<i>Health:</i> Drinking water quality; mould and respiratory diseases.

Step 4 –Risk Evaluation
Figure 4 – Risk Evaluation Matrix



Summary of Risk

Rating	Risk Scenario
Extreme	
High	Heavy Rains
Moderate	High Winds
Low	Snow and Extreme Cold
Negligible	

Step 5 – Risk Control and Adaptation Measures

Risk Scenario	Control or Adaptation Measure	Time Frame	Cost	Effectiveness	Acceptability	Comment/Evaluation
Heavy Rains	Downspout Disconnection	Short	Modest	High	High	Require public education campaign
	Improved Stormwater Management and Retention	Medium	Medium	High	Medium	

Risk Scenario	Control or Adaptation Measure	Time Frame	Cost	Effectiveness	Acceptability	Comment/Evaluation
	Storm / Sanitary Separation	Long	High	High	Medium	
	Ecosystem Restoration / Creek Enhancement	Medium	Medium	Medium	High	GHG reduction credit
	Demand Management	Short	Modest	Low	Medium	
Extreme Cold	Warming Centers	Short	Modest	High	High	
	Housing Retrofit Incentive	Short	Medium	High	High	
	Alternate Heating or Renewable Energy					

3. Case Study: Sea Level Rise in the Lower Mainland

The workshop held in Metro Vancouver decided to consider two aspect of climate change impacts:

- Sea level rise in the lower mainland, and
- Extreme rainfall events.

The first breakout group considered in detail sea level rise as one component of the future climate.

Step 1: Getting Started

The group considered potential project team members and key stakeholders. (Note: the project team would consist of three or four members of those listed in the table below).

Team Members	Stakeholders
Land-use Planners	Waterfront industries/businesses
Roads/Drainage/Utility Engineers	Agricultural associations
Communications (regional + local)	First Nations
Environmental Rep	Railways
Protection Services (Fire, Police, Coast Guard...)	Waterfront homeowners/landowners/Neighborhood associations
Provincial Rep	ENGO's, NGO's
Corporate Analyst	
Ministry of Highways	
Port Metro Van	
Economist	
BIEMP/FREMP	

Step 2: Preliminary Analysis.

Table 2: Preliminary Risk Assessment

Risk Scenario	Vulnerability	Frequency			Consequence			Comment or control measure
		1	2	3	1	2	3	
Sea Level Rise								
Dyke Breach								

Habitat loss	Sensitive ecosystems Targeted fisheries Loss of migratory birds		X	X	
Saline contamination	Irrigation water Arable land Potable water		X		X
Compromised Docks		X		X	
Compromised infrastructure	Flooded roads Damaged sewer/water Railway lines		X		X
Flooded airport		X			X
Sewage treatment plant	Effluent discharge disease	X			X
Storm related flooding	Dykes vulnerable Residential/industrial properties Loss of businesses		X		X
Residential losses			X		X
Loss of tax base			X	X	

Step 3: Risk Estimation.

Table 3.1 – Estimate of Frequency of Risks

Frequency	Very Unlikely	Occasional Occurrence	Moderately Frequent	Occurs Often or More Frequently	Virtually Certain to be Much More Frequent
	100+ years	100 years	50 years	25 years	0 years

Risks from Risk Scenario

Habitat Loss

X

Saltwater contamination

X

Compromised Infrastructure

X

Frequency	Very Unlikely	Occasional Occurrence	Moderately Frequent	Occurs Often or More Frequently	Virtually Certain to be Much More Frequent
	100+ years	100 years	50 years	25 years	0 years

Compromised sewage treatment plant

X

Storm-related flooding

X

Table 3.2.1 Estimate of Consequences: Habitat Loss

Impact / Degree	Social factors				Economic factors			Environmental factors			
	Displacement	Health & Safety	Loss of Livelihood	Cultural Aspects	Property Damage	Financial Impact	Impact on Municipal Finances	Air	Water	Land	Eco-systems
Very low	X	X		X				X			
Low											
Moderate			X		X	X	X				X
Major									X	X	
Very Severe											

Overall Risk: Low

Table 3.2.2 Estimate of Consequences: Saltwater Contamination.

Impact / Degree	Social factors				Economic factors			Environmental factors			
	Displacement	Health & Safety	Loss of Livelihood	Cultural Aspects	Property Damage	Financial Impact	Impact on Municipal Finances	Air	Water	Land	Eco-systems
Very low	X	X		X				X			
Low											
Moderate			X		X	X	X				X
Major									X	X	
Very Severe											

Overall Risk: Moderate

Table 3.2.3 Estimate of Consequences: Compromised Infrastructure

Impact / Degree	Social factors				Economic factors			Environmental factors			
	Displacement	Health & Safety	Loss of Livelihood	Cultural Aspects	Property Damage	Financial Impact	Impact on Municipal Finances	Air	Water	Land	Eco-systems
Very low		X		X							
Low								X			
Moderate	X		X						X	X	X
Major					X	X	X				
Very Severe											

Overall Risk: Moderate

Table 3.2.4 Estimate of Consequences: Compromised Sewage Treatment Plants

Impact Degree	Social factors				Economic factors			Environmental factors			
	Displacement	Health & Safety	Loss of Livelihood	Cultural Aspects	Property Damage	Financial Impact	Impact on Municipal Finances	Air	Water	Land	Eco-systems
Very low	X			X							
Low					X						
Moderate		X	X			X	X	X		X	
Major											
Very Severe									X		X

Overall risk: Moderate

Table 3.2.5 Estimate of Consequences: Storm Related Flooding

Impact Degree	Social factors				Economic factors			Environmental factors			
	Displacement	Health & Safety	Loss of Livelihood	Cultural Aspects	Property Damage	Financial Impact	Impact on Municipal Finances	Air	Water	Land	Eco-systems
Very low											
Low								X			
Moderate				X							
Major			X							X	
Very Severe	X	X			X	X	X		X		X

Overall Risk: Very Severe

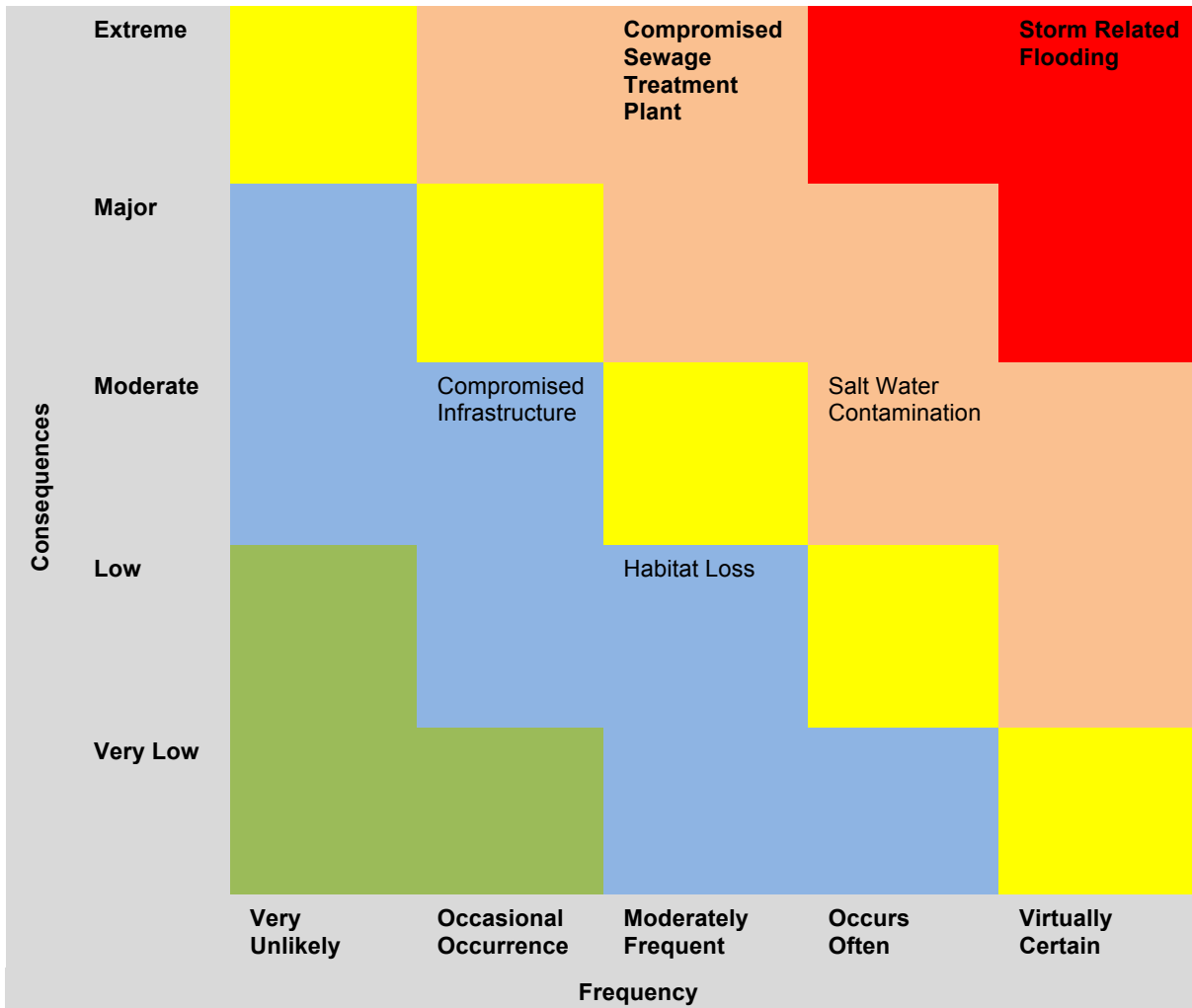
TABLE 3.3: Stakeholders' Risk Perception.

Climate Factors: (Hazards)	Risk Scenarios - Aspects of Hazards and Risks to Community	Stakeholders and perception of Risk
Sea Level Rise	Habitat Loss	ENGO's First Nations Ecotourism -As important as any other Risk Scenario -Political -Food Security
	Group did not have time to complete for other risks in the scenario	

Step 4: Risk Evaluation.

Using the data developed in Step 3, the group produced the table below:

Figure 4: Risk Evaluation Matrix: Sea Level rise on BC's Lower Mainland.



The group found that storm-related flooding and compromised sewage treatment facilities were the highest risks associated with sea level rise in the 2010-2035 time frame.

Step 5: Risk Controls and Adaptation Measures.

Because of a shortage of time, the group considered only risk controls/adaptation measures associated with storm-related flooding.

Table 5.1 – Risk Controls and Adaptation Measures

Risk	Control or Adaptation Measure	Time Frame	Cost	Effectiveness	Acceptability	Comment / Evaluation
Storm-Related Flooding	Improved Dykes	Medium	High	High	Medium	Prioritization / Phasing
	Sea-wall installation	Short	Medium	High	Medium	
	Pump station Capacity	Short	Medium	Medium	High	
	Zoning Restrictions	Long	High	High	Modest	
	Evacuation Plans	Short	Modest	Medium	Medium	
	Updating Building Codes	Medium	Modest	High	Low	
	Public Warning System	Short	Modest	Medium	High	

4. Case Studies: Extreme Weather in the Lower Mainland.

The workshop held in Metro Vancouver decided to consider two aspect of climate change impacts:

- Sea level rise in the lower mainland, and
- Extreme rainfall events.

The second breakout group considered in detail high precipitation events as one component of the future climate.

Step 1: Getting Started

The group considered potential project team members and key stakeholders. (Note: the project team would consist of three or four members of those listed in the table below).

Team Members	Stakeholders
Alan Ngo	People in low-lying areas
Dipak Dattani	Base of slopes / on slopes
Brent Burton	Engineers
Lynne Vidler	Health authority
Fiona Dercole	Ski resorts
Ken Bennett	Stream keepers
Helen Popple	DFO
Teresa Sharp	MoE / EMBC / Dyking Authority
Trudi Trask	Planners
Reuben Koole	Transportation (snow & rain)
Jim Bruce	Watershed management
	Metro Vancouver / FVRD
Agriculture groups	First Nations communities

Step 2: Preliminary Analysis.

Table 2: Preliminary Risk Assessment

Risk Scenario	Vulnerability	Frequency			Consequence			Comment or control measure
		1	2	3	1	2	3	
Heavy Rain	Storm sewer overflow			X	X			
	Contaminated drinking water		X				X	
	Overland flooding / buildings		X	X			X	

	Urban landslides	X		X
	Septic field failure	X		X
	CSO / STP upsets		X	X
	Stream bank erosion	X		X
	Habitat disturbance	X		X
Heavy Snow	People w/ mobility challenges	X		X
	Mobility	X		X
	Snow clearing		X	X

Step 3: Risk Estimation.

Table 3.1 – Estimate of Frequency of Risks

Frequency	Very Unlikely	Occasional Occurrence	Moderately Frequent	Occurs Often or More Frequently	Virtually Certain to be Much More Frequent
Storm sewer overflow				X	
Contaminated drinking water			X		
Overland flooding / buildings				X	
Urban landslides			X		
Septic field failure				X	
CSO / STP upsets			X		
Stream bank erosion				X	
Habitat disturbance				X	
Snow: People w/ mobility challenges				X	
Snow: Mobility			X		

Frequency	Very Unlikely	Occasional Occurrence	Moderately Frequent	Occurs Often or More Frequently	Virtually Certain to be Much More Frequent
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Snow clearing

X

Table 3.2.1 Estimate of Consequences: Storm Sewer Overflow

Impact Degree	Social factors				Economic factors			Environmental factors			
	Displacement	Health & Safety	Loss of Livelihood	Cultural Aspects	Property Damage	Financial Impact	Impact on Municipal Finances	Air	Water	Land	Eco-systems
Very low	X							X			X
Low			X							X	
Moderate		X		X	X	X			X		
Major							X				
Very Severe											

Overall Risk: Moderate

Table 3.2.2 Estimate of Consequences: Contaminated Drinking Water Source.

Impact Degree	Social factors				Economic factors			Environmental factors			
	Displacement	Health & Safety	Loss of Livelihood	Cultural Aspects	Property Damage	Financial Impact	Impact on Municipal Finances	Air	Water	Land	Eco-systems
Very low	X			X	X			X		X	
Low			X			X					X
Moderate									X		
Major		X					X				
Very Severe											

Overall Risk: Low

Table 3.2.3 Estimate of Consequences: Overland flooding

Impact Degree	Social factors				Economic factors			Environmental factors			
	Displacement	Health & Safety	Loss of Livelihood	Cultural Aspects	Property Damage	Financial Impact	Impact on Municipal Finances	Air	Water	Land	Eco-systems
Very low											
Low											
Moderate								X			
Major	X	X		X					X		X
Very Severe	X		X		X	X	X			X	

Overall Risk: Extreme

Table 3.2.4 Estimate of Consequences: Urban Landslides

Impact Degree	Social factors				Economic factors			Environmental factors			
	Displacement	Health & Safety	Loss of Livelihood	Cultural Aspects	Property Damage	Financial Impact	Impact on Municipal Finances	Air	Water	Land	Eco-systems
Very low								X			
Low											
Moderate	X		X	X		X			X	X	X
Major	X	X			X		X			X	
Very Severe											

Overall risk: Moderate

Table 3.2.5 Estimate of Consequences: Snow - Mobility

Impact Degree	Social factors				Economic factors			Environmental factors			
	Displacement	Health & Safety	Loss of Livelihood	Cultural Aspects	Property Damage	Financial Impact	Impact on Municipal Finances	Air	Water	Land	Eco-systems
Very low				X					X	X	X
Low	X		X					X			
Moderate					X	X					
Major		X					X				
Very Severe											

Overall Risk: Moderate

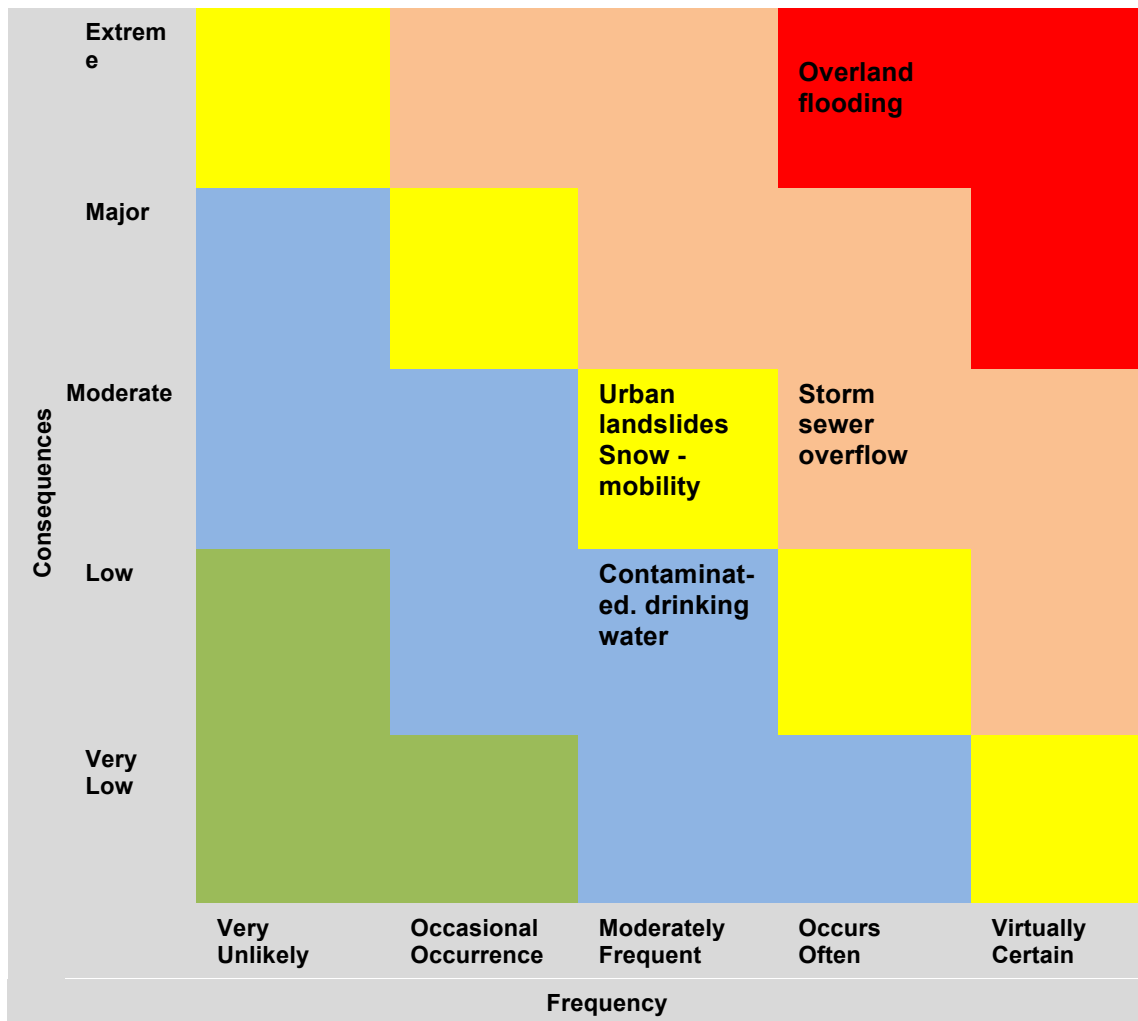
TABLE 3.3: Stakeholders' Risk Perception.

Climate Factors: (Hazards)	Risk Scenarios - Aspects of Hazards and Risks to Community	Stakeholders and perception of Risk
Heavy Rain	Storm sewer overflow	DFO-3 / Residents-3 / Provincial-2 / Local-3 / RTB-2 / FN-3
	Contaminated drinking water	DFO-2 / Residents-3 / Provincial-3 / Local-3 / RTB-3 / FN-3
	Overland flooding / buildings	DFO-3 / Residents-3 / Provincial-3 / Local-3 / RTB-3 / FN-3
	Urban landslides	DFO-2 / Residents-3 / Provincial-3 / Local-3 / RTB-2 / FN-3
Heavy Snow	Mobility	DFO-2 / Residents-3 / Provincial-3 / Local-3 / RTB-3 / FN-3

Step 4: Risk Evaluation.

Using the data developed in Step 3, the group produced the table below:

Figure 4: Risk Evaluation Matrix: High Precipitation Levels on BC's Lower Mainland.



The group found that overland flooding was the highest risk associated with high precipitation levels in the 2010-2035 time frame.

Step 5: Risk Controls and Adaptation Measures.

Table 5.1 – Risk Controls and Adaptation Measures

Risk	Control or Adaptation Measure	Time Frame	Cost	Effectiveness	Acceptability	Comment / Evaluation
Overland flooding	Raise / improve dykes	5yrs	\$\$\$\$	Mod-high	Moderate	Regional differences
	Increase pump capacity	3yrs	\$\$\$	High	High	
	Floodplain mapping / zoning	1yr	\$	Moderate	Moderate	Land use change = decades
	DPs / MBEs	1yr	\$	High	Moderate	Land use change = decades
	Land purchase	Long-term	\$\$\$	High	Low	
	Dredging / debris management	Short-term	\$\$	Moderate	Moderate	Depends on envir. approvals
Snow - mobility	Increase capacity	Short-term	\$\$	High	High	Purchase vs. contract
	Public education	Ongoing	\$	Low	Moderate	Subsidized shovels
	Parking regulations	Short-term	\$	Moderate	Low	Potential cost recovery
	Facility closures	Short-term	\$	Moderate	High	Snow days!
	Road closures	Short-term	\$	High	Moderate	Local implementation

Workbook

This Annex contains the templates suggested in Chapter 4 of Volume 1:

- The risk scenarios (Step 2)
- Estimates of Frequency or Probability of risks (Step 3)
- Estimates of Consequence of risks (Step 3)
- Stakeholder Risk Perceptions (Step 3)
- Evaluation of Risks (Step 4)
- Adaptation Measures and Risk Controls (Step 5)

The templates can be photocopied for use by risk project teams. The headings of these templates are suggestions only. The project team can change them to suit their needs.

Table 2: Preliminary Hazard and Risk Scenario Assessment (Step 2)

HAZARD: Describe.

RISK	EVENT OR RESULT	FREQUENCY			CONSEQUENCE			COMMENT or POSSIBLE CONTROL
		1	2	3	1	2	3	
	Add as many rows as needed for the events for each risk							

Notes: Make rough estimates of (these will be expanded in Step 3)

Frequency:

- 1. Unlikely to occur
- 2. Moderately frequent occurrence
- 3. Almost certain to occur

Consequences:

- 1. Low
- 2. Moderate
- 3. High

Table 3.1: Estimates of Frequency or Probability of Risks (Step 3) (Use as many rows as needed)

Probability or Frequency Risk Event	Very Unlikely to Happen	Occasional Occurrence	Moderately Frequent	Occurs Often	Virtually Certain to Occur

Note: If the event is ongoing the frequency should be related to it reaching a more severe level than what is occurring now.

Table 3.2: Estimates of Consequences of Risks (Step 3) Risk Event (Use one table for each risk event)

Impact Degree	Social factors				Economic factors			Environmental factors			
	Displacement	Health & Safety	Loss of Livelihood	Cultural Aspects	Property Damage	Financial Impact	Impact on Municipal Finances	Air	Water	Land	Eco-systems
Very low											
Low											
Moderate											
Major											
Very Severe											

TABLE 3.3: Suggested display for stakeholders and risk perception (Step 3).

Climate Factors: (Hazards)	Risk Scenarios - Aspects of Hazards and Risks to Community (Use as many rows as needed)	Stakeholders and perception of Risk

Figure 3: Risk Evaluation Matrix (Step 4)

OVERALL CONSEQUENCE OR IMPACT SEVERITY	Extreme					
	Major					
	Moderate					
	Low					
	Very Low					
		Very Unlikely to Happen	Occasional Occurrence	Moderately Frequent	Occurs Often	Virtually Certain to Occur
FREQUENCY/PROBABILITY						

- Extreme risk:**
 Immediate controls required
- High risk:** High priority control measures required
- Moderate risk:** Some controls required
- Low risk:** Controls not likely required
- Negligible risk:** Do not require further consideration

Table 5.1: Risk Controls and Adaptation Measures (Step 5)

Risk (Use as many rows as needed)	Control or Adaptation Measure (Use as many rows as needed)	Time Frame	Cost	Effectiveness	Acceptability	Comment / Evaluation

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