HAZARD RISK AND VULNERABILITY ANALYSIS

for the

SECHELT INDIAN GOVERNMENT DISTRICT

SUNSHINE COAST EMERGENCY PROGRAM

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TABLE OF CONTENTS

APPENDICES

* Note: Due to inconsistencies in Environment Canada's historical climate data for the SIGD, Appendix E is based on the Gibsons weather station (Climate ID No. 1043150) and is assumed to be an accurate reflection of climate trends in the SCRD over time.

SECTION 1.0 INTRODUCTION

This risk assessment is designed to provide an analysis of the hazards that may present risks to the Sechelt Indian Government District (SIGD).

While no municipality or region is without risk, the objective of the hazard and risk analysis is to investigate prominent natural and human-caused events and identify any threats that may require a timely and coordinated response to protect lives and property, and to reduce economic losses. A quantitative analysis of the hazards, risks and response capabilities specific to the SIGD is summarized in Appendix A. Qualitative data, definitions and more extensive analysis of these hazards follow in Sections 2.0 and 3.0.

1.1 Scope and Methodology

The intent of this HRVA is to provide a substantiated basis from which local planners, responders and politicians can create an effective emergency plan. Our results are based on existing information, survey data and limited primary research due to time restrictions governing this project. This analysis uses both quantitative and qualitative methods to determine hazard ratings for the area of interest. EmergeX proprietary tools have been utilized in conjunction with the Provincial Emergency Program's (PEP) HRVA Toolkit to provide the most accurate assessment possible, taking into consideration that the analysis – because it is qualitative *and* quantitative – is to some degree subjective. Duplication of this assessment by third parties may not provide exactly the same results.

In this analysis, survey data was compiled and cross-referenced with extensive background and historical research, as well as observation data. This information was then considered in the context of the seven impact criteria utilized by the PEP HRVA Toolkit (see Appendix B). The impact criteria were individually ranked on an ascending scale from one to four, one being the least severe and four being the most severe. These numbers were totaled for an overall consequence score (for a maximum total of 28), and were then contrasted against a likelihood rating of one to six, one being the least likely and six being most likely (for a maximum total of 6). Each hazard was then given an aggregate score which combined impact consequence and likelihood (i.e. 15/4), which provided the basis for a risk ranking of ***low***, ***moderate*, *high*** or ***very high*** (see Appendix A). Hazards which could be entered directly into the PEP HRVA Toolkit and positioned on a modified risk matrix were left as-is, and provided a benchmark for hazards which could not be directly entered into the Toolkit (for example, if a particular hazard was not listed, such as 'Blizzards'). Hazards that were not listed on the Toolkit were calculated in the same fashion (consequence versus likelihood) and plotted within the matrix accordingly.

EmergeX Planning Inc. accepts no responsibility for any loss by the SIGD related to items discussed in this risk assessment. Information received through interviews with SCRD staff and outside parties with interest in the SIGD is applicable for the period of study only.

1.2 Hazards

The foundation of emergency response planning requires identification of the potential hazards that might affect the SIGD. Hazards are threats that could present problems to the health and safety of people, damage property, harm the environment, or cause economic hardship.

Factors considered in developing a list of hazards for the SIGD include:

- Demographics
- Geography and Geology
- Industry and Other Technologies
- Transportation Modes and Routes
- Weather and Climate

1.3 Risks

A risk is a *probability* that an incident involving a hazard will lead to an adverse consequence. Historical occurrences, changing circumstances, outside influences and similar occurrences happening elsewhere are examined when analyzing risks.

1.4 Impacts

Different hazards have different potential consequences. These impacts can be categorized as follows:

Geographic	Widespread (will affect most of the region) Localized (will affect a few blocks) Specific (will affect one or two buildings or locations)
Economic	Jobs Structural Damage Non-structural Damage Infrastructure Damage Economic Survival Transportation
Political	Perception of Blame Credibility or lack thereof

Social	Death Injury Housing Education Family Life
Environmental	Vegetation Wildlife Water Air Soil

Social values often exceed environmental concerns in the planning and building of community infrastructure. For instance, the traditional approach to stormwater management has been to contain and convey rainwater as quickly as possible off of the site. A major flood event can cause significant property damage, and sometimes loss of life. Hence, the emphasis on efficiently and effectively removing water from private or community property and disposing of it into local watercourses, lakes, or the ocean.

The long-term efficient disposal of stormwater can have a negative impact on small watercourses within the SIGD, either by changing the rate and volume of water moving through these streams, or by reducing the volume of water available to these systems in summer-time dry periods. In this report, some predicted risks to ecological receptors (e.g., fish, invertebrates, amphibians) may be higher than that predicted for "human receptors".

Within the context of this HRVA, consideration of the natural environment often cannot (or simply does not) take precedence over protection of human health, life and property. Philosophical issues aside, it is important to begin evaluating the risks of natural and man-made hazards to the natural environment.

1.5 Capability

The SIGD has limited capacity to respond independently to emergencies or disasters within its jurisdictional area. Fire and police services are provided by the District Municipality of Sechelt, which enjoys mutual aid agreements with response agencies in neighbouring municipalities. Appendix D describes the region's capability to responding to hazards alone, or in a joint effort with other agencies. In this category, normal response means that one or two departments respond using day-to-day procedures and resources.

See Appendix D.

1.6 Background

Located to the immediate east of Sechelt town centre, the SIGD covers approximately 10.71 km² of land along the eastern shores of Trail Bay in the Strait of Georgia.

Table 1.0

Demographics	
Population (2001)	795
Male	420 (53%)
Female	375 (47%)
Average age	41.7 yrs.
Percentage of Aged Population (65 yrs. and older)	20%
Percentage of Young Population (15 yrs. and younger)	20%
English Speaking	96%
French Speaking	1.3%
Other Language	3.7%
Aboriginal Population	53%
Households	
Total	335
Owned	240
Rented	35
Average value owned dwelling	$0
Average gross rent	$0
Population in private household	N/A
Incidence, low income	N/A

Source: BC Stats

The data in Table 1.0 provides a snapshot of the population demographics and housing profile within the SIGD. This information is highly relevant and should be considered a crucial element of any emergency plan. Numerous hazards such as floods, interface fires, earthquakes and human health emergencies can have a serious impact on vulnerable populations (i.e. the very old and the very young), just as certain types of disaster can have a tremendous impact on the housing market and local economy. Failure to consider these issues in the development of emergency management strategies can cause secondary, unanticipated problems such as the widespread displacement of families and low-income households that may be more service-dependent than those with greater financial resources.

See Appendices A & B – Risk Matrix and Hazard Tables.

SECTION 2.0 NATURAL HAZARDS AND RISKS

Natural hazards are commonly referred to as 'acts of God'. They are natural incidents that have the potential to cause damage and hardship to people, communities, the environment and the economy.

2.1 ATMOSPHERIC

2.1.1 Blizzards

Blizzards combine high winds (typically in the 90 to 130 kilometers per hour range), blowing snow and low temperatures. The effects of the storm are always intensified by the wind chill factor associated with high winds. Blizzard conditions occur most often in unforested areas where there are no trees present to break the effects of the wind. Combining strong winds, low temperatures and poor visibility, blizzards may wreak havoc on traffic, buildings, communications, and livestock.

Because the SIGD is coastal and unsheltered, there is very little to be done about high winds associated with blizzard activity. Fortunately, the region's climate is such that temperatures rarely drop below freezing and blizzards are a fairly uncommon occurrence. However, the SIGD is still subject to larger and more distant weather patterns, which occasionally cause local temperatures to drop below average, creating unusually cold conditions that may last for several days. When these cold snaps are combined with the precipitation normally experienced during winter months, blizzards can, and have occurred.

High winds have the potential to interrupt power sources necessary for heating and as such, the safety of particularly vulnerable populations (i.e. the elderly and transients) should be considered in the event of extreme weather. This risk however, is generally perceived to be ***low***.

2.1.2 Snow Storms

Snowstorms vary from light sprinkles of snow to accumulations of several meters. Unlike blizzard, they are not associated with high winds. Populations in areas, which do not usually receive much snow on an annual basis, may be severely impacted by even moderate accumulations of snow. The wide distribution networks of hydroelectric and communication lines and towers are also affected by heavy snowfall. Accumulation of snow on these lines may cause breakage, disrupting service and power to wide areas.

Based on random sampling of SCRD community members, this risk is considered to be ***low*** to ***moderate***, with recurrence intervals ranging between one and five years. Transportation, including ferry access to and from the Sunshine Coast may be interrupted or delayed due to heavy snowfall, and dangerous driving conditions may cause motor vehicle accidents as a corollary effect of inclement weather. These incidents combined may be sufficient to burden local response agencies such as fire, police, ambulance and public works. Due to historical climate data that is available for the Sunshine Coast, the likelihood or risk of a snowstorm seriously impacting the SIGD is considered to be ***low***.

2.1.3 Ice Storms and Ice Fog

An ice storm combines high wind, freezing temperatures and freezing rain or drizzle. An ice fog combines very cold temperatures and a source of warm moisture. In many urban and rural places throughout the province, wood burning emits high levels of particulate pollution and moisture to the atmosphere. The disruption of transportation systems, communication and infrastructure can have very serious and potentially fatal consequences.

Because the temperature along the Sunshine Coast does not typically drop below zero degrees Celsius, ice storms are not frequent occurrences. However ice fogs, can occur at sea where moist air, higher winds and cooler temperatures may pose a hazard to ships operating within the Malaspina Strait or the Strait of Georgia. Vessel traffic and poor visibility may create conditions where marine collisions are possible, though the chances of such an incident occurring because of ice fog are ***low.***

2.1.4 Hail Storms

Hail storms consist of precipitation in the form of balls or irregular lumps of ice. By convention, hail has a diameter of 5 millimeters or more, while smaller particles may be classified as either ice pellets of snow pellets. The impact and hazard of hailstorms is, in many respects, similar to that of blizzard conditions, as agriculture and property are both seriously damaged by hail.

Typically, these events occur in central Canada and throughout the prairies and do not generally occur along the Pacific coast where temperatures are warmer than the interior. Natural Resources Canada does not report any hailstorms of note occurring along coastal British Columbia over the last 100 years. This hazard poses a ***low*** risk to the SIGD.

2.1.5 Lightning

Lightning is caused by the union of three contingent factors: moisture laden air, the instability of existing weather systems and a triggering agent which causes air near the ground to ascend. A lightning strike can damage transmission lines, affect aircraft, disrupt communication systems, damage or destroy structures, and cause forest fires. Lightning strikes can also cause severe or fatal injuries to people.

Survey data collected by EmergeX indicates that lighting hazard could potentially affect the SIGD, though the risk factor is generally considered to be moderate to low. It is reasonable to expect lightning strikes to occur within the SCRD once a year or more, however the extent of damage caused by lightning will depend on what is hit and how quickly response agencies can recover from ensuing problems. Overall, this risk is considered to be ***moderate***.

2.1.6 Hurricanes

Hurricanes are usually defined as storms with winds of greater than 110 kilometers per hour, and usually over 600 kilometers in diameter. While the risk of an actual hurricane is low in British Columbia, the effects of a hurricane may be approximated in the local context by the severe winter storm. The effects of these storms can be extensive and costly, especially for coastal areas.

Generally, hurricane or hurricane-type storms approach coastal British Columbia as remnants of typhoons that originate off Asia, or as extra-tropical storms traveling in a northwesterly direction from the Pacific Ocean. On October 12, 1962, British Columbia received the final effects of Typhoon Freda, which hit Vancouver and Victoria, killing seven people and causing an estimated $10 million in damage to buildings and hydro lines. Winds were recorded at an average of 74 km/h with gusts reaching up to 145 km/h (Natural Resources Canada, 2004). On October 11 – 12, 1984 (exactly twenty two years later), the tail end of Hurricane Ogden swept through the west coast of British Columbia, killing five fishermen and causing considerable damage (Ibid). Similarly, extra-tropical storms hit coastal Oregon in both 1995 and 1999.

These weather events can cause extensive flooding and damage critical infrastructure, including communication networks, power supplies, sewage systems, water supplies and transportation networks including ferry service, as heavy rains are often accompanied by high winds. Corollary effects include landslides, slumping or subsidence, as soil becomes waterlogged and saturated with rain and road washouts. Though the SIGD is not in a high-risk zone for these types of storms, they have occurred with relative frequency and have the capacity to cause widespread damage. This risk is categorized as ***moderate***.

2.1.7 Tornadoes

A tornado is a very rapidly rotating air funnel hanging from a cumulonimbus cloud and is usually observed as a 'funnel-shaped' cloud. The risk of tornadoes is greatest in areas where there are frequent thunderstorms and hot, humid weather. Small forms of tornadoes such as waterspouts are frequently reported in the Vancouver and Victoria areas, especially during the summer months. Land based tornadoes do not typically happen along coastal regions of British Columbia. This risk is identified as ***low***.

2.1.8 Heat Waves

A heat wave can take a number of forms. Such events can be characterized by temperatures significantly above the mean for an extended period of time, or by a combination of high temperatures with high humidity and a lack of air motion. Impacts of heat waves can range from crop losses to high mortality due to heart prostration or the aggravation of existing conditions such as high blood pressure or heart disease. The elderly and very young are particularly vulnerable to very hot and humid conditions.

According to historical weather statistics collected by Environment Canada, summer temperatures in Gibsons, British Columbia have not measured over 33 degrees Celsius in the last 21 years, and hot spells have not typically lasted more than 4 or 5 days. (Environment Canada, 2005). Random sample data collected by EmergeX Planning Inc. indicates that local residents perceive heat waves to be a low risk hazard that generally occurs within the SCRD every 10 years. It is important to note however, that there has been a tendency for both extreme and average monthly temperatures to increase slightly over time, which suggests that heat waves may become a more significant risk in the years to come. At present this risk is considered to be ***low***.

2.1.9 Global Warming

Global warming is an increase in the average temperature of the earth's surface and is influenced significantly by the greenhouse effect, which is caused by the trapping of solar heat by various gases in the earth's atmosphere. There has been controversy over the magnitude of this effect because of the uncertainty over various feedback processes, especially those involving cloud cover. The most worrying prediction was that over the next hundred years, there would be a global sea-level rise of about 70 centimeters and this would pose a risk of flooding for many coastal settlements. While the average regional temperature has been increasing slightly over time, the risk of immanent flooding or drought as a direct consequence of global warming is ***low***.

2.2 GEOLOGICAL

2.2.1 Landslides

Landslides and rockslides are the result of downward and outward movements of slope materials reacting to the force of gravity and cover a wide variety of landforms and processes. Slide material may be composed of natural rock, soils, artificial landfills or combinations of these components.

A number of areas within the SCRD have been designated as having high landslide or rock fall hazard. This is a particular concern where lots or locations zoned as having high potential for this hazard interface with areas zoned as residential, commercial or contain infrastructure necessary for the continued function of essential services. Large-scale landslides can also occur when heavy rainfall, especially in areas that have steep pitch and are unprotected by vegetation, trees and root mat systems. Logged slope sides, creek or river ravines, and steep areas below large, rapidly melting snow packs can pose a serious hazard for landslide activity. The north side of Mount Donaldson has significant bare patches which could potentially slip into Clowhom Lake in the event of heavy rains and melting snowpack which, in turn, can cause a sizeable wave or elevation in water levels sufficient to breach Clowhom Dam (see Fig. 2.0). The hazard of dam failure is covered in more detail in Section 3.1.5.

Fig. 2.0 Clear cut areas on the north face of Mount Donaldson.

In January 2005, landslides caused by the interface of heavy rain and soft soils affected one household in Gibsons and forced the evacuation of its owners. The descent of sand, logs and rock caused localized damage and could easily have caused septic overflow and gas leakage, creating a larger problem for a number of homes nearby.

Extensive gravel mining in the SIGD suggests that the area is underlain with soft soils which can become saturated with water and thus pose a threat to infrastructure and property in vulnerable areas. This risk is therefore considered ***moderate***.

2.2.2 Submarine Slides

Submarine landslides, like their terrestrial counterparts, involve the movement of slope materials in response to gravitational and geological forces. The movement of slope materials involves water charged and coarse-grained sediment flowing rapidly on submarine slopes or channels. Submarine landslides with sufficient displaced volume can generate destructive surface waves. See Section 2.5.2 for the impact assessment relative to this hazard.

2.2.3 Land Subsidence

Land subsidence occurs when a surface has been undermined and deformation and ground movement occur. Causes of subsidence include the mining of rocks, minerals and ores; subsurface excavations; extraction of subterranean liquids such as water, oil or gas; and natural processes such as groundwater flowing through soluble rock like limestone.

The SCRD has experienced land subsidence in the recent past, which indicates that it is a very real hazard with high likelihood of occurrence. In January of 2005, several residences in Halfmoon Bay experienced significant ground movement brought on by a prolonged period of heavy rain. At 8151 Redroofs Road, a section of privately owned property with clayey soil composition slumped one meter, causing a 32-foot retaining wall to become unstable and sag. At the same time, 5141 Redroofs Road experienced ground slippage, causing a privately owned home to shift laterally on its supports. DPA 5 – Beachfront Escarpments – in Pender Harbour is also identified as having active slumping, soil creep, caving erosion and seepage hazards.

Again, gravel mining activity in the vicinity of the SIGD suggests that soft soils may be vulnerable to slumping, caving or slippage, which presents a risk to people and property in locations characterized by highly permeable soil conditions. Overall, the risk of land subsidence is identified as ***high***.

2.2.4 Avalanches

An avalanche is the movement of snow and ice in response to the force of gravity down an incline. The risk of avalanche is most intense in glacial valleys, as transportation and infrastructure is subjected to what is known as 'avalanche crossfire'.

While the Sunshine Coast receives light to moderate snowfall in winter months, avalanches typically occur in higher altitude locations only and do not generally interface with developed or residential areas within the SIGD. The threat to public safety and critical infrastructure however, is considered to be ***low***.

2.2.5 Debris Avalanches and Debris Flows

Debris flows are a form of rapid mass movement in which loose soils, rocks and organic matter, combined with air and water, form a slurry that flows down-slope. Debris avalanches consist of avalanches of mud, rock, brush, trees and other debris loosened and propelled by torrential rains. It is likely that debris avalanche flows will continue to grow if potentially hazardous sites are developed without adequate protective measures. There is potential for this hazard to damage critical infrastructure such as bridges (Chapman Creek Bridge), roadways (Highway 101 and residential streets), communication lines, gas and hydro lines and other facilities (water intakes and sewage lines). Because debris flows are often a result of heavy rain, flooding commonly occurs at the same time which can make response and recovery operations more troublesome.

A number of areas throughout the SCRD are identified as having high potential for debris flow, mostly where creeks and ravine valleys exist. Destructive debris flows occurred in November of 1983 in Roberts Creek, which originated in a clear-cut area along Clough

Creek during a period of heavy rain. The debris and water ran beneath Orange Road causing severe property damage to houses in the immediate area. This hazard is widespread throughout the SCRD and poses a significant risk to infrastructure and property where designated in OCPs. The risk rating for this hazard is ***high***.

Environmental Concerns Associated with Debris Flows

Like property affected by debris flows, aquatic habitats are also very vulnerable to debris flows, which often discharge into watercourses. The erosion and sedimentation associated with debris flows often block access to fish trying to work their way upstream to spawn, or may block juvenile fish from out-migrating from streams into estuaries and open ocean. The movement and velocity of debris in watercourses can bury or wash out salmon redds (nests) or young rearing fish. In addition, food supplies can also be obliterated by large debris flows.

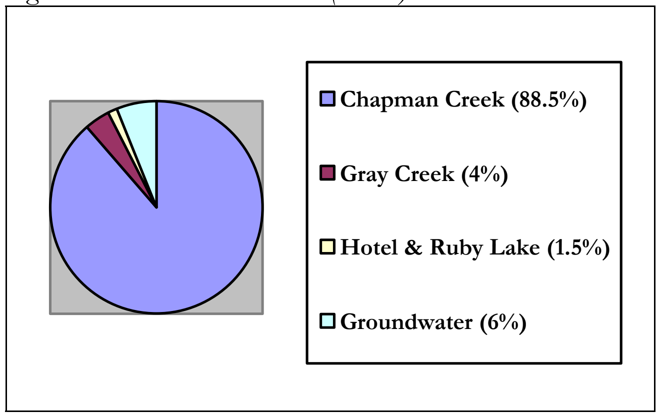
Clear cuts and building on unstable slopes can be significant contributors to debris avalanches / flows. Urbanization often causes increased runoff, which can generate flooding above and beyond normal flood levels for a watercourse and its floodplain. This increased flooding can seriously exacerbate the frequency and magnitude of local debris flow areas. In an effort to combat injury to humans or property, local governments sometimes spend considerable sums stabilizing debris flow paths. This "hardening" of flow paths can further alter natural hydrologic regimes, resulting in even greater peak flows, and increasing the potential for high-flow events that would not have otherwise occurred. Decreased instream habitat complexity often results, reducing the quality of the habitat to support fish. The risk rating to aquatic habitats is ***moderate-to-high***.

2.3 HYDROLOGICAL

2.3.1 Drought

Drought results from abnormal water deficiency, resulting in crop failures, dust storms, deficient and polluted water supplies, and distressed economic and ecological systems. Droughts are usually due to natural causes but are exacerbated by increased strain on the environment, urbanization and other human factors. While usually considered in the context of agriculture, many other resources and commercial activities are affected. Drought conditions can also create rural and interface fire hazards, which are covered in Section 3.3.

Fig. 2.1 SCRD Water Sources (2001)



http://www.scrd.bc.ca/documents/water%20supply.pdf

The Sunshine Coast typically experiences hot, dry summers and instances of drought are not uncommon. Historical climate data provided by Environment Canada shows that rainfall during the months of June, July and August has been as low as 59.5 mm (Gibsons – 1967); 55.3 mm (Sechelt – 1996); 41.4 mm (Sechelt – 2002); and 47.8 mm (Sechelt – 2003). Because the SIGD draws nearly all of its drinking water from creek and lake sources, drought can have a serious impact on the well-being of local residents. The region's aggressive water conservation strategy and drought-tolerant approach to landscaping will be helpful in mitigating the effects of dry, hot weather. The risk of drought however, remains ***moderate***.

Environmental Concerns Associated with Drought Conditions

The greatest potential effect on aquatic habitats as a result of drought conditions is associated with the maintenance of summer – time base flows in watercourses within the SCRD. As areas develop (regardless of land use activity), the importance of good stormwater management practices increases. Many of the floodplain streams of the SCRD are fed, at least in part, by groundwater flows in the summertime. Maintaining year-round base flows in aquatic habitats is important for keeping these areas viable rearing grounds for juvenile fish. By capturing and infiltrating as much storm water as possible, juvenile fish have a better chance of surviving drought periods.

Wetlands within the SCRD are also vulnerable to drought conditions. Increasing development around wetland areas (e.g., increased total impervious area, or paved surfaces) can lead to drying of these areas, much like the effect of droughts on streams. Some wetlands naturally go dry in the summer, at least on the surface, but often maintain moist or saturated soils. The moist areas that remain in periods of dry conditions are very important for the survival of numerous species of local invertebrates and amphibians. As communities within the SCRD grow, it is important that development activities do not increase the extent or duration of drying in wetland habitats that would normally occur if the areas were isolated from the effects of development. In other words, the function and survival of local wetlands can be compromised if the systems have to cope with both a natural drought cycle *and* the reduction of water inflows resulting from the traditional piping of stormwater into a stream or lake. The risk to streams and wetland habitats in the SCRD as a result of drought is ***moderate-to-high*,** depending upon the degree of adjacent development and the land use restrictions in place to protect these habitats.

2.3.2 Erosion and Accretion

Erosion is the wearing away of land by the action of natural forces. Coastal erosion is marked by the carrying away of beach material by wave action, tidal currents or by deflation. Similarly, riverbank erosion is the result of river currents moving riverbank material. Accretion is defined as the buildup of land by natural or artificial means.

In the SIGD, erosion is most likely to occur in the Trail Bay and Porpoise Bay areas, which are subject to tidal activity and storm wave action. Particular attention should be paid to the effects of erosion on critical infrastructure, specifically road or bridge washouts. The Chapman Creek Bridge presents a particular vulnerability to the SIGD, and for all communities north of Roberts Creek, as it is the only means of accessing the BC Ferries terminal in Langdale. In the event of erosion or washout, this could complicate access and evacuation via road. As vulnerable areas are identifiable and slow erosion/soil creep is preventable through hazard abatement programs, this risk is identified as ***moderate***, provided that land use planning initiatives are proactive in mitigating or avoiding this hazard altogether.

Environmental Concerns Associated with Erosion and Sedimentation

Erosion and sedimentation can have a high impact on aquatic environments that receive the sediment load. While sediment movement and accretion is part of a stream channel's natural morphologic processes, human development often increases both the frequency of high-sediment deposition events and the magnitude of impact. Excessive sedimentation can bury nests of salmon eggs, can cut off the oxygen supply to invertebrates that live in stream substrates, and can kill small aquatic plants and microorganisms, upon which many other stream dwellers depend for food. High quantities of sediments suspended in the water column can also aggravate the gill and respiratory tissues of local fish populations, stressing the animals and increasing their risk of mortality. The risk is considered ***moderate***, with the same caveats as listed above for protection of property.

2.3.3 Local Flooding

This type of flooding may be associated with an extreme hydrological event, but it is most often caused by poor blockage or impaired drainage. In some cases, it is an annual event which occurs on agricultural land and has no major consequences. In other cases it can cause severe hardship in residential or developed areas. Because the majority of the SCRD's potable water comes from creek or well sources, local flooding can potentially contaminate local drinking water with sediment, run off and other pollutants. This is particularly important where agricultural land that supports livestock exists in proximity to potable water sources. Sewers may back up and overflow; houses and buildings may suffer water damage. Creeks may swell and avulse, basins may overflow and discharge doubling the flood risk to downstream areas. Roads may wash out, making transportation, access and evacuation difficult or impossible – again, Chapman Creek is an especially vulnerable point within the SIGD and the SCRD. Overall this risk is considered to be ***moderate***.

2.3.4 Rain Storms

The basic cause of most river floods is excessive rainfall, which causes significant elevations in river level and ultimately the inundation of low-lying floodplain areas. Rain storms themselves cause damage by overwhelming drainage capacities, causing saturation-induced landslides, snow melt, ground slumping, erosion and debris flow, and where large snow deposits accumulate, may cause avalanches.

Rain storms are not uncommon in the SIGD and at times, can last for several days. The wettest time of year is typically from October to January, with November consistently bringing in 200 – 300 mm of rain. Critical infrastructure in these areas assumes higher level of vulnerability. Overall, rainstorms pose a ***moderate*** risk to the SIGD.

Environmental Concerns Associated with Flooding and Rain Storms

Reduced fish access to spawning and rearing habitat can often result from a flood event, regardless of the magnitude of the event. Floodwaters often damage or obliterate fish passage to upstream spawning and rearing habitats. The SCRD has much of their sensitive salmonid breeding and rearing habitat mapped at a fairly gross level of detail (Sunshine Coast Habitat Atlas, 2003). However, more detailed mapping may be needed to locate these areas and begin planning/mitigative works to restore access to priority salmonid breeding/nesting/rearing areas post-flood event.

In addition, with increasing land development in flood-prone areas (such as flood plains and areas at the base of steep slopes and ravines), more long-term planning may be needed to manage the impacts of stormwater. With increasing density in flood-prone areas, smaller and smaller storm return periods may cause damage to aquatic habitats similar to damage currently caused by larger events. For example, the habitat disturbance currently resulting from a 10-to-20 year return period may result from a 5-year return period as land development densities rise. Increased urbanization invariably tends to decrease the water quality of storm water entering surrounding rivers and streams. Discharges from urban areas are often high in effluents, industrial pollutants, dust, oils, metals or chemicals (or any combination of these contaminants).

Effective use of emerging stormwater management techniques that maximize a site's infiltration potential and provide a cleaner discharge to receiving water bodies can help to limit the impacts of small-to-medium size flood events. Infiltration both improves water quality and decreases the effects of changes in peak flows discharged to watercourses.

While many communities within the SCRD contain development permit areas for their environmentally sensitive aquatic habitats, a detailed perusal of development permit conditions and / or environmental protection bylaws (such as tree removal and replacement or soil deposit and removal) would be required to accurately determine the risk to aquatic habitats posed by flood events. Overall, the risk to aquatic habitats within developed portions of the SCRD is considered to be ***moderate***.

2.3.5 Freshets

Local flooding can also be caused by the rapid melting of snow packs, which has the same effect on rivers as rain-induced flooding. In the SIGD, freshet runoff is the highest between May and June, but varies depending on snowpack depth, temperature, and rainfall. While water levels increase somewhat predictably, flash floods or mass erosion caused by freshets are not common. Because the SIGD does not usually receive high levels of snowfall, the risk of flooding caused by freshet is considered to be ***low***.

2.3.6 Storm Surges

Storm surges are described as increases in water levels that exceed levels normally associated with astronomical tides. They are caused by winds driving waters shoreward and are often coupled with low-pressure systems, which in turn cause increased sea levels at the same time. Coastal land forms such as deltas, spits and backshore areas are most vulnerable to storm surge flooding.

Low-lying coastal areas within the SIGD are at highest risk for storm surges. Based on random sampling data collected by EmergeX Planning Inc., local residents are fairly confident that storm surges present a low risk to the SCRD as a whole, though certain areas (primarily residential beachfront) assume greater vulnerability to this particular hazard. In the SIGD this risk is considered ***low***.

2.3.7 Ice Jams

Ice jams result from the accumulation of ice fragments that build up and restrict the flow of water by causing a temporary obstruction. Jams form during freeze-up as well as break-up periods, but break-up jams typically have the greater flood potential as they are associated with ice thaw and melting.

The absence of ice accumulation along rivers and waterways within the SIGD are such that the hazards associated with ice jams are ***low.***

2.3.8 Jökulhlaups or Glacier-Outburst Floods

The hydrology of some glaciers systems is characterized by the sudden catastrophic release of stored water in outburst floods or Jökulhlaups (an Icelandic term meaning 'glacier-flood'). Jökulhlaups may be triggered by (a) the sudden drainage of an ice-dammed lake below or through the ice dam; (b) lake water overflow and rapid fluvial incision of ice, bedrock or sediment barriers; or (c) the growth and collapse of subglacial reservoirs. Some of the biggest floods in history have been caused by jökulhlaups. In 1918, a major flood occurred in Iceland as a result of a subglacial eruption of the Katla volcano, which lies beneath the Myrdalsjökull ice cap, which produced a peak discharge of 300,000 cubic meters of water, ice and debris per second.

While there are sizeable snow packs above the mountains which hem in the Sunshine Coast, the large glaciers required for catastrophic outburst floods do not exist in proximity to developed areas within the SIGD. Geothermal activity which precipitates rapid ice melt beneath glacial beds or fields is also notably absent. This risk is therefore considered to be ***low.***

2.4 SEISMIC

According to the National Building Code of Canada (NBCC) 1990, the SIGD is located in a region that has been designated as Seismic Zone 4, of 6 possible zones (Zone 6 assuming the greatest risk of seismic activity). These zones reflect horizontal velocity as a percentage of gravity force, and take into account historical earthquake intensities as well as frequency of occurrence (see Table 2.0)

Table 2.0

NBC Seismic Zone	Horizontal Velocity
0	.00g
1	.05g
2	.10g
3	.15g
4	**.20g**
5	.30g
6	.40g

Source: http://www.pep.bc.ca/hazard_preparedness/NBC_Seismic_Zones-1990.pdf. 03 February, 2005.

Three types of damaging earthquakes are known to occur in coastal British Columbia and could potentially affect the SIGD:

1) Shallow or Crustal Earthquakes
2) Juan de Fuca Plate or Sub-Crustal Earthquakes
3) Plate Boundary or Subduction Earthquakes

2.4.1 Shallow or Crustal Earthquakes

Crustal earthquakes are the most common type of quake and typically occur along faults at an average depth of 10-20km. Though the magnitude of these quakes tends to be lower than sub-crustal or subduction quakes, they can and have caused significant damage due to their proximity to land surface. The impact of a crustal earthquake on human settlements and infrastructure depends on a number of factors such as: its magnitude or size; lateral distance from the earthquake focus or source; depth; type of faulting affected; local soil composition; and frequency of ground motion. This type of event is usually followed by a large number of aftershocks that can be just as damaging as the initial shake. Due to the frequency with which these quakes occur and their potential to cause harm to urban settlements and infrastructure, this risk is considered ***high***.

2.4.2 Juan de Fuca Plate or Sub-Crustal Earthquakes

At average depths of 30 – 70km beneath Georgia and Puget Sounds, these quakes occur less frequently but are more typically more destructive than sub-crustal earthquakes. Southwestern British Columbia and Northern Washington have experienced some very large sub-crustal quakes in the past, the largest occurring in Seattle in 1945 (M5.5) and again in 1965 (M6.5). Because these quakes have fairly frequent recurrence intervals, they pose a significant threat to the SIGD, however their impact is often tempered by focus depths. Overall, this is a ***high*** risk to the SIGD.

2.4.3 Subduction Earthquakes

Subduction earthquakes occur when a massive shift takes place at the junction of multiple tectonic plates. These quakes are by far the most powerful as they release a tremendous amount of energy over a very wide area. Fortunately, these quakes are very infrequent, with an average recurrence interval of 590 years ± 105 years (Onur & Seeman, 2004). Southwestern British Columbia vulnerable to this threat however, as it is located in an area known as the Cascadia Subduction Zone, near the intersection of the Juan de Fuca, North America and Pacific plates. Research indicates that these plates are currently locked and are accumulating strain which will ultimately be released in one or more large earthquakes, similar to the one which occurred off the coast of North America, 305 years ago (magnitude 9), and in the Indian Ocean, December 26, 2004 (M9.0).

Depending on where the rupture occurs and the length of the rupture area along the fault line, the SCRD (along with the remainder of southwestern British Columbia) could experience a Subduction earthquake. However, given that the likelihood of this event occurring within the next 50 years has been estimated at 11 per cent (Onur & Seeman, 2004, p. 1), the risk factor is considered to be ***moderate.***

2.4.4 Earthquake Risk in the SIGD

Based on probabilistic seismic hazard models developed by the Geological Survey of Canada, statistical estimates for the occurrence of 'structurally' damaging ground shaking due to crustal or sub-crustal earthquakes have been determined for various regions throughout British Columbia (Onur & Seeman, 2004). While the SIGD itself has not been assessed for seismic probability, Vancouver BC has been evaluated and is proximate enough to provide a 'best guess' as to the likelihood of a significant earthquake affecting the Sunshine Coast. Using the Modified Mercalli Intensity Scale (MMI) as a description of earthquake effects at a given intensity level (expressed in Roman numerals), Onur & Seeman (2004) provide a percentage probability of three earthquake intensities being exceeded over a period of 10, 50, and 100 years. Results for the Vancouver area are as follows:

MMI	Description of Effects	Probability of Being Exceeded in	
V	Felt indoors by practically all, outdoors by many or most. Buildings tremble throughout. Broken dishes, glassware to some extent. Hanging objects, doors swing generally. Pictures knocked against walls or swung out of place.	10 years	26%
		50 years	77%
		100 years	95%
VI	Felt by all, indoors and outdoors. General excitement, some alarm. Damage slight in poorly build buildings. Fall of plaster, cracks in plaster and fine cracks in chimneys in some instances. Broken dishes, glassware in considerable quantity, as well as some windows. Overturned furniture in many instances.	10 years	8.6%
		50 years	36%
		100 years	60%
VII	General alarm, all run outdoors. Some or many find it difficult to stand. Damage negligible in buildings of good design, slight to moderate in ordinary buildings, and considerable in poorly built or badly designed buildings. Cracked chimneys to considerable extent and walls to some extent. Fall of plaster in considerable to large amounts. Dislodged brick and stone. Overturned heavy furniture.	10 years	2.5%
		50 years	12%
		100 years	22%

2.4.5 Effects on Electrical Power

Overhead towers and lines, except where they cross waterways, are generally expected to survive a moderate earthquake. The impact of seismic shaking on underground lines however is not well understood. BC Hydro expects loses in substations of both ceramic damage and anchorage failure. Power failures are typical in post-earthquake environments and interruptions to service may last days or weeks. This can cause serious problems for buildings that require a continuous power source such as hospitals, communication and response facilities. In these instances, back-up power sources and generators are essential. Restoration of power will depend largely on the extent of the damage sustained and will likely be in priority sequence – critical infrastructure and essential services will be restored first, followed by residential and commercial areas. Consideration should be given to the time of year and weather, as prolonged power outages can also affect heating and air conditioning units leaving particularly vulnerable populations such as the elderly, disabled or very young at higher risk of exposure.

2.4.6 Effects on Gas Supply

One area of considerable concern is the transition points of major pipelines from liquefiable to solid soil. Another area of major concern is pressure regulating stations on liquefiable soil adjacent to rivers. Gas lines on major highway bridges are also vulnerable.

The effects of a gas supply interruption on the SCRD include leakage of contaminates into soil or groundwater, explosion, fire and injury or death caused by toxic fumes. Fire following earthquake is very common in post-disaster environments. The additional strain that this places on first responders and local resources (human and material) can be significant, and as such damage to local or proximate gas supplies should be of concern to planning and response personnel.

2.4.7 Effects on Water Supply

Given the potential risk to local or proximate gas supplies, interruption to local water supply can be problematic – limited capacity for fire suppression being the most obvious issue. Less obvious is the potential for water and fuel to combine due to leakage, which can complicate response by causing fire spread. Similarly, hospitals and clinics require a reliable and clean water source to fulfill their operational role, particularly at a time when the number of in-patients or casualties may exceeds the daily average. Downed power lines and live wiring is hazardous when introduced to pooling water, which can endanger the lives of both victims and first responders. In an effort to create 'disaster resilient communities' local residents should be advised to maintain a fresh, 3 - day supply of drinking water in their homes.

The SCRD relies on a combination of wells, water lines and pumping stations to serve members of the community. Overall, there are 20 reservoirs and over 300km of pipeline running potable water from the Chapman Creek Water Treatment Plant to SCRD residents. Interruption to this water supply would also affect the sewage system and local residents should know what to do if such an event occurs. Improper waste disposal can cause numerous health related issues that can place an unnecessary strain on already-taxed medical service providers. City engineers will need to isolate breaks in sewage trunks in order to prevent leakage of blackwater and human waste. In some instances, potable water may have to be tested for contaminates before consumption.

2.4.8 Effects on Roads

It is difficult to predict what damage will occur to roads throughout the SCRD. Slumping and cracking are not uncommon during an earthquake, nor are rockfalls, landslides, liquefaction or subsidence. Areas identified to be at risk of these events should be considered, particularly where their occurrence might impede access or evacuation. The Chapman Creek Bridge is of primary importance, as it is the only means for wheeled vehicles to reach Sechelt, and all communities north of Sechelt, via road. Residential and developed districts built next to or in hazardous areas identified in OCPs should be aware of the potential risks and corollary effects associated with seismic shaking.

2.4.9 Effects on Telephone Service

Telus' main concern is the integrity and effective operation of its communications network. Controls and network management procedures are in place, which allow telephone service to be re-routed around affected areas. As such, Telus is confident that it can respond effectively to any disaster that might affect their infrastructure. System overload by customers is likely to be a primary cause of interruption for both land lines and cellular service. Essential Line Treatment (ELT), or Priority Access Dialing (PAD), is one method that can be used to mitigate this risk. All essential City phones and the EOC should be put on ELT/PAD through the Provincial Emergency Program (PEP). Local residents should be informed of the problems caused by system overload and encouraged to utilize an 'Out-of-Area Contact' system.

2.5 TSUNAMIS

Tsunamis are large wave events generated by large surface impacts, or when the floor of a water body moves suddenly, displacing the water on top of it (Myles, 1985; Clague, 2001; in Anderson & Gow, 2004). Although usually associated with earthquakes, tsunamis also can be triggered by many other types of phenomena, including submarine or terrestrial slides, submarine and terrestrial volcanic eruptions, explosions and even bolide (e.g. asteroid, meteor, comet) impacts (Clague, 2001; Paine, 1999 in Anderson & Gow, 2004). Tsunami hazards along the Lower Mainland of British Columbia generally fall into three categories:

1) Telegenic or distant, earthquake-induced tsunamis
2) Local tsunami (marine)
3) Local tsunami (terrestrial)

2.5.1 Telegenic Tsunamis

Telegenic tsunamis have distant origins and are typically generated as a result of an earthquake along a subduction zone. Depending on the size of the fault rupture, these tsunamis can be very large or very small. In 1964, a 9.2 subduction quake in Prince William Sound, Alaska, generated the largest and most destructive tsunami to affect coastal British Columbia in the last 100 years. Townships on the northern and western shores of Vancouver Island were affected, but the eastern side of Vancouver Island and exposed communities on the mainland were not impacted (Anderson & Gow, 2004). However, waves traveling northward through the Strait of Georgia could potentially breach on shore lines of the Lower Mainland, particularly if they are a result of a subduction quake originating off the coast of northern Washington.

The impact of a telegenic tsunami on the SIGD will depend on a number of factors including (but not limited to): location of earthquake focus and direction of wave travel, magnitude of quake and corresponding wave size. Because the SIGD is somewhat sheltered by Vancouver Island, telegenic tsunamis originating in the Cascadia Subduction Zone (southwest of Vancouver Island), the Kamchatka Subduction Zone (southeast of Russia's

Kamchatka Peninsula), or the Aleutian Subduction Zone (south of the Aleutian Islands) are not likely to cause serious damage to its member communities.

As mentioned in Section 2.4.3, subduction earthquakes, though serious, are considered rare. Furthermore, because the Sunshine Coast is sheltered from open-ocean by Vancouver Island, telegenic tsunamis are considered to be a ***low*** risk hazard to the SIGD.

2.5.2 Local Marine Tsunamis

Local marine tsunamis are those which are caused by submarine slides or slumping in local waters. In 1975 a large submarine slide at the head of Douglas Channel triggered a local tsunami which caused approximately $600,000 in damage to boats, docks and other property in Kitimat Harbour (Clague, 2001). Though infrequent and often times difficult to detect, these events give residents little warning time due to their proximity to the focus or site of initiation. They can be caused by earthquakes (in which case the earthquake *is* the warning), but more frequently are triggered by non-seismic events such as abnormally low tides, coastal construction activity, heavy rainfall, strong winds, atmospheric pressure changes and sudden soil deposition (especially in deltaic areas) during flooding (Rabinovich et. al, 2003, 1276).

Although there has been some risk of local marine tsunamis affecting the northern portion of the Sunshine Coast (Irvines Landing and Garden Bay area), no such threat has been identified which would impact the SIGD. This risk is therefore ***low.*** However, future geological assessments may change this hazard rating as more information about local marine tsunamis in the Strait of Georgia becomes available.

2.5.3 Local Terrestrial Tsunamis

These events are caused by land slides and can occur in both oceanic and fresh water regions of British Columbia (Anderson & Gow, 2004). In 1880, 27 acres of farmland, located on the north side of the Fraser River in Haney (now Maple Ridge), slid into the Fraser River, causing a displacement 12 m high (Anderson & Gow, 2004). Local terrestrial tsunamis are most often caused by slope failure though on rare occasion, can be caused by an earthquake-induced landslide. The likelihood of such an occurrence causing loss of life and property within the SIGD is low, though some areas (see Section 2.2.1) may be more prone than others. Overall, this risk is rated as ***low***.

2.6 VOLCANIC

A volcano is a vent in the crust of the earth's surface through which molten rock (magma) is extruded onto the surface of the earth as lava and volcanic debris flows, and also into the earth's atmosphere as volcanic gases and rock fragments. While the SIGD is not in immediate danger from volcanic activity, three formations within the Garibaldi Mountain Range and the Cascade Mountain Range are classified as 'dormant' and can be expected to erupt at some point in the future.

Mt. Baker is the most active of the three and is situated in the Cascades, approximately 100km south of Vancouver. Mt. Baker's last eruption occurred in 1880, though sulphurous gases and steam were vigorously emitted from the 450 meter-wide Sherman Crater in 1975. This expulsion is thought to have resulted from a rearrangement of the hydrothermal system within the mountain following a small earthquake. Mt. Garibaldi, located in the Garibaldi Range approximately 80km north of Vancouver (near Squamish), is less than 10,000 years old and has the potential to produce large quantities of ash that could affect nearby communities, including those along the Sunshine Coast. Mt. Meager is the youngest explosive volcano in the Garibaldi Range, its last eruption occurring 2350 years ago, when a massive ash plume covered most of southwestern British Columbia and extended into southern Alberta. The nature of past eruptions at Mt. Meager suggests that this volcano poses a significant long-distance threat to communities across southwestern British Columbia and Alberta (Natural Resources Canada, 2002).

In the short term, the greatest volcanic hazard to threaten the SIGD is ash drifting from the Cascade volcanic belt, which includes Mt. Baker. The Garibaldi Range is much less active. This risk is therefore classified as ***low***.

2.6.1 Ash Falls

During an explosive eruption, a volcano may produce a large plume composed of ash, gases and other volatile materials. These plumes can travel hundreds of kilometers, depending on their density, altitude, wind direction and speed. The dispersion of ash poses serious health and economic concerns. Fine particles could be inhaled into the lungs, creating or increasing respiratory problems. Falling ash can contaminate water supplies, damage crops, disrupt transportation and communication facilities. In severe cases, heavy ash has been responsible for structural collapse – just one inch can weigh 10 – 15 lb/ft^2. Ash can also stall internal combustion engines and clog air filters making it impossible to operate machinery. Wet ash conducts electricity, causing power outages and short circuits. Eruption clouds can interrupt telephone and radio communication. Of all volcanic events this hazard is most likely to impact the SIGD, however the infrequency of volcanic eruption and range of variables affecting ash dispersal are such that this risk is ***low.***

2.6.2 Other Volcanic Hazards

In addition to ash falls, other primary volcanic hazards include pyroclastic flows and surges, lava flows and lahars. Secondary hazards include mud and debris flows as well as landslides. As the SIGD is not in proximity to active or dormant volcanoes, the risk of lahars, slides, or pyroclastic and lava flows is ***low***.

2.7 WILDFIRES

Wildfires differentiate from interface fires in that they occur in wilderness areas, away from human settlements. While there is always some wildfire activity each year in British Columbia, the province maintains that it has excellent wildfire protection services and a superior record of fire suppression. Annual fire hazard ratings are inextricably linked to weather and climate patterns and are therefore difficult to predict however, it is known that without adequate programs to reduce fuel loading buildup, the potential for wildfires increases significantly (Filmon, 2003, p. 6).

Fortunately for the SIGD, the temperate coastal climate helps to reduce extreme fire hazard conditions. In 2003, 71 fires burned throughout the Sunshine Coast Fire District, destroying a total of 10.3 ha. 54 of these fires were caused by lighting strikes while 17 were caused by human carelessness (unextinguished campfires) (Ministry of Forests, 2005a). As the 2003 Firestorm in BC's interior demonstrated, wildfires can quickly overwhelm the capacity of local response agencies and easily become uncontrollable. The potential economic, environmental, and social damage a wildfire can cause should not be underestimated. Overall, this risk is considered ***high.***

2.8 DISEASES AND EPIDEMICS

2.8.1 Human Diseases and Pandemics

Advances in epidemiology and vaccine technologies have effectively reduced the risks of widespread infection from many communicable diseases. Improved methods of combating infection, such as sulpha drugs and antibiotics are indicative of the progress made in disease prevention and treatment. However, new diseases or strains of diseases such as Hepatitis C and influenza are of increasing concern. The risk of a H5N1 avian influenza pandemic has been identified by the World Health Organization (WHO) as particularly high, and all urban areas with relatively high population densities are vulnerable though the impact of an influenza pandemic depends on a number of differing factors, including public awareness and quality of publicly available healthcare. Children and the elderly face greater risk as their immune systems tend to be weaker than the general population, as do individuals who are immunorepressed.

While an effective vaccine for the H5N1 influenza virus has not yet been produced, there are a number of measures that local authorities, in cooperation with the provincial and federal governments, can undertake to reduce vulnerability to a pandemic:

> Local public health authorities are responsible for planning the local response to an influenza pandemic with direction from both the provincial, territorial and federal level. This involves liaising with local partners (e.g., emergency responders, hospitals, mortuary services) in advance of a pandemic to facilitate a coordinated response when pandemic influenza strikes in the community. It is likely that the local public health authorities, through existing or enhanced surveillance, may be the first ones to detect influenza in their community. It is

essential that the lines of communication within the community and up the line to the provincial, territorial and federal levels are clear and established in advance of a pandemic (Public Health Agency of Canada, 2005).

In the event of a pandemic, St. Mary's Hospital (which has a 31-bed capacity), Sechelt Medical Clinic, Totem Lodge, Gibsons Medical Clinic, Pender Harbour and District Health Centre, Trail Bay Doctors, and Upstream Family Medicine could easily be overwhelmed if an outbreak of the H5N1 virus is not contained. Medical health practitioners and service providers will also be susceptible to infection and may have difficulty fulfilling their critical role in emergency response. The British Columbia Pandemic Influenza Preparedness Plan details the roles and responsibilities for local, regional, provincial and federal authorities (BC Centre for Disease Control, 2005). Local governments should act quickly to understand and know what measures, including mutual aid, must be in place to deal with a pandemic. This risk is considered ***high.***

2.8.2 Animal Diseases

Animal diseases or sicknesses can be spread from animals to animals and from animals to humans. They are classified into several groupings by a number of criteria:

- Non infectious diseases
- Infectious diseases
- Parasitic diseases

Although animal diseases are primarily a concern for farmers who often suffer severe economic impacts as a result of such a hazard, the potential for cross-species contamination means that there is a significant health concern for human populations. Examples include: foot and mouth disease; rabies; West Nile Virus; Bovine Spongiform Encephalopathy (BSE or 'mad cow disease' which can cause Creutzfeldt - Jakob Disease – CJD – in humans); and avian influenza.

Each disease, bacteria or virus has a different vector and etiology, which complicates group classification and risk ranking. As residents of the SIGD typically have access to a high standard of health care and effective public information tools, the likelihood of an animal-based disease overcoming the local population is generally low. However, given the current risks associated with avian influenza outbreaks, the fact that the H5N1 pathogen is easily transmitted between bird species (water fowl, wild birds and farmed poultry), and the potential for animal-to-human infection, this risk should be considered ***moderate*** (See Section 2.8.1 'Human Diseases and Pandemics' for more information on avian influenza and public health risks).

2.8.3 Plant Diseases and Pest Infestation

Plant diseases are generally defined as any series of harmful physiological processes caused by irritation of the plant by some invading agent. These agents are typically referred to as plant pathogens and include viruses, bacteria, fungi, and algae. Government agricultural departments routinely handle outbreaks of plant diseases and infestations though occasionally incidents become difficult to control and may require an emergency response by various agencies.

British Columbia is currently struggling with a Mountain Pine Beetle (*Dendroctonus ponderosae*) epidemic, which began in 1993. In 2004, the beetle was estimated to have affected about seven million hectares of forest throughout the province. Aside from emergency harvesting measures, sustained temperatures of -25 Celsius in the early fall or late spring and -40 Celsius in the winter have been identified as a contributing factor in eradicating the MPB. As the Sunshine Coast does not experience such extreme weather even at the coldest time of year, natural suppression of the beetle may not be possible if the region were to be affected. Currently the SCRD does not appear to be suffering from a Mountain Pine Beetle infestation however, the Ministry of Forests warns that the direction and spread rate of a beetle infestation is impossible to predict with certainty (Ministry of Forests, 2005b).

In the past, the Pine beetle, Spruce beetle (*Dendroctonus rufipennis*) and Douglas Fir beetle (*Dendroctonus psuedotsugae*) have been present in southern and coastal areas of British Columbia (Ministry of Forests, 1995). The Sunshine Coast and SIGD have not yet experienced a pest infestation, though historical precedence does not preclude the SCRD from suffering a beetle epidemic in the future. Careful forest management practices must be followed to prevent such an event from occurring. Overall this threat is currently identified as ***low***.

SECTION 3.0 HUMAN CAUSED HAZARDS AND RISKS

Human caused hazards are also referred to as technological hazards. They are hazards which are caused by human beings via an act, omission or commission.

3.1 ACCIDENTS

An accident is considered to be an event occurring by chance or arising from an unknown case. It is unexpected and causes loss or injury.

3.1.1 Aircraft Crashes

The possibility of an aircraft accident affecting the SIGD is remote, but possible. It should be noted that the Sechelt – Gibsons Airfield, the only airfield supporting the region, is located approximately 1.5 km from Chapman Creek, which supplies 90% of the SCRD with its drinking water. The possibility therefore exists for the direct or indirect contamination of local water supply through aircraft accidents or through the seepage of contaminates such as aircraft fuel, lubricants and other hazardous substances into groundwater. This risk consideration should be kept in mind as the SCRD deliberates over the extension of the Sechelt – Gibsons airfield.

Float planes facilities exist in various locations throughout the SCRD. Charter and scheduled services are provided by Sechelt Gibsons Air, Tofino Air, Pacific Wings, Coast Western Airlines and Glacier Air. The potential for aircraft accidents is thus increased due to a considerable amount of air traffic in the region. A crash-landing or other such incident can easily overwhelm the response capability of the regional district, particularly if a mass-casualty incident transpires. Corollary issues include fire, structural damage, and hazardous materials spills. As there is very little the SIGD can do to prevent or mitigate such an incident and its capacity to respond is limited, this risk is considered to be ***moderate***.

3.1.2 Marine Accidents

Marine accidents are shipping events that threaten human life, property and natural resources. Collisions, fires, foundering and dangerous goods spills are examples of marine accidents. Nuclear accidents are also a possibility as nuclear powered ships and submarines occasionally transit through the Strait of Georgia, en route to the Nanoose Bay Range and other proximate areas. Although this type of accident is possible, the probability of a nuclear incident occurring is low. Collisions at sea and marine accidents more generally are a moderate risk.

The Sunshine Coast is a very active area where vessel traffic is concerned. BC Ferries are in operation between Langdale and Horseshoe Bay and Earls Cove and Saltery Bay, while private boaters and transport barges frequently transit local waters with a variety of cargo. Dangerous goods used in pulp processing at the Howe Sound Mill (Port Mellon) and the Weyerhaeuser Stillwater mill (Powell River) are frequently transported via rail barge through the Strait of Georgia, and to a lesser extent, Malaspina Strait (see Section 3.4 for information on hazardous materials). BC Ferries also carry large volumes of diesel fuel and lubricants between Nanaimo and Horseshoe Bay.

In this context, the greatest marine threat to the SIGD is pollution created by spillage or vessel collision in the Strait of Georgia. If they are large enough close enough to the coast, oil or fuel spills could have a serious impact on the community in an economic and environmental sense. Depending on the substance released, the amount, proximity to inhabited areas, prevailing wind and tidal conditions, accidental discharge of some dangerous goods may require evacuation due to toxic fumes. Given that the closest hazardous materials response teams for marine spills are deployed from Surrey, BC and that the SCRD has limited capacity to respond independently, this risk has been identified as ***moderate.***

3.1.3 Motor Vehicle Accidents

Motor vehicle crashes occur whenever a motor-powered vehicle collides with another vehicle, fixed or moving structure, or loses control and incurs damage. Numerous vehicular accidents occur within SCRD boundaries each year, and primarily involve personal motor vehicles. Accidents involving large numbers of people or dangerous goods however, can be very serious.

Highway 101 is the primary transportation route for wheeled vehicles passing through the SCRD. The road itself runs directly through the SIGD and is a significant concern as a variety of dangerous goods is transported through the SCRD via road. Motor vehicle accidents within regional or municipal boundaries can give cause for evacuation over a wide area due to fire or hazardous materials spill. Depending on the location of an incident, access and evacuation may be impaired. Alternate means of moving people and resources between municipalities should be considered. If evacuation is not possible due to incident location or type of incident (i.e. chlorine spill)

Shelter In Place (SIP) options should be considered. In such an instance, local residents must be informed as to what SIP means, how to do it, and how to access situation updates on response and recovery. This risk is therefore rated as ***moderate***.

3.1.4 Rail Accidents

No rail lines exist in proximity to the SIGD. The closest rail lines are located approximately 60 km southwest, in the town of Squamish. A derailing or other incident is therefore not likely to have a serious impact on the SIGD. This risk is rated as ***low***.

3.1.5 Dam Failures

A dam breach is defined as a breach in the dam itself, its foundation, abutments, or spillway, which results in large or rapidly increasing, uncontrolled releases of water from the reservoir. In areas where a community is dependent upon a single dam as their source of water, vandalism or human error in the operation of the dam can cause significant water shortages.

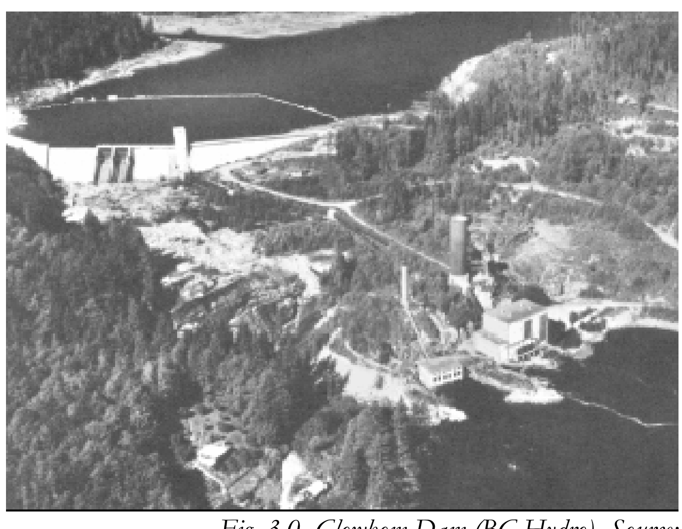


Fig. 3.0 Clowhom Dam (BC Hydro) Source: www.bchydro.com/bcrp/strategic_plan/ch14_final.pdf

The closest dam to the SIGD is the 21 meter high Clowhom Dam, located approximately 40km up Salmon Inlet. The Clowhom reservoir receives water from a 382 km² drainage basin that is subject to large, short-term fluctuations in inflows (BC Hydro, 2003). Most runoff is caused by warm temperatures in April and May, when snowmelt and heavy rainfall produce a sharp increase in local stream flow, which generally continues until June and July. The heaviest peak flows occur from fall rainstorms between September and December, when a combination of heavy rainfall, large snow pack and warm air temperatures create a very heavy peak flow that tends to stabilize in January, when temperatures stabilize below freezing and stream flow stops until spring (BC Hydro, n.d.).

A combination of heavy seasonal rains, warm temperatures and rapidly melting snow pack could increase water levels to the point of overflow, and landslides may also increase water levels substantially. The north side of Mount Donaldson is notably bare of vegetation which could potentially slip into the Clowhom Basin in the even of abnormally heavy rains. BC Hydro's Dam Safety Program Annual Report (2003) provides a risk matrix for all dams with identified actual and potential (as yet unconfirmed) deficiencies and provides a separate measure of likelihood of a dam's future poor performance. While included among those with identified or potential deficiencies, Clowhom Dam is categorized as having both low aggregate deficiency rating as well as a low consequence rating. A breach or failure of the dam infrastructure is not likely to pose a significant flooding hazard to the SIGD, as excess water is expected to dissipate into Salmon Inlet. Risk of flooding due to dam failure is thus considered to be ***low***.

3.2 EXPLOSIONS AND LEAKS

3.2.1 Gas Explosions and Gas Leaks

Gas leaks and explosions occur when natural gas or gasoline pipelines rupture. These ruptures are usually attributed to poor design or corrosion; however leaks can also be caused by natural hazards such as earthquakes or landslides, as well as human error.

Accidents involving gas piping typically fall into three categories:

1. **Third Party Damage:** The rupture of an underground main or service piping generally correlates with excavation activity by a third party, that is, not employees of Terasen Gas. Although Terasen Gas has an active warning and prevention program to address excavation risks, about 100 such incidents occur each year throughout the Lower Mainland.

2. **Underground Leakage:** Leakage from underground pipe can occur where corrosion or mechanical joint problems exist. About 85 percent of such leaks are detected by sensitive equipment used by Terasen Gas to continually survey their distribution system. The remaining leaks are reported to the public or other agencies.

3. **Impact Damage to Gas Meters:** Terasen Gas protects above-ground meter sets that are vulnerable to vehicle traffic by installing large steel posts. Nevertheless, a small number of vehicle accidents lead to broken gas meters and leakage each year. Such events invariably require immediate evacuation of the local building or area.

Terasen Gas owns and operates gas mains throughout the Lower Mainland and Sunshine Coast. In the SCRD, these lines run along municipal boundary lines and parallel the BC Hydro right-of-way. For the most part, these lines do not come into close proximity to densely populated or highly developed areas. From a beachhead north of Sechelt, twin ten-inch lines cross underwater to Anderson Bay on Texada Island.

To respond to natural gas pipeline incidents, Terasen Gas has an emergency plan, communication procedures, trained crew and specialized equipment in place, and will move quickly to minimize impact. Distribution shut off valves are used to isolate sections of pipeline in a serious event, and are inspected and maintained annually. Radio-equipped crews are available during workdays and emergency crews are on stand-by around the clock. Crews are given annual refresher training, which covers a number of topics such as analysis of leakage situations, live gas leak repairs and firefighting. Terasen Gas also provides training to local fire and police departments so that they can assist in coordinating a response to a natural gas incident. Gas leaks caused by natural hazards (landslides, earthquakes etc.) which cause damage or injury within the SIGD are lower probability occurrences than those caused by human error (excavation, accident, poor maintenance). While leakage or explosion caused by human error is for the most part preventable, the impact of such of such an event on critical infrastructure and human safety may be quite serious. This risk is identified as ***moderate***.

3.2.2 Mine Explosions

Mine explosions are usually caused by a buildup of explosive gases in mine drifts or shafts. These gases can be set off by a spark or by miners entering, working in, or leaving the area. Sechelt is home to the largest open-pit gravel mine in North America. As such, there is minimal danger of gas accumulation in underground shafts. The Construction Aggregate Ltd. (CAL) gravel mine in Sechelt performs is open-pit and very little blasting. When explosives are needed they are brought in on a per-use basis by demolitions contractors who store blasting agents in an off-site location (Gord Dirkson, CAL, pers. comm., March 8, 2005). Due to the absence of closed-pit mining activity and the lack of explosives material kept on-site at the Sechelt gravel mine, the risk of a uncontrolled mine explosion within the SIGD is considered to be ***low***.

3.3 FIRE

3.3.1 Structural Fire

Urban fires are a reality in any municipality, region or district and have the capacity to spread quickly to adjoining structures such as homes, commercial buildings and other infrastructure. Generally, local agencies are able to control fires without relying on external resources or support but occasionally, an event becomes so severe that managing it requires the assistance of neighbouring communities. Calculating the frequency of urban fires is difficult as most outbreaks tend to be random accidents, excepting criminal acts of arson. Estimating a community's ability to respond, based on available resources and the existence of mutual aid agreements, is a much more efficient way of calculating the risk of urban fire.

Sechelt and the Sechelt Indian Government District (SIGD) are served by one local fire department, which is staffed by 38 members, 35 of whom are volunteers. The Sechelt Fire Hall is located at 5525 Trail Avenue, and its major resources include:

- Four (4) engines (three pumper trucks and one ladder)
- One (1) Rescue Vehicle
- Two (2) Command Vehicles
- One (1) Support Vehicle (pickup truck)
- One (1) Utility Maintenance and Passenger Van
- Basic spill containment and decontamination equipment for Hazardous Materials
- Mutual Aid Agreements with all fire halls in the SCRD (Gibsons, Roberts Creek, Halfmoon Bay and Pender Harbour)

As with any first response service, speed of delivery is dependent on a variety of extraneous factors, such as weather, traffic, vehicle access and number of concurrent dispatches. Overall, the community has a solid resource base from which to address fire outbreaks however the impact of such a hazard can potentially be quite severe. This risk is rated as ***high.***

3.3.2 Wildland Interface Fire

Abnormally hot, dry weather and excessive fuel loading often make forest areas particularly vulnerable to lightning strikes and human carelessness. Once burning, a wildland fire can spread quickly due to high winds and easily overwhelm the capacity of local response agencies. Aside from the environmental and economic impact, wildland fires become particularly devastating when they encroach upon human settlements and critical infrastructure. When this occurs, they become 'interface' fires and because of their difficulty to manage, can be extremely destructive.

The Firestorm of 2003 made the risk of interface fires abundantly clear to communities across British Columbia. Between July and August, over 2,500 fires burned throughout the interior, causing 344 homes and businesses to be lost, 45,000 people to be evacuated, and 260,000 hectares of forest to be destroyed. The total cost of the Firestorm was estimated to be $700 million, though the greatest loss of all was that of three pilots who died in the line of duty (Filmon, 2003, p. 10).

As a means of hazard identification and risk management, the Sunshine Coast Regional Fire Centre completed interface community fire hazard rating and mapping in 1999 for all populated areas within the SCRD. The numerical rating system considered a number of factors for various points throughout the SCRD, such as:

Fuel load	Forest fire history
Topography	Land use
Weather and climate	Fire protection capability
Existing mutual aid agreements	Fire potential on adjacent lands

Each category was ranked and given a score against a total of 169. The rating scheme was as follows:

Interface Community Fire Hazard Rating

0-55	Low	Green
56-70	Moderate	Yellow
71-85	High	Orange
86+	Extreme	Red

The resulting data was then plotted and mapped to provide a visual representation of interface fire hazards within SCRD. Sechelt town centre is rated very low while immediately adjacent areas rated as moderate. Survey data collected by the regional forest district indicates that the most significant fire risk is a result of fuel loading, problematic topography (steep cliffs, gullies and rock outcrops), the concentration of critical infrastructure in the area and high land use activity. Offsetting that risk is Sechelt's fire protection capability and water coverage area, which supports the SIGD. Given that interface fires are unaffected by political boundaries however, the issue of adjacency and proximate risk are of note. Roberts Creek north has been designated as high risk, due largely to limited fire suppression capability, limited water coverage, and problematic topography in isolated areas.

As mentioned in Section 2.7, 71 wildfires fires burned throughout the Sunshine Coast Fire District in 2003, representing a clear risk to the municipalities and townships within the SCRD, including the SIGD. Without adequate fuel management, suppression and response capabilities, wildfires can easily become interface fires and destroy property, infrastructure and forested lands. Their ability to spread quickly particularly when high winds (such as those experienced along the coast) provoke flame spread poses a serious threat to the SIGD, particularly if responders have difficulty reaching affected areas. In light of this threat reality the high potential for loss or damage, and the limited fire-fighting resources within the SIGD, this risk is considered ***very high***.

3.4 HAZARDOUS MATERIALS ACCIDENTS - *in situ*

Materials considered hazardous are explosives and blasting agents, flammable and inflammable gases, flammable liquids and solids, poisons, etiological agents, corrosive substances, hazardous and biomedical wastes. This category involves spills, leakages or accidents in fixed locations as well as the proper disposal of these hazardous materials.

The greatest concentration of hazardous materials is in the Howe Sound Pulp and Paper Mill (HSLP). Aside from fuel products, the mill also utilizes large quantities of:

Substance	ID No.	Spill Evacuate	Fire Evacuate	Volume On-Site	Comment
Sulfuric Acid	1830	100 M	800 M	108.8 m^3	Toxic fumes
Caustic Soda	1824	200 M	800 M	2,629 m^3	Non-combustible Toxic gas

Sodium Chlorate	2428	100 M	800 M	1,461 m^3	Accelerated Burning Toxic Gas, Explosive
Chlorine Dioxide	9191	100 M	800 M	579 m^3	Very toxic vapor when spilled in water Accelerated burning
Hydrochloric Acid	1789	100 M	800 M	11 t.	Non-combustible Toxic gas
Hydrogen Peroxide	2105	100 M	800 M	189 t.	Accelerated burning Toxic gas
Methanol	1230	200 M	800 M	164 m^3	Highly flammable Toxic gas
Propane	1978	800 M	1600 M	24 t.	Extremely flammable Explosive vapors
Sulfur Dioxide	1079	200 M	1600 M	1,141 t.	Non-combustible Corrosive vapors

Source: CANUTEC Emergency Response Guidebook, 2000

The site-specific Emergency Response Plan (2004, updated) details the human health and environmental risks of the various chemicals housed on site (chemical information contained in abbreviated Materials Safety Data Sheets). The response plan for the mill also contains information such as:

- A description of the spill containment infrastructure (e.g., perimeter dikes around bulk chemical storage and process tanks);
- A list of on-site and off-site protective gear and clothing, including spill response equipment;
- Both an internal and external contact list, including spill response agency personnel and emergency response equipment suppliers and emergency response contractors.

The plan is updated annually, and contains a detailed revision history of all elements of the plan.

Local response to hazardous materials spills is limited as fire departments within the SCRD have basic spill containment capacities only. Aside from HSLP however, few facilities exist that could threaten the people, property and environs of the SIGD. The exceptions are likely to be proximate fueling stations that could potentially leak or explode and sewage treatment facilities (pipelines and treatment plants) that could contaminate Band lands. *In situ* hazardous materials accidents are therefore considered a ***low*** risk to the SIGD.

3.4.1 Airborne Hazardous Materials Accidents

Environmental assessments on industrial emissions from HSLP indicate that the vast majority of winds in Howe Sound originate from the north and south. Easterly wind events are relatively rare and airborne emissions or contaminates are unlikely to pass over the Tetrahedron Mountain Range, which acts as an effective buffer between HSLP and communities northwest of Roberts Creek (McKeown, Leney, & Lim, 2002). Thus, the geological and meteorological characteristics of the region are such the potential for hazardous airborne materials affecting SIGD residents is limited. The communities of Langdale, Hopkins Landing, Granthams Landing and Gibsons may be at higher risk however, as they are to the south of Port Mellon and the HSLP mill. The small residential area most at risk from airborne hazardous materials is located in Port Mellon/Hillside itself.

In the event of a fire or explosion, the potential for uncontrolled release of hazardous materials into the environment is greater and could potentially affect SIGD. Local authorities and residents of at-risk communities should be familiar with Shelter in Place (SIP) and evacuation protocols response alternatives to airborne hazardous materials, as well as the usage and meaning of public warning/information systems. See Section 3.5 and the *CANUTEC Emergency Response Guidebook 2000* for more information regarding evacuation and public safety for each substance.

During normal, daily operations, the likelihood of a hazardous materials accident is low, however the potential damage such an event could cause is high. However, the natural barrier that is provided by the Tetrahedron Mountain Range and the prevalence of northerly and southerly winds reduces the risk of airborne hazardous materials accidents to the SIGD. This risk should therefore be considered ***low.***

3.4.2 Hazardous Materials Accidents – transport routes

Hazardous materials can occur on any of the known transportation routes in British Columbia including air, marine, rail and road. The areas most vulnerable to the hazards associated with dangerous goods such as PCBs, chemical spills or the leakage of flammable gases corresponds to those places where transport routes and the risk of natural or person-induced hazards exist.

Because HSLP receives most of its chemicals via rail barge or tank barge, there is significant potential for marine-based hazardous materials accidents to occur. Depending on the nature and extent of the spill, response procedures may impact travel through the SCRD, including ferry traffic. Response to large-scale marine accidents is coordinated by the Ministry of Water, Air and Land Protection through their regional office in Surrey, BC, with support from the responsible party and external agencies (CANUTEC, Burrard Clean, Environment Canada) as required. Dangerous goods delivered by transport truck are primarily fuels such as diesel, propane, and gas, are frequently carried through the SCRD via Highway 101.

In terms of local response to a traffic spill, the Sechelt Fire Department has limited capacity to deal with hazardous materials or dangerous goods, and the SIGD has none. Though mutual aid agreements exist between all fire halls in the SCRD, responders are only capable of containment and some decontamination. Evacuation may be coordinated locally however, clean-up and recovery will be orchestrated externally. This risk is ***high.***

3.4.3 Hazardous Materials Impacts - Howe Sound Pulp and Paper Limited Partnership (Port Mellon)

Human Health Concerns

Howe Sound Pulp and Paper produces both Kraft pulp and newsprint. Since 1997, Kraft pulp has been bleached exclusively with chlorine dioxide and newsprint pulp has been semi-bleached without the use of any chlorine containing chemicals. No major changes to mill processing or the secondary effluent treatment system have been made since the last mill update in the early 1990s. The mill has three discharge authorization permits from the provincial Ministry of Water, Land and Air Protection:

ENVIRONMENTAL MEDIA	CONDITIONS	MONITORING REQUIREMENTS
Landfill (17 ha developed in three phased cells)[1]	• Each cell lined with a 1.5mm thick high density polyurethane liner. • A leachate collection and conveyance system, as well as treatment system. • A leak detection system. • Maximum allowable waste volume per year that can be landfilled.	• Semi-annual analysis of leachate for: pH, biological oxygen demand, and specific conductivity. • Annual analysis of leachate for dioxins and furans. • Semi-annual sampling of 6 off-site groundwater wells (receiving environment).
Air emissions	• Specifies maximum air emissions (per day) from a recovery boiler, a wood residue boiler, a lime kiln, a smelt dissolving tank, a bleach plant and chemical preparation scrubbers, and miscellaneous mill sources.	• Depending on the source, sampling may be continuous, monthly, or quarterly (as specified). • Monthly reports (and one annual) to be submitted to the Ministry, including any details of hours when any source was not in compliance with permit conditions.

Effluent emissions[3]	• Maximum daily emissions volumes from various effluent treatment plants or effluent storage cells: wastewater treatment plant, cooling water and stormwater source cell, woodchip storage facility leachate collection sump. • Requires site to also be in compliance with federal *Pulp and Paper Effluent Regulations*.	• Grab and composite effluent sampling: chemical analysis. • Acute biological toxicity testing (rainbow trout, monthly and *Daphnia magna,* weekly 96-hour LC50). • Monthly reporting required.

1 Landfill permit issued in 1996; landfill permitted to be active through 2011.
2 Air emissions permit issued in 1978; most recent amendment in 2003.
3 Effluent permit issued in 1976, most recent amendment in 2005.

Monitoring programs related to human health are described below:

Howe Sound dioxin / furan trend monitoring program (Hatfield Consultants, 2004a)

Since 1989, the pulp mill has been required to undertake an organochlorine monitoring program in the marine receiving environment (annual sampling). This study was initiated following the discovery of very high concentrations of dioxins and furans in marine sediments and shellfish in the Howe Sound area (resulting in the closure of commercial and recreational fisheries). Resource managers were concerned about the health risk to the public from exposure to dioxins and furans through consumption of resident fish and shellfish, and the long-term effects of the compounds on the marine receiving environment.

The dioxin/furan trend monitoring program evaluates concentrations of the compounds in sediment, Dungeness crabs (*Cancer magister*) and finfish (dogfish and rockfish). Since 1989, following revisions to the effluent processing and associated pollution abatement programs, dioxin and furan levels have dropped significantly. The declines in shellfish concentrations have led to some modifications of fisheries advisories for Howe Sound. Since September 1997, all of lower Howe Sound and the section of the Sunshine Coast southeast of Sechelt were opened to non-commercial crab fishing, with some consumption advisories. This area remains closed to commercial fishing.

Environmental Concerns

Receiving environment monitoring programs have been part of mill operations for quite some time. Currently, two programs are in operation:

Howe Sound Environmental Effects Monitoring (EEM) Program (Hatfield Consultants, 2004)

Mill effluent is tested for sublethal toxicity on several marine organisms: topsmelt (*Atherinops affinis*), echinoderms (sea urchins), and marine micro-algae (*Champia parvula*). The results from the most recent monitoring cycle are as follows: Effects ranged from no effect at the highest effluent concentration for the topsmelt, to 25% effect size on reproduction for both the sea urchins and micro-algae (at effluent concentrations of 25% and 19% volume/volume, respectively). In other words, the sublethal toxicity tests indicated that marine organisms in the receiving environment are unlikely to be affected by mill effluent, as effluent concentrations in the receiving environment will be considerably lower than those that illicited any effect size in the test organisms.

To evaluate the effects of the mill effluent on fish habitat, benthic invertebrates were collected (in 2003) from 20 stations in Howe Sound, at varying distances from the pulp mill discharge point. Benthic invertebrates are a good indicator of environmental "harm" or disturbance, because there are relatively stationary and serve as an important food source for more-mobile fish. Benthic invertebrate density (number of bugs per unit area) and taxa richness (number of different species) were higher at stations closer to the discharge point, indicating enrichment from the pulp mill effluent. This effect has been observed in previous monitoring cycles.

While there is no sublethal toxicity expected for marine organisms, there are still some notable effects on human health and the receiving environment as a result of the pulp mill effluent discharge. Careful monitoring of mill operations and discharges are necessary to maintain an understanding of the effects of the effluent on the Howe Sound environment over time. Overall, the risk of the pulp mill on the receiving environment is judged ***moderate-to-high.***

3.5 POWER OUTAGES

Power outages occur on a regular basis however, they become of concern when the power outage is for a significant amount of time or when the temperatures are very low and persons, livestock or businesses are affected. Power outages often occur in heavy winds, ice or snow storms, which cause hydro poles to fall or cause trees or other debris to land on them. Power outages can also occur during landslides, avalanches and earthquakes, and frequently occur as a result of motor vehicle accidents. As well, equipment failure in a substation or transformer – or overuse of electrical power – can cause brownouts, which are reduced electrical capacity or outages.

Service interruptions are a serious concern, particularly for critical infrastructure such as hospitals, communication facilities and associated equipment, and response agencies (police, fire, ambulance). Agencies and utilities that fill a key role in emergency operations should have back up electrical sources and generators so that they can continue to function in all conditions.

The SIGD is located within BC Hydro's 'Metro Area' operating region, which covers service areas from Powell River to Squamish, Sechelt south to North Vancouver, and southeast to Coquitlam and Edmonds in Vancouver. Corporate records indicate that over the last 10 years, service interruption to the Metro Area has overwhelmingly been a result of adverse environmental conditions, specifically corrosion (on average 70-80%) followed by brush or building fire (15-20%). The other most common causes of power interruption have been attributed to interference caused by trees, equipment failure, and adverse weather, particularly lightning strikes and high winds. Within the Metro Area, the average power outage is between two and three hours in duration, which is typical of most operating regions within the Province. The SIGD does not appear to be at significantly higher risk of power outages beyond what is normally expected in routine conditions. When power outages do occur, BC Hydro is generally quick to restore service to its customers within the SIGD.

While the probability or frequency of this event affecting SIGD is high, the impact of temporary power outages is typically quite low. This risk is therefore classified as ***moderate.***

3.6 RIOTS

A riot is a violent public disorder, specifically a disturbance of the public peace by a group of persons with either a common or random intent to destroy property, assault persons or otherwise disturb the peace. The most likely form of civil disobedience is likely to come from union picket, strikes or environmental protests. This risk is rated as ***low***.

3.7 STRUCTURAL COLLAPSE

Structural collapse occurs when a building or structure collapses due to engineering or construction problems, metal fatigue, trauma, or as a result of changes to the load bearing capacity of the structure. If people are in the building, are on or near the structure when it collapses, injuries and death can potentially be high. When buildings or large structures collapse, they often cause ruptures in existing infrastructure such as gas lines, electrical, water, sewage, and telephone lines. For these reasons, fire is often a corollary hazard that follows structural collapse.

There are a number of critical facilities that, should they suffer structural failure or collapse, could have a serious impact on the SIGD (see Appendix F – GPS Coordinates for Critical Infrastructure in the SIGD):

Port Mellon / Howe Sound
HSLP

Gibsons
Swimming Pool – 953 Gibsons Way
Gibsons Elementary School – 783 School Rd.
Cedar Grove Elementary School – 1196 Chaster Rd.
Elphinstone Secondary School – 840 Gibsons Way
Gibsons Marina

Gibsons Medical Clinic – 821 Gibsons Way
Gibsons Express Propane – 661 Park Rd.

Langdale
BC Ferries Terminal
Langdale Elementary School – 1551 Johnson St.

Roberts Creek
Roberts Creek Elementary School – 1088 Roberts Creek Rd.

Sechelt Indian Government District
St. Mary's Hospital – 5544 Sunshine Coast Highway.

Sechelt
Sunshine Coast Arena – 5982 Shoal Way
St. Mary's Hospital – 5544 Sunshine Coast Highway.
Sechelt Medical Clinic – 5531 Inlet Ave.
Trail Bay Doctors – 5755 Cowrie Rd.
Upstream Family Medicine – 108-4430 Sunshine Coast Highway
Chapman Creek Bridge – Sunshine Coast Highway
Sechelt – Gibsons Airport
Kinikinnik Elementary School – 6030 Lighthouse Ave.
Sechelt Elementary School – 5800 Cowrie St.
West Sechelt Elementary School – 5609 Mason Rd.

Chatelech Secondary School – 5909 Cowrie St.
Stephanson Bulk Fuel and Cardlock – 5812 Sechelt Inlet Rd.

Halfmoon Bay
Halfmoon Bay Elementary School – 8086 Northwood Rd.

Pender Harbour
Headwater Marina – 5167 Wilkinson Rd.
Pender Harbour and District Health Centre – 5066 Francis Peninsula Rd., Madeira Park
Pender Harbour Secondary – 13639 Sunshine Coast Highway.
Madeira Park Elementary – 5012 Gonzales

3.8 TERRORISM

Terrorism is considered to be a hostile act committed against the state, through the systematic use of terror as a means of coercion. Terrorism can include a number of different types of actions. Most common among them are bomb threats or blowing up a site or structure with an explosive device. Sabotage to buildings and infrastructure, kidnapping or hostage-taking are also frequently used terrorist tactics.

While small-scale criminal acts of terrorism may occur with great infrequency, terrorism on a large scale does not present a particularly lucid threat to the SIGD. Some critical infrastructure may be of interest to persons or organizations wishing to disrupt social and economic order. For example, the Construction Aggregates Ltd. gravel mine may be a potential target for extreme environmental activists or disgruntled organizations with political or economic motives. The security of infrastructure necessary for the safety and well-being of SIGD citizens should be considered in the local emergency management strategies (i.e. Clowhom Dam, Chapman Creek Bridge, St. Mary's Hospital, BC Ferries Terminal in Langdale, and various industrial facilities in Port Mellon) and business continuity plans should be encouraged. Overall, the threat of terrorist activity within the SIGD is considered to be ***low***.

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FREQUENCY	Low	Moderate	High	Very High	
6	Snowstorm Erosion Power Outage	Rain Storm Lightning	MVA	Structural Fire	**Very Likely**
5	Blizzard Hail Storm	Storm Surge Heat Wave	Flood Landslide/Subsidence Debris Flow Marine Accident	Wildfire Interface Fire	**Moderate/Likely**
4	Ice Storm/Ice Fog Global Warming	Drought Plant Disease	Air Crash	Hazmat Spill Earthquake Human Epidemic	**Occasional/ Slight Chance**
3	Freshet	Hurricane Submarine Slide	Gas Leak/Explosion Structural Collapse Animal Epidemic		**Unlikely/Improbable**
2	Avalanche	Terrorism	Mine Accident		**Highly Unlikely Rare**
1	Tornado Ice Jam Jokulhaups Volcano Rail Accident	Dam Failure Tsunami Riot			**Very Rare**
SEVERITY	**0 - 7**	**7 - 14**	**14 - 21**	**21 - 28**	

HAZARD	IMPACT DETAIL	CONSEQUENCE 1 = very low, 2 = low 3 = high, 4 = very high	OVERALL	LIKELIHOOD (1-6) 1 = v.rare, 2 = rare, 5 = likely, 6 = v.likely
BLIZZARDS	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 2 2 1 1 2	10	5
SNOW STORMS	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 2 2 2 1 2	11	6
ICE STORMS & ICE FOGS	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 2 2 1 1 1	9	4
HAIL STORMS	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 1 2 1 1 1	8	5
LIGHTNING	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 2 2 2 3 2	13	6

HAZARD	**IMPACT DETAIL**	**CONSEQUENCE** 1 = very low, 2 = low 3 = high, 4 = very high	**OVERALL**	**LIKELIHOOD (1-6)** 1=v.rare, 2=rare, 5=likely, 6=v.likely
HURRICANES	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 2 3 3 3 2	15	3
TORNADOES	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 2 2 2 3 2	13	1
HEAT WAVES	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 2 1 1 2 2 2	11	5
AVALANCHES	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 2 2 1 2 1	10	2
DEBRIS AVALANCHES & DEBRIS FLOWS	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 2 3 2 2 1	12	5

HAZARD	IMPACT DETAIL	CONSEQUENCE 1 = very low, 2 = low 3 = high, 4 = very high	OVERALL	LIKELIHOOD (1-6) 1=v.rare, 2=rare, 5=likely, 6=v.likely
LAND SLIDES	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 2 2 2 2 2	12	4
SUBMARINE SLIDES	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 2 3 2 2 1	12	3
LAND SUBSIDENCE	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 2 2 2 2 1	11	5
DROUGHT	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 2 2 4 3 3 2	17	4
EROSION & ACCRETION	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 1 1 2 2 1	9	6

HAZARD	IMPACT DETAIL	CONSEQUENCE 1 = very low, 2 = low 3 = high, 4 = very high	OVERALL	LIKELIHOOD (1-6) 1=v.rare, 2=rare, 5=likely, 6=v.likely
LOCAL FLOODING	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 2 3 3 3 2	15	4
RAIN STORMS	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 1 2 2 2 1	10	6
FRESHET	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 1 1 1 2 1	8	3
ICE JAMS	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 1 1 1 1 1	7	1
JOKULHAUPS	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 1 1 1 1 1	7	1

HAZARD	IMPACT DETAIL	CONSEQUENCE 1 = very low, 2 = low 3 = high, 4 = very high	OVERALL	LIKELIHOOD (1-6) 1=v.rare, 2=rare, 5=likely, 6=v.likely
STORM SURGES	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 1 2 2 2 1	10	5
SEISMIC	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	2 2 4 4 3 2 3	20	4
TSUNAMIS	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 2 2 2 2 1	11	2
VOLCANIC	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 1 1 1 1 1	7	1
WILDFIRE	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 2 3 2 4 2	15	6

HAZARD	IMPACT DETAIL	CONSEQUENCE 1 = very low, 2 = low 3 = high, 4 = very high	OVERALL	LIKELIHOOD (1-6) 1=v.rare, 2=rare, 5=likely, 6=v.likely
HUMAN DISEASES	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 4 3 1 1 1 3	14	4
ANIMAL DISEASES	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 2 2 1 1 1 2	10	2
PLANT DISEASE PEST INFEST'N	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 1 1 1 4 3	12	4
AIR CRASHES	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	2 2 1 1 1 3 1	11	4
MARINE ACCIDENTS	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 2 1 1 1 3 1	10	5

HAZARD	IMPACT DETAIL	CONSEQUENCE 1 = very low, 2 = low 3 = high, 4 = very high	OVERALL	LIKELIHOOD (1-6) 1=v.rare, 2=rare, 5=likely, 6=v.likely
MOTOR VEH. ACCIDENTS	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	2 2 1 1 2 2 1	11	6
RAIL ACCIDENTS	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 1 1 1 1 1	7	1
DAM FAILURE	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 1 1 1 2 1	8	2
GAS EXPLOSION & GAS LEAKS	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 2 2 2 3 3 2	15	4
MINE EXPLOSIONS	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 2 2 2 2 3 2	14	2

HAZARD	IMPACT DETAIL	CONSEQUENCE 1 = very low, 2 = low 3 = high, 4 = very high	OVERALL	LIKELIHOOD (1-6) 1=v.rare, 2=rare, 5=likely, 6=v.likely
URBAN FIRE	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 4 3 3 2 2	16	6
INTERFACE FIRE	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 4 4 4 4 4	22	5
GLOBAL WARMING	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 1 1 1 1 1	7	4
HAZMAT SPILLS in situ	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 2 2 2 4 2	14	4
HAZMAT SPILLS transport routes	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 2 2 3 2 3 2	15	4

HAZARD	IMPACT DETAIL	CONSEQUENCE 1 = very low, 2 = low 3 = high, 4 = very high	OVERALL	LIKELIHOOD (1-6) 1=v.rare, 2=rare, 5=likely, 6=v.likely
POWER OUTAGE	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 1 2 2 1 1 2	10	6
RIOTS	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 2 2 2 3 1 2	13	1
STRUCTURAL COLLAPSE	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 2 4 3 3 1 2	16	3
TERRORISM	a. Fatality b. Injury c. Critical Facilities d. Lifelines e. Property Damage f. Environmental g. Social/Economic	1 2 2 2 3 2 3	15	2

APPENDIX C - Environmental Risk Matrix
Sechelt Indian Government District

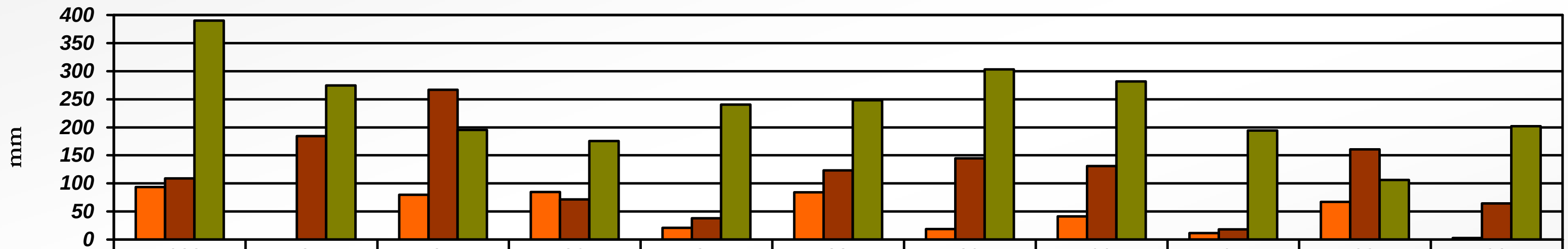
	Contam Air	Contam Water	Contam Soil	Contam Sediment	Erosion	Sedimentation	Aquatic Habitat Damage	Terrestrial Habitat Damage	Wetland Habitat Damage
Lightning								X	
Local Flooding		X	X	X	X	X	X		X
Rain Storms					X	X			X
Freshets					X	X			
Storm Surges					X	X	X	X	
Drought							X	X	X
Glacier-Outburst Floods					X	X	X		
Landslides	X	X	X	X	X	X	X	X	X
Land Subsidence		X			X	X	X	X	X
Avalanche					X	X	X	X	X
Debris Avalanche & Debris Flow		X	X	X	X	X	X		X
Erosion & Accretion	X	X	X	X	X	X	X		X
Earthquake (all)	X	X	X	X	X	X	X	X	X
Wildfire	X	X			X	X	X	X	
Interface Fire	X	X	X	X	X	X	X	X	X
Dam Failure					X	X	X	X	
Gas Explosion	X								
Mine Explosion	X	X	X	X	X	X	X	X	
Hazardous Materials Accident	X	X	X	X	X	X	X	X	X

APPENDIX D - RESPONSE CAPABILITY
SECHELT INDIAN GOVERNMENT DISTRICT

	FIRE	POLICE	BCAS	CCGA-P
GIBSONS	37 Members (34 volunteer) 3 Pumper Trucks 1 Ladder 1 Command Vehicle 1 Rescue Truck 1 Support Pickup Truck 1 Maintenance/Passenger Van Basic Spill Containment & Decontam	**SCRD RCMP**	2 Ambulances 15 Available Responders 1 Casualty Collection Unit Gibsons Medical Clinic	**GIBSONS Unit 14** Dedicated Response Vessel (DRV) Carswell Titan 249XL 26 ft. Maximum Capacity 18 persons Unit Strength 30 persons Owner Operator Vessel (OOV) Canoe Cove 53 ft.
SECHELT	38 Members (35 volunteer) 4 Engines 1 Rescue Vehicle 1 Tanker 2 Command Vehicles 1 Utility Truck Basic Spill Containment & Decontam	**SCRD RCMP**	Sechelt Medical Clinic St. Mary's Hospital Trail Bay Doctors Upstream Family Medical Clinic	**HALFMOON BAY Unit 12** DRV Zodiac Hurricane 733 26 ft. Maximum Capacity 21 persons Unit Strength 35 persons OOV Model Unknown 30 ft.
SIGD	**SECHELT FD**	**SCRD RCMP**	**BCAS SECHELT**	**N/A**
SCRD	**PENDER HARBOUR** 23 Members (23 volunteer, 1 paid) 2 Engines 1 Light Attack Vehicle 1 Command Vehicle **HALFMOON BAY** 30 Volunteers 1 Pumper 2 Engines 1 Tanker 1 Rescue No Hazmat Capability	**SCRD RCMP** 31 Members 7 Auxiliary 16 Vehicles 2 ATVs 1 Zodiac 2 Sattelite Phones/Ham Radios	**PENDER HARBOUR** 1 Ambulance 26 Available Responders 1 Casualty Collection Unit	**PENDER HARBOUR Unit 61** DRV Model Unknown 26 ft. Maximum Capacity 10 -12 persons Unit Strength 12 persons OOV Fiberform Sedan 28 ft. Maximum Capacity 12 - 15 persons

APPENDIX E – CLIMATE DATA
SECHELT INDIAN GOVERNMENT DISTRICT

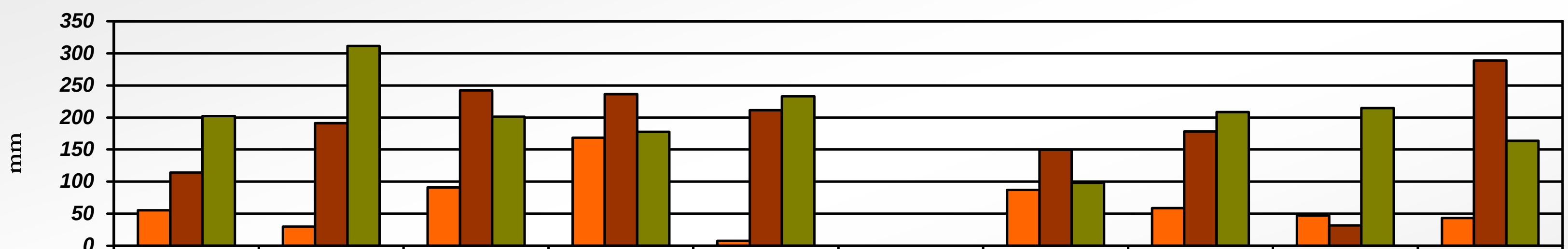
Average Monthly Precipitation (rain)



	1983	84	85	86	87	88	89	90	91	92	93
Sep	93.5	M	79.8	84.6	20.9	84	18.6	41.5	11.8	67.1	3
Oct	109.1	184.4	266.8	71.8	38.1	123.2	144.8	131	18.4	160.9	64.5
Nov	390.2	274.5	195.4	175.5	240.5	248.4	303.4	281.9	194.3	106	202

Year

Average Monthly Precipitation (rain)

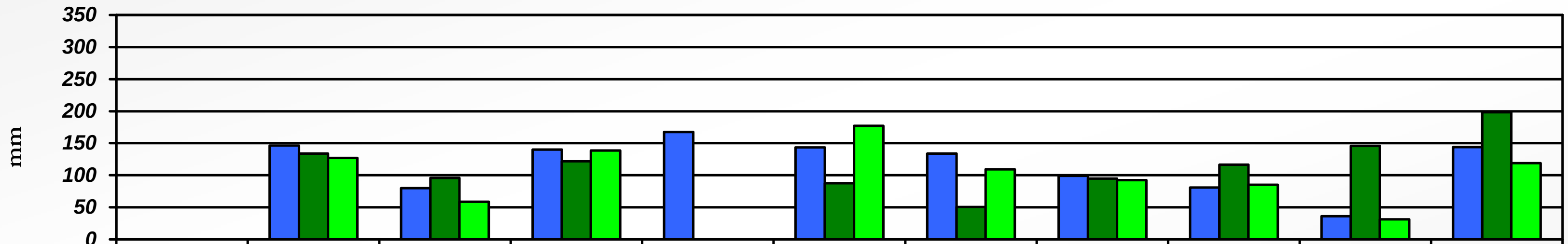


	1994	95	96	97	98	99	2000	2001	2002	2003
Sep	55.5	29.9	91	168.4	7.5	M	86.9	58.9	47	43.5
Oct	114	191	242.3	236.5	211.5	M	149.5	178.2	31.9	289
Nov	202	311.6	201	177.5	233	M	98	208.3	214.8	163.9

Year

APPENDIX E – CLIMATE DATA
SECHELT INDIAN GOVERNMENT DISTRICT

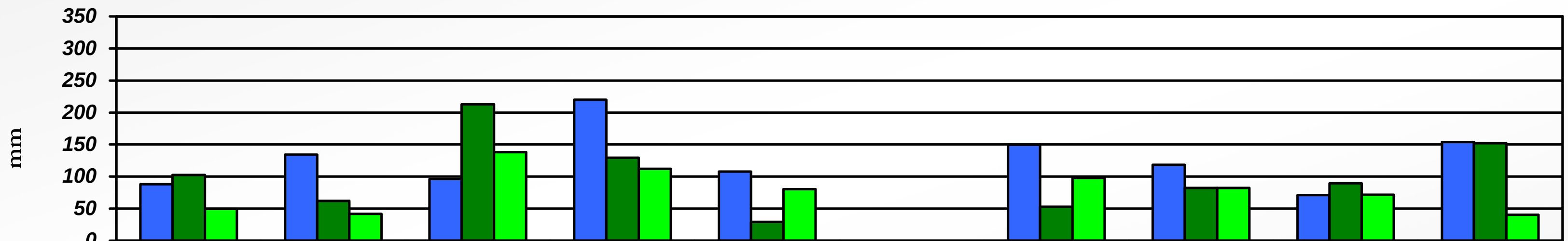
Average Monthly Precipitation (rain)



	1983	84	85	86	87	88	89	90	91	92	93
Mar	M	146.2	79.7	140.1	167.3	143.5	133.7	99.2	81	35.9	144
Apr	M	133.7	95.6	122	M	87.6	50.4	95	116.4	145.8	198.3
May	M	127.1	58.7	138.7	M	177.4	109.3	92.5	85.2	31.4	119.1

Year

Average Monthly Precipitation (rain)

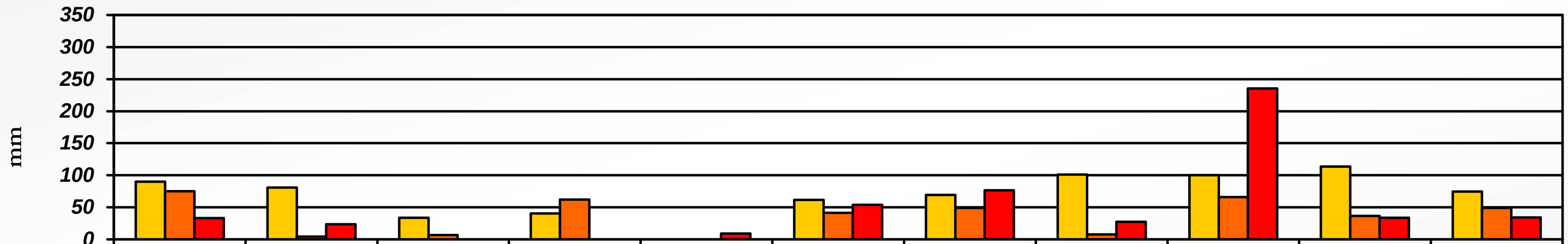


	1994	95	96	97	98	99	2000	2001	2002	2003
Mar	88	134.5	96.2	219.8	108	M	149.7	118.2	71.4	154.2
Apr	102.7	62.3	213	129.5	29.5	M	52.9	82.2	89.4	152.1
May	49.6	42	138.1	112	80.5	M	97.8	82.3	71.8	40.2

Year

APPENDIX E – CLIMATE DATA
SECHELT INDIAN GOVERNMENT DISTRICT

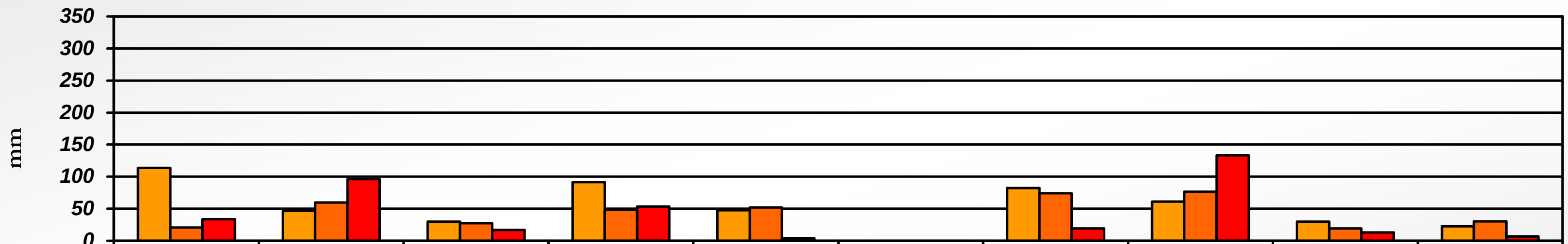
Average Monthly Precipitation (rain)



	1983	84	85	86	87	88	89	90	91	92	93
Jun	90.2	80.9	33.7	40.2	M	61.5	69.4	101.2	100	113.6	74.8
Jul	75.2	4.1	6.7	61.9	M	41.3	49.2	7.5	65.8	36.7	49.3
Aug	33.1	23.8	M	T	9.3	54	76.5	27.4	235.2	33.9	34

Year

Average Monthly Precipitation (rain)

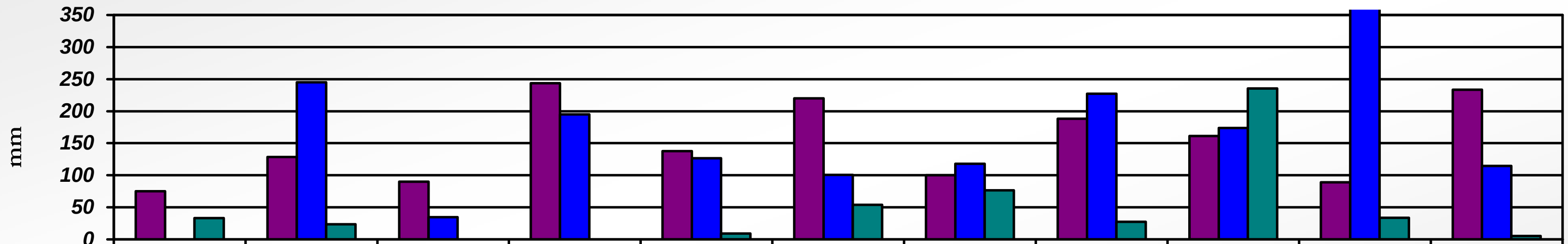


	1994	95	96	97	98	99	2000	2001	2002	2003
Jun	113.6	46.5	29.7	91.5	47.5	M	82.5	61.3	30	22.8
Jul	20.6	59.5	27.4	48.1	52.2	M	74	76.4	19.2	30.3
Aug	33.5	96.5	17	53.5	4	M	19.2	133.5	13	6.8

Year

APPENDIX E – CLIMATE DATA
SECHELT INDIAN GOVERNMENT DISTRICT

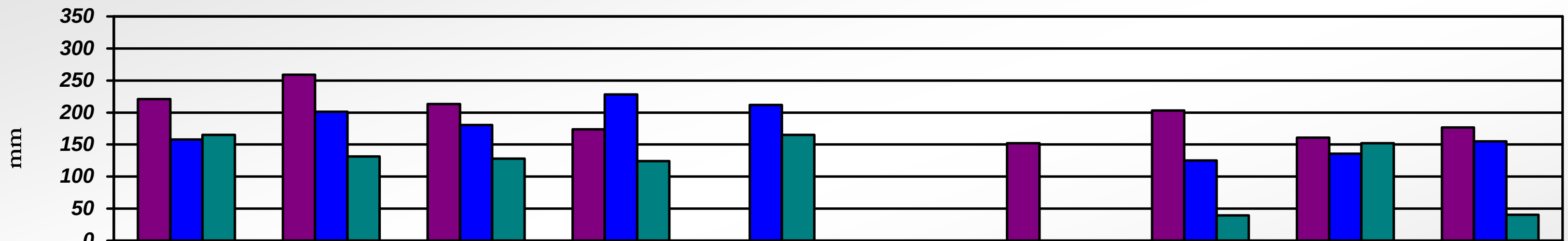
Average Monthly Precipitation (rain)



	1983	84	85	86	87	88	89	90	91	92	93
Dec	75.3	128.6	90	243.8	137.9	220	99.9	188.1	161.3	89.2	233.3
Jan	M	245.2	34.6	194.9	126.7	100.8	117.9	227.1	173.6	379.2	114.5
Feb	33.1	23.8	M	T	9.3	54	76.5	27.4	235.2	33.9	5.5

Year

Average Monthly Precipitation (rain)

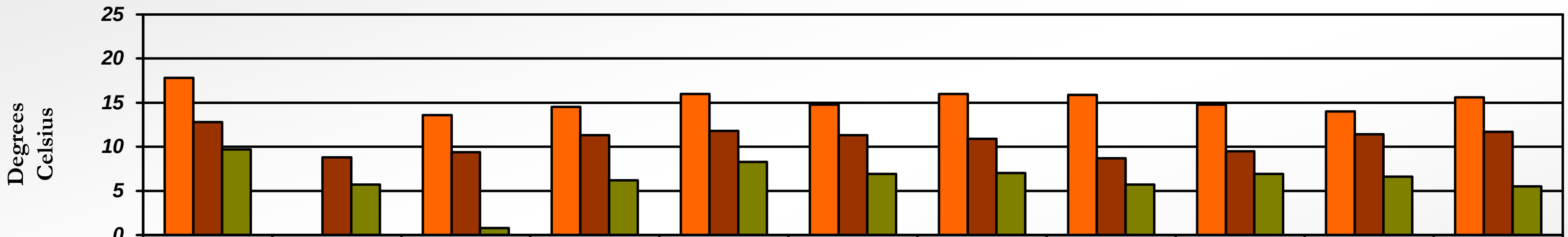


	94	95	96	97	98	99	2000	2001	2002	2003
Dec	221.1	258.8	213.4	173.9	M	M	152.2	203.1	161	176.6
Jan	158.1	201.2	180.7	228	212	M	M	125.3	136	155
Feb	165	131.3	127.9	124.3	165	M	M	39.4	152	40.3

Year

APPENDIX E – CLIMATE DATA
SECHELT INDIAN GOVERNMENT DISTRICT

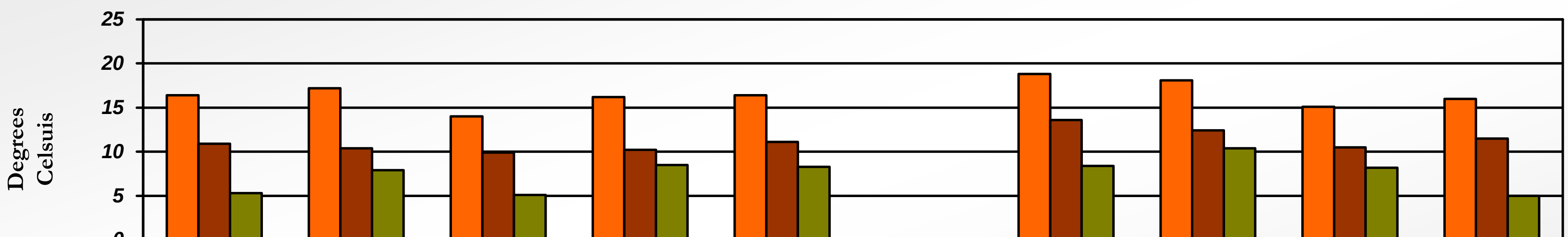
Average Monthly Temperature



	1983	84	85	86	87	88	89	90	91	92	93
Sep	17.8	M	13.6	14.5	16	14.8	16	15.9	14.8	14	15.6
Oct	12.8	8.8	9.4	11.3	11.8	11.3	10.9	8.7	9.5	11.4	11.7
Nov	9.7	5.7	0.8	6.2	8.3	6.9	7	5.7	6.9	6.6	5.5

Year

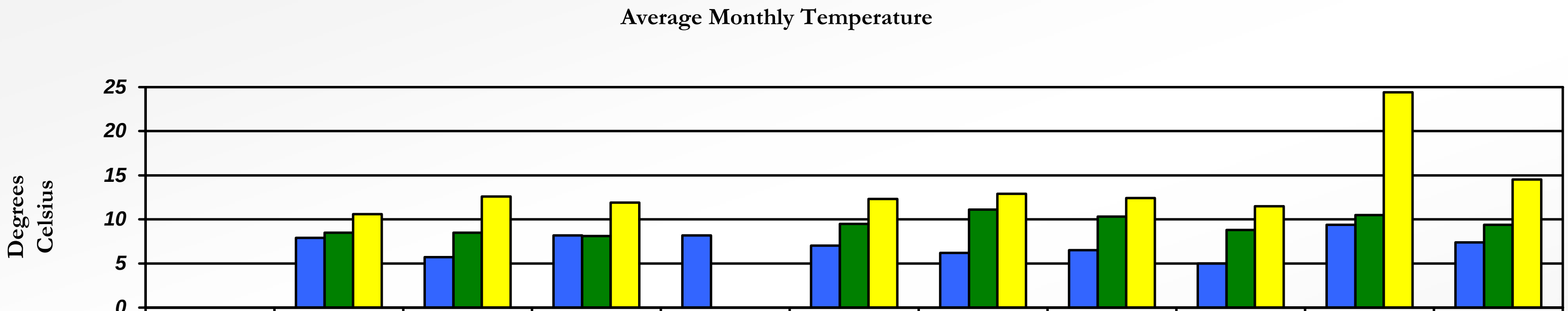
Average Monthly Temperature



	1994	95	96	97	98	99	2000	2001	2002	2003
Sep	16.4	17.2	14	16.2	16.4	M	18.8	18.1	15.1	16
Oct	10.9	10.4	9.9	10.2	11.1	M	13.6	12.4	10.5	11.5
Nov	5.3	7.9	5.1	8.5	8.3	M	8.4	10.4	8.2	5

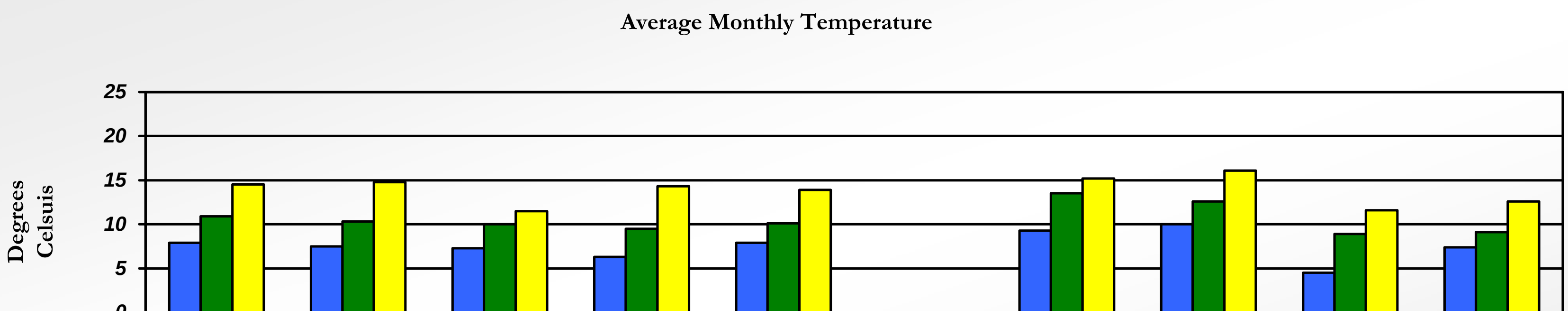
Year

APPENDIX E – CLIMATE DATA
SECHELT INDIAN GOVERNMENT DISTRICT



	1983	84	85	86	87	88	89	90	91	92	93
Mar	M	7.9	5.7	8.2	8.2	7	6.2	6.5	5	9.4	7.4
Apr	M	8.5	8.5	8.1	M	9.5	11.1	10.3	8.8	10.5	9.4
May	M	10.6	12.6	11.9	M	12.3	12.9	12.4	11.5	24.4	14.5

Year

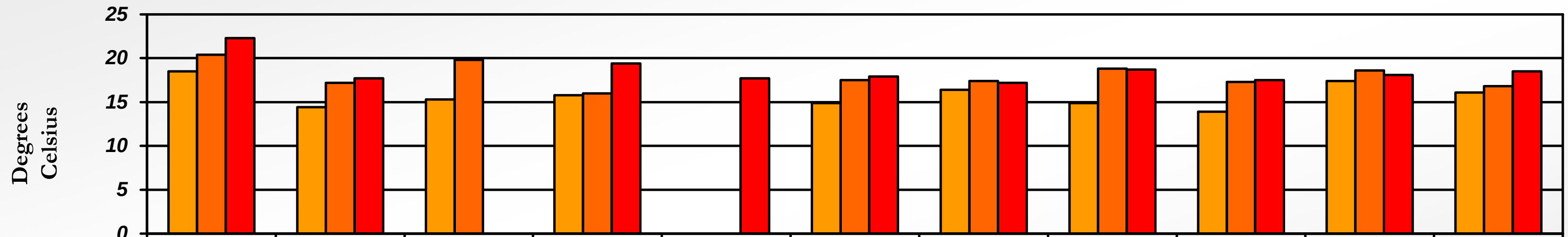


	1994	95	96	97	98	99	2000	2001	2002	2003
Mar	7.9	7.5	7.3	6.3	7.9	M	9.3	10	4.5	7.4
Apr	10.9	10.3	10	9.5	10.1	M	13.5	12.6	8.9	9.1
May	14.5	14.8	11.5	14.3	13.9	M	15.2	16.1	11.6	12.6

Year

APPENDIX E – CLIMATE DATA
SECHELT INDIAN GOVERNMENT DISTRICT

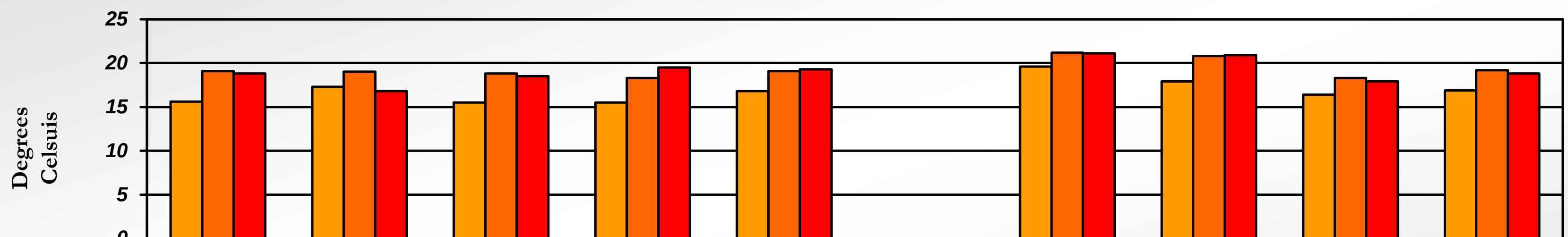
Average Monthly Temperature



	1983	84	85	86	87	88	89	90	91	92	93
Jun	18.5	14.4	15.3	15.8	M	14.9	16.4	14.9	13.9	17.4	16.1
Jul	20.4	17.2	19.8	16	M	17.5	17.4	18.8	17.3	18.6	16.8
Aug	22.3	17.7	M	19.4	17.7	17.9	17.2	18.7	17.5	18.1	18.5

Year

Average Monthly Temperature

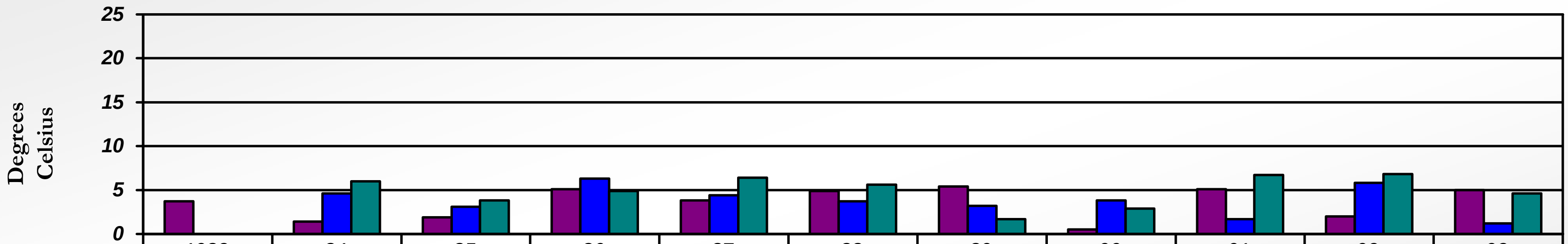


	1994	95	96	97	98	99	2000	2001	2002	2003
Jun	15.6	17.3	15.5	15.5	16.8	M	19.6	17.9	16.4	16.9
Jul	19.1	19	18.8	18.3	19.1	M	21.2	20.8	18.3	19.2
Aug	18.8	16.8	18.5	19.5	19.3	M	21.1	20.9	17.9	18.8

Year

APPENDIX E – CLIMATE DATA
SECHELT INDIAN GOVERNMENT DISTRICT

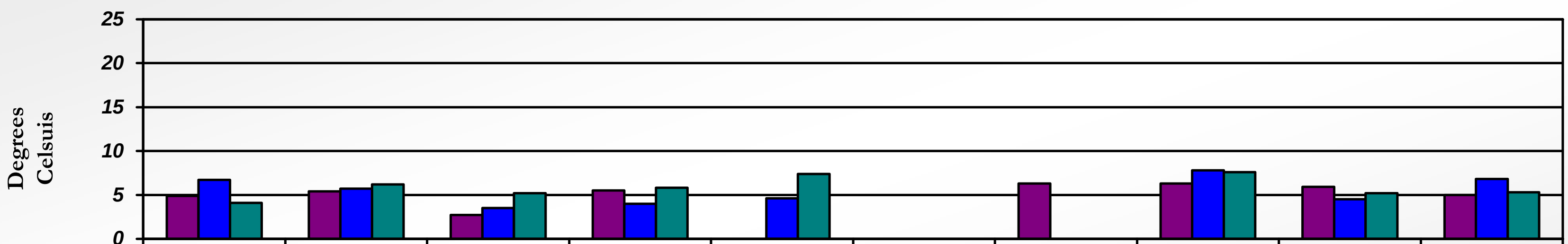
Average Monthly Temperature



	1983	84	85	86	87	88	89	90	91	92	93
Dec	3.7	1.4	1.9	5.1	3.8	4.9	5.4	0.5	5.1	2	5
Jan	M	4.6	3.1	6.3	4.4	3.7	3.2	3.8	1.7	5.8	1.2
Feb	M	6	3.8	4.9	6.4	5.6	1.7	2.9	6.7	6.8	4.6

Year

Average Monthly Temperature



	1994	95	96	97	98	99	2000	2001	2002	2003
Dec	4.9	5.4	2.7	5.5	M	M	6.3	6.3	5.9	5
Jan	6.7	5.7	3.5	4	4.6	M	M	7.8	4.5	6.8
Feb	4.1	6.2	5.2	5.8	7.4	M	M	7.6	5.2	5.3

Year

APPENDIX F – GPS Coordinates for Critical Infrastructure in the SIGD

Name	Coordinate
St. Mary's Hospital	123° 44' 56" W 49° 28' 31" N
Communication Tower (Monkey Tree Ln.)	123° 44' 11" W 49° 28' 8" N