



Community Risk Assessment

Hazards, Vulnerabilities and Risks of Major Emergencies

District of Oak Bay

2024

Prepared by the
District of Oak Bay Emergency Management Program

in partnership with
Smart Risk Control, Inc.



The District of Oak Bay acknowledges that the land on which we gather is the traditional territory of the Coast and Straits Salish Peoples. Specifically, we recognize the Lekwungen peoples known today as the Songhees and Esquimalt Nations, and that their historic connections to these lands continue to this day.

Limitation of Liability – This report presents information available at the time of production and may contain errors or omissions. Users of this information are cautioned of the limitations of this study and assume full responsibility for its application.

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EXECUTIVE SUMMARY

Purpose – The Community Risk Assessment outlines the hazards of primary concern within the District of Oak Bay and highlights areas of vulnerability as of 2024. This comprehensive assessment guides the development of risk reduction policies and actions for hazard mitigation, emergency response, municipal business continuity, and disaster recovery.

Vulnerable Elements – The risk assessment identifies key points of vulnerability in the community, social and built elements that are likely to suffer impacts of greater magnitude or severity from various hazards. These include:

- The District is home to approximately 18,000 residents, including 6,150 (34%) over the age of 65 years. Seniors are the fastest growing demographic in Oak Bay. These individuals tend to be at greater risk of physical harm during severe weather events and other types of disaster, due to mobility limitations and/or living alone or in greater isolation.
- In 2016, about 1,400 households (19%) spent 30% or more of their income on shelter costs. Residents living below the affordability standard included 745 renters and 650 owners. Economic disparity affects the ability of residents to prepare for and recover from disaster.
- Of the 7,810 private households in Oak Bay, about 32% of residents live alone, amounting to 2,435 single occupant households. These individuals may require assistance in preparing for emergencies and during response, especially in evacuations.
- The entire community relies on the continuous delivery of utility services by the District, through the Capital Regional District, and by various commercial service providers. Prolonged failure of electrical power and water delivery services could lead to widespread serious impacts. Vulnerable underground infrastructure as well as District owned and operated facilities require upgrades to sustain impacts from a variety of events, such as earthquakes. These upgrades will help protect life safety, as well as ensure the continuity of utilities.

Hazards – The District of Oak Bay has experienced few major emergencies in past decades. The risk assessment identified 11 reasonably foreseeable hazard types that warrant action due to the combination of probability of occurrence and expected consequences. The relative risks are:

Highest Risk	Atmospheric Hazards, Human Disease, Utility Failure
Moderate Risk	Earthquake, Flooding/Storm Surge, Tsunami, Wildland-Urban Interface Fire
Lowest Risk	Hazardous Materials, Major Urban Fire, Mass Casualty Incidents, Structure Collapse

Conclusions – Oak Bay residents and businesses face the greatest risk from atmospheric hazards, such as extreme heat, cold spells, windstorms, rainstorms, and drought incidents that are increasing in frequency and severity due to climate change. The current COVID-19 pandemic continues to threaten residents and presents the potential for future variants, and other diseases are increasingly likely. The Community Risk Assessment identifies 45 actions for consideration in four categories: 1) Hazard mitigation, 2) Emergency response, 3) Municipal business continuity, and 4) Disaster recovery.

COMMUNITY RISK ASSESSMENT

Hazards, Vulnerabilities, and Risks
of Major Emergencies in the District of Oak Bay

2024

1.0 INTRODUCTION

The District of Oak Bay has a unique hazard landscape, and although rare, the potential for major emergencies that could result in damage and injury are present. Examples of these hazards include severe rainfall, extreme heat events, human diseases, and earthquakes, any of which could impact residents, businesses, and institutions.

To better manage these emergencies, this Community Risk Assessment identifies the types of harmful events that may occur, how likely they are, and their potential consequences. Understanding these risks is essential for District leaders and staff to determine actions in hazard mitigation, emergency response, municipal business continuity, and disaster recovery.

In addition, risk information helps residents, business owners, and other community members take appropriate steps to protect themselves from harm. In October 2018, BC became the first Canadian province to adopt the United Nations "Sendai Framework," a collective process that helps build resilience at individual and community levels.

The Sendai Framework highlights the need for "disaster risk management" at the municipal level by promoting increased risk awareness among those who may be affected and can act to better safeguard themselves.

The 2024 Community Risk Assessment includes input from many sources and knowledgeable persons. Municipal staff in the Fire, Police, Engineering Services, Public Works, Corporate Services, and Planning departments supplied essential information on multiple hazards and vulnerabilities within the community. Several external organizations, including the University of Victoria, BC Hydro, and the Capital Regional District supplied relevant supporting facts.

A complete list of references may be found at the back of this report.

For some hazards, such as earthquakes or climate change, it is not feasible to directly prevent incidents and their impacts. The Risk Assessment focuses on recommendations that increase resilience in areas of vulnerability.

Legal Requirement to Assess Risks

British Columbia's *Emergency and Disaster Management Act* requires the District of Oak Bay to assess the extent of risks for reasonably foreseeable hazards, including those associated with climate change.

The risk review for each hazard considers:

- The likelihood, frequency, or probability of occurrence
- The potential consequences of each hazard incident, such as impacts on individuals, animals, or places, including objects or sites of cultural and/or heritage value.

1.1 Municipal Operations

The District of Oak Bay consists of a Mayor and six Councillors, each elected to a 4-year term. Oak Bay currently relies on 229 full-time-equivalent employees serving in the following departments:

- Administration
- Community Building and Planning
- Corporate Services
- Engineering and Public Works
- Financial Services
- Fire
- Parks, Recreation and Culture
- Police

Under BC's *Emergency and Disaster Management Act*, District Council is responsible for the direction and control of the local authority's emergency response. However, Council can delegate its responsibilities to the local emergency management organization, which may include all District personnel.

Implications of Municipal Operations

Council is responsible for all aspects of emergency management and maintaining an emergency management plan.

Mitigation: Provide GIS maps to enhance risk understanding. Prepare a municipal Hazard Mitigation Program.

Emergency Response: Inform public and businesses about risks to promote preparedness (web content, etc.). Hold evacuation training and practice sessions in ICS for operational departments, e.g., Police, Fire, Public Works. Provide adequate supply of physical maps to support evacuations. **Business Continuity:** Update the municipal Business Continuity Plan. Inform all municipal staff on hazards and promote preparedness at home.

Recovery: Prepare a Disaster Recovery Plan to include municipal and community recovery.

1.2 The Community

The District of Oak Bay is located on the Southern tip of Vancouver Island. The District name derives from the Garry Oak tree, found throughout the area. As shown in Figure 1, the District is bordered by the District of Saanich to the north, the City of Victoria to the west, the Strait of Juan de Fuca to the south, and Haro Strait and the Salish Sea on the east.

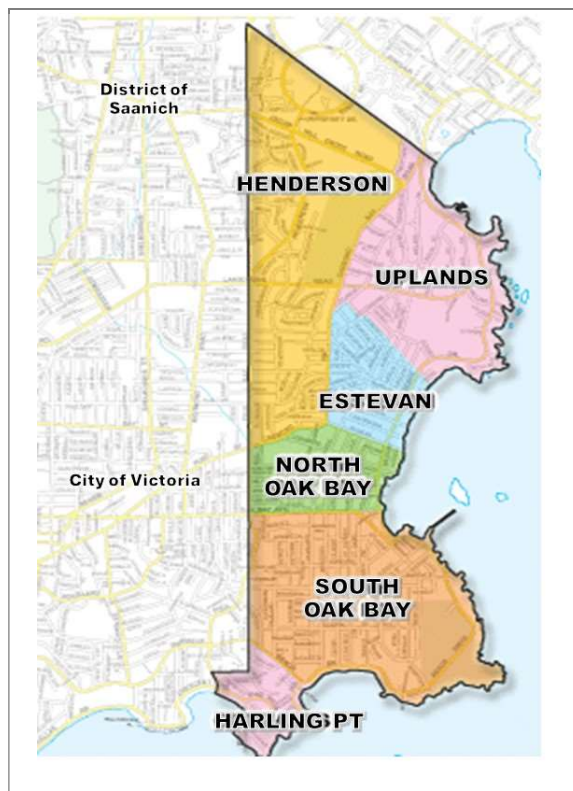


Figure 1. Location of Oak Bay

The University of Victoria campus is also situated to the north, with shared service delivery agreements between Saanich and Oak Bay.

History

Oak Bay is situated on the traditional land of the Lekwungen-speaking people, who occupied the area since time immemorial before colonization.

European explorers arrived in the late 1700's, and Fort Victoria was established in 1843. Most of the land that currently makes up Oak Bay was owned by the Hudson's Bay Company and several family farms. The District was officially incorporated in 1906.

Setting

Oak Bay's attractive setting provides both a home for residents and a destination for boaters and travelers. The natural environment includes ocean shoreline, creeks, and Garry Oak ecosystems, as well as ample beaches for walking, three golf courses, and two marinas. Commercial areas centre around Oak Bay Avenue and Estevan Village, with ready access to shops, institutions, schools and parks.

First Nations

The District of Oak Bay includes traditional territories of the L'kwungen peoples, including the Songhees, Esquimalt, Pauquachin, Tsawout, Tsartlip, and Tseycum Nations. There are no reserves or treaty lands. Consultation with the Nations confirms the presence of cultural places within the District, including monuments that reference pre-colonial use of the land.

Culturally significant locations include:

- Loon Bay (Sungayka)
- Willows Beach (Sitchanaith)
- Bowker Creek (Thaywun)
- Turkey Head (Spewhung)
- Anderson Hill Park (The Guardian)
- McNeill Bay (Chikawich)
- Trafalgar Park Lookout
- Harling Point (Sahsima)

The District is committed to ongoing consultation and cooperation with Songhees and Esquimalt Nations in managing risks from emergencies to promote cultural safety.



Spewhung Monument

Implications of History, Setting and First Nations

Oak Bay has experienced very few major emergencies since incorporation, signalling the relative safety of the landscape and community. However, threats are likely to increase due to a changing climate and aging infrastructure.

Emergency Response: Engage and develop relationships with First Nation partners regionally, as required by the EDM Act.

Geography

The District of Oak includes 10.5 square kilometres of terrain. The eastern and southern seashores provide access to beaches and views of Haro Strait, the Southern Gulf Islands, San Juan Islands, and Washington State. The District includes more than 8 kilometres of waterfront.

The District of Oak Bay, like the rest of the Capital Region, is situated in one of the most active seismic zones in North America. Earthquake threats include the Cascadia Subduction Zone off the west coast of Vancouver Island, and shallower earthquakes near Georgia Strait and Puget Sound.

Some coastal and low elevation areas are subject to localized flooding during heavy rainfall events, as well as risk of tsunami inundation, such as McNeill Bay to Turkey Head. The coast is subject to king tides that, when combined with storm conditions, can lead to foreshore flooding and increased erosion.

The District includes nine key biodiversity and environmentally sensitive areas:

- Anderson Hill Park
- Bowker Creek
- Harling Point
- Hobbs Creek
- Kohweechela / Mary Tod Island
- Trafalgar Park
- Trial Island (managed Federally)
- Uplands Park – Cattle Point



Trafalgar Park

Implications of Geography

Earthquakes of moderate to large magnitude rank among the hazards of greatest concern for the community. The extensive shoreline and the relative low elevation in some areas, expose infrastructure to damage from storm surge and tsunamis.

1.3 Climate

Throughout history, Oak Bay has been relatively shielded from much of the severe weather that frequently impacts other regions of BC. These conditions include extreme temperature fluctuations, heavy precipitation, and wildfires.

However, Oak Bay has encountered hurricane-force winds, substantial snowfalls, intense rainfall, droughts, and extreme heat emergencies. Due to the rarity of such occurrences, many residents may not be prepared for climate threats.

Weather

Oak Bay experiences mild to moderate climatic conditions, with relatively wet winters and dry summers. Extreme temperatures recorded at nearby Victoria International Airport include a low of -15°C on January 28, 1950, and a high of 39.4°C on June 28, 2021.

The weather on southern Vancouver Island reflects the *El Nino* phenomenon that occurs every 2 to 7 years. Warm ocean currents generate rising air that brings warmer and drier winters in BC. *La Nina*, the opposite phase, results in colder and wetter winters.

District of Oak Bay

Snowfall events of more than 50 cm in a single day are rare but have occurred. Notably, one December day in 1996 Greater Victoria weather stations recorded 64.5 cm of snow. The largest recorded snowfall in the region occurred in 1887 at 91 cm.

Winds predominantly blow from the west, channelling through the Juan de Fuca Strait. During the summer, outflow winds from the northern BC mountains via fjords and valleys can be hot, dry and strong, increasing the risk of wildfire spread on Vancouver Island.

Figure 2 highlights the range in average precipitation over the course of the year, with heavy rainfall events usually in November, December, and January.

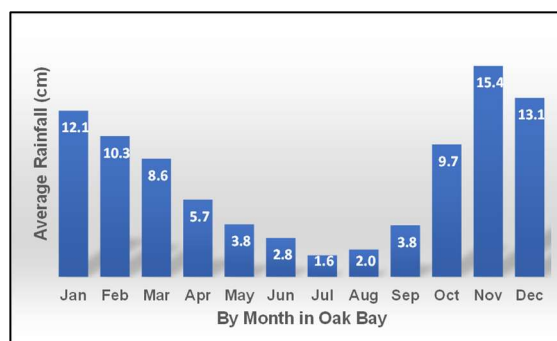


Figure 2. Avg. Annual Rainfall by Month

Climate Action and Emergency Management

Local impacts of climate change have so far been relatively modest. However, significant large-scale impacts are expected in the form of increased precipitation, higher temperatures, rising sea levels, and increased extreme weather events, with more weather variability.

This Community Risk Assessment acknowledges the importance of climate action in tandem with emergency management to reduce risks in Oak Bay and increase resilience.

Oak Bay has partnered with the University of BC's Coolkit program, which is designed to engage and mobilize residents on climate-change solutions in the community, including neighbourhood conversations and actions to advance household sustainability.

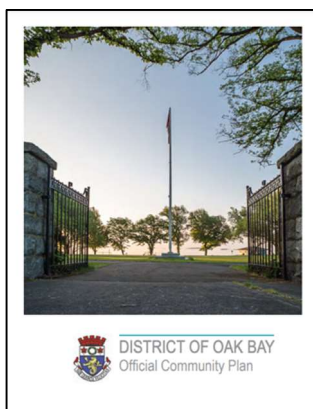
The changing climate raises the likelihood of some emergencies, largely represented in the second part of this document under the headings of Atmospheric Hazards, Flooding / Storm Surge, and Wildland-Urban Interface Fire. Climate emergencies may compound the risks, such as when severe drought weakens trees that are then subject to windstorms and wildfire.

While Oak Bay's Official Community Plan notes the long-term conditions and effects of ongoing greenhouse gas emissions, and strategies to address them, the Oak Bay Emergency Program addresses the more immediate consequences of climate-induced loss events.

Climate change could have far-reaching and/or unpredictable environmental, social, and economic consequences, which may lead to impacts such as supply chain disruptions; price

increases for food, fuel, home insurance, building materials, and appliances; an increase in long term health impacts on vulnerable individuals; disruption of long-term hydro power capability; and the arrival of domestic and international climate refugees.

As with other emergencies, like earthquakes and structure fires, many climate-related hazard



impacts can be reduced through targeted action beforehand. These actions include the hazard mitigation and adaptation options outlined in both the OCP and this *Community Risk Assessment*.

Implications of Climate Change

The expected climate future may mean increases in the frequency and severity of several hazards for the District of Oak Bay, including events that could require the activation of an Emergency Operations Centre, such as the following examples:



Intense rainfall events (e.g., atmospheric river), leading to localized flooding and evacuation, as well as damage to roads and other infrastructure, parks, and surface water contamination.



Drought periods, with water shortages, potential business closures, food insecurity, tree mortality, and an increase in wildfire risk.



Extreme heat events (e.g., heat dome), including the potential for illness, such as heat exhaustion, and death.



Extreme cold events (e.g., polar vortex), causing heavy snow and blizzard conditions, road closures, power outages, and frozen water pipes.



Severe winds (e.g., typhoon), leading to downed trees, structure damage, prolonged power outage, storm surge, and damage to marinas and boats.



Wildfire smoke due to increased frequency of wildfires in other communities, resulting in health impacts on vulnerable persons.



Human diseases, pests, and parasites in increased frequency as the local climate changes.



Sea level rise, leading to increased shoreline erosion, foreshore landslides, saltwater intrusion, and increased flooding of low-lying areas due to storm surge and tsunami.

1.4 Demographics

Population

In 2021, Oak Bay's population numbered 17,990 residents, a drop of 0.6 percent since 2016. This is significantly lower than the increase within the province for the same period at 7.6 percent.

Figure 3 summarizes community residents who may be vulnerable to major emergencies due to age, income level, or household composition. These persons may need specialized assistance in preparing for emergencies and require additional attention when threats materialize.

Figure 3. Oak Bay Vulnerable Populations

Demographic Category	Number
Total Population	17,990
Seniors age 75+	3,745
Households with children	1,785
Individual Income < \$30k	4,950
Age 65+ below poverty line	460
One-person households	2,435

Income Levels – Statistics Canada counted 4,950 individuals with a 2021 after-tax income under \$30,000, accounting for about 28 percent of all Oak Bay residents. As of 2020, there were 460 seniors of age 65 years or older below the poverty line (low-income measure, after tax).

Household Composition – Living in isolation also contributes to risk in major emergencies. Among the 17,990 residents in Oak Bay, about 14 percent live alone. As of 2021, that amounts to about 2,435 single occupancy households in the community, many of whom are elderly. Single-parent families, accounting for 550 households in the District, are also more vulnerable during emergencies.

Age Groups – The age distribution of Oak Bay residents, shown in Figure 4, draws attention to a highly vulnerable group within the community.

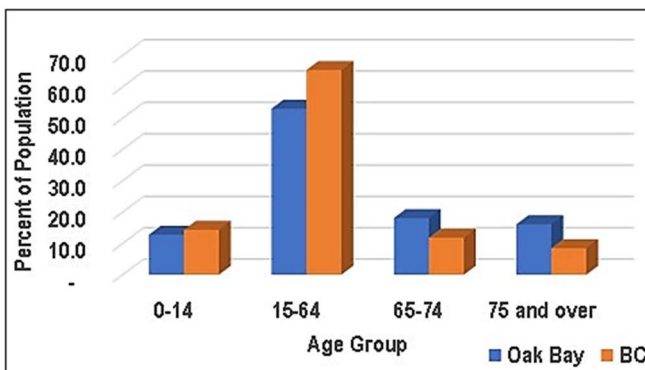


Figure 4. Age Distribution in Oak Bay, 2021

The 2021 federal census notes 6,150 residents of age 65 or older, accounting for 34 percent of the population, as compared with the provincial proportion of about 20 percent. This group includes nearly 4,000 seniors aged 75 or older. Older residents tend to be more vulnerable to severe heat, utility outages, and other disasters.

Language – Nearly all residents report at least a working knowledge of English, with 255 residents identifying as speaking only French, and 95 individuals reported no knowledge of English or French. Others may be present during an emergency, such as international tourists, students, or boaters.

Vulnerability increases for people within several risk categories. Low-income households may include children or consist of seniors living alone.

Implications of Demographics

BC's Min. of Emergency Management & Climate Resilience (EMCR) identifies several factors that influence individual vulnerability in disasters. Aspects include age, mobility, income, ethnicity, language, and dependence on others. Oak Bay expects residents to play a major role in their own protection. **Emergency Response:** Explore collaboration with local and regional service organizations with capacity to assist the disadvantaged. Advance neighbour-helping-neighbour programs in the District and promote self-reliance.

Land Use / Neighbourhoods

Buildings constructed in Oak Bay before 1950 are likely to suffer greater structural damage in an earthquake. There has been little new construction in Oak Bay since the 1970's. Municipal buildings (e.g., Municipal Hall, Fire and Police buildings, Public Works building, and recreation centres) have not been seismically upgraded. Critical district-owned buildings are vulnerable and at risk of significant damage in a major earthquake.

Local dwellings include about 2,145 apartments, mostly in buildings that have fewer than five storeys. In 2021, Oak Bay added more than 410 apartment units in buildings of five or more storeys. Even a moderate earthquake would likely render many dwellings uninhabitable until repaired.



Multi-Storey Apartment Building in Oak Bay

Implications of Land Use / Neighbourhoods

Some neighbourhoods have limited routes they can use for evacuation by vehicle. Preparedness can take advantage of the many pre-existing neighbourhood groups, to help facilitate conversations about preparedness and supporting neighbours in emergencies.

Special Occupancies

Special occupancies include buildings where there may be a high density of persons at the time of an emergency. Institutions that serve the aged and disabled in Oak Bay include several care homes, as listed in Figure 5.

Figure 5. Care Homes in Oak Bay

Name	Max # Occupants
Shannon Oaks	117
Carlton House	88
Marrion Village	52
Elgin Gardens	43

The sudden release of a toxic chemical within or near a high-density occupancy would require immediate measures to safeguard individuals. High density occupancies typically allow ready transmission of respiratory diseases, such as influenza and COVID, without precautions.

Due to rising housing costs, an increasing number of people are living in their cars or on boats, including the Cattle Point parking lot and the anchorages near Oak Bay Marina and Willows Beach.

The consequences of emergencies at special occupancies tend to be more extreme than at other locations. For example, care homes often demand more time to alert and evacuate residents due to diverse ages and capabilities. In an emergency that affects the entire building, such as an earthquake or structure collapse, special occupancy facilities have an increased potential to become sites of mass casualty.

Implications of Special Occupancies

Managers of care homes are responsible for preparing emergency plans that protect occupants. Other regional service organizations can provide immediate services to those in need. **Emergency Response:** Inform special occupancies about response actions during extreme heat, prolonged power outage, water supply interruption, and earthquake.

Special Events

The District promotes and supports dozens of special events each year to enliven the community and encourage economic activity.

Many of these events call for full or partial closure of a public road.

As shown in Figure 6, most special events take place in the summer months, with many reoccurring avenue markets in the summer. Some notable large events are scheduled throughout the fall and winter, including Trick-or-Treat on the Avenue, the Royal Victoria Marathon, and the Christmas Festival Light up.

Figure 6. High Attendance Special Events in Oak Bay

Month	Event	Typical Attendance
May	Oak Bay Half Marathon	2,000
June - Sept	Summer Markets	2,000
June	Oak Bay Tea Party	10,000
Jul	Collector Car Festival	10,000
Jul	Garagellenium	-
Aug	Bowker Creek Brush Up	2,000
Oct	Royal Victoria Marathon	-
Oct	Trick-or-Treat on the Avenue	5,000
Nov	Christmas Festival Light Up	2,000

Disasters in other North American cities highlight the potential for a major emergency at an Oak Bay special event. Any gathering of hundreds or thousands of visitors can lead to concerns for personal injury.



Collector Car Festival in Oak Bay

Hazards unique to special events include fire in a tent, vehicle impact on pedestrians or cyclists, explosion of propane-fired equipment, crushing due to overcrowding or panic, parade float

accident, firearms or bomb threat, and exposure to transmissible human disease.

Oak Bay Police are exploring options for better crowd safety during Oak Bay Avenue events such as fixed blocks in place on either end of the avenue when it is closed to pedestrians, or strategically placing parked cars. Police have identified UVic, Camosun College, municipal hall, banks, and Oak Bay High School as the highest risk locations of an act of violence.

Police have also noted an increase in calls related to mental health and substance abuse in the community, as well as a rising trend in gang recruitment efforts. In the event of a large-scale protest, the Greater Victoria Public Safety Unit has 40 officers available to assist Oak Bay Police.

Implications of Special Events

Special events that draw thousands of people to outdoor, unsheltered areas presents unique challenges in emergency management. Although loss incidents are highly unlikely, it is prudent to expect the types of impacts that have occurred elsewhere, and to take reasonable steps in hazard mitigation and emergency response. **Mitigation:** Adopt a risk management approach and municipal program for special events, including coordinated safety reviews by Police and Fire Departments.

In addition to these hazards, the presence of large event crowds would complicate the District's response to a major emergency, such as a major structure fire, a sudden wind or hailstorm event, or an earthquake. Tourists may not know where to go for information or assistance.

1.5 Infrastructure

Electrical Power Systems

Oak Bay relies on electrical power provided by the BC Hydro and Power Authority. Commercial businesses and industries count on a consistent level of service, as do schools, health care

facilities, and other institutions. Many residents rely on BC Hydro for essential needs, such as heating, cooling, refrigeration, cooking, communications, and home medical equipment.

BC Hydro supplies electricity to Vancouver Island from the Peace River hydroelectric system and the Columbia River facilities, as well as through six generating systems on Vancouver Island. Oak Bay receives electrical power via three routes, as outlined in Figure 7.

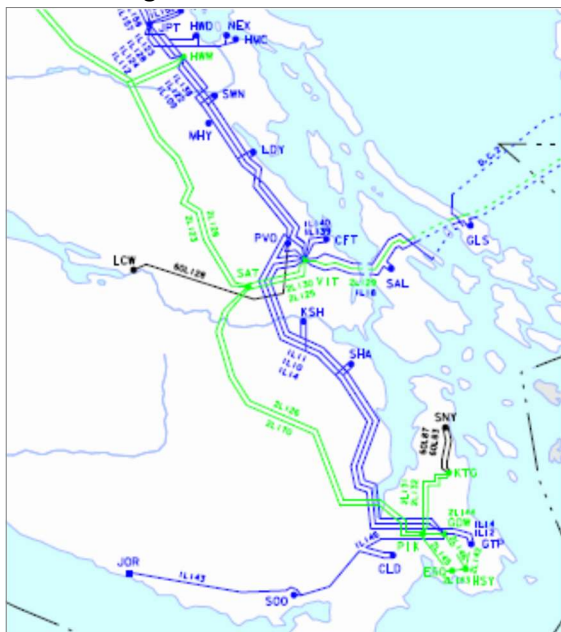


Figure 7. BC Hydro Routes to Oak Bay
Image: BC Hydro

Two 138-kV AC circuits and two high-voltage direct current circuits deliver electrical power to Vancouver Island using submarine cables from Tsawwassen to Galiano Island and Salt Spring Island, then to a substation near Duncan. BC Hydro then transmits power overland to Oak Bay customers.

A northern route connects two 500-kV alternating current circuits south of Powell River to a terminus found north of Qualicum Beach on Vancouver Island. If the southern route were disrupted, local customers of BC Hydro could receive power via this northern route. BC Hydro's Bay Street Substation serves the District of Oak Bay.

Power may also arrive via the Jordan River generation system, which supports the District of Oak Bay

Vancouver Island grid during peak-use times or when there are outages. Using a single turbine powerhouse built in 1971, the Jordan River facility is capable of 170 Megawatts, if needed. The Jordan River Dam faces significant risk of failure in a large subduction earthquake.

Implications of Electrical Power Systems

A prolonged loss of power could threaten the lives of residents, particularly during extreme heat and cold. Some people rely on electrically powered medical equipment, such as for oxygen therapy. While weather events pose the primary threat to sustained electrical power delivery, interruption events are likely to last a matter of days at most.

Although long-term power disruption is possible, it would require multiple simultaneous failures in BC Hydro facilities serving Vancouver Island. A major earthquake, severe weather event, or regional wildfire could trigger such failures.

Water Systems

Oak Bay residents, businesses, and institutions rely on a steady supply of potable water from the Capital Regional District (CRD). This service extracts water from the Sooke Lake Reservoir as the primary source. This reservoir can supply about 93 million cubic metres of water, with more available from the adjacent Goldstream and Leech Water Supply Areas. The CRD increased the reservoir 15 years ago, and there is further expansion capacity if needed.

Water from the Sooke Reservoir flows via the Kapoor Tunnel to the Goldstream Water Treatment Plant, where the water is disinfected to eliminate pathogens such as bacteria, viruses and parasites. All CRD critical water facilities are supported by backup generators in case of power outage. CRD staff monitor water quality to ensure it complies with BC provincial regulations and federal guidelines.

Most of the CRD large water transmission mains are made of either steel pipes with welded joints, or ductile iron or polyvinyl chloride, the most seismically resilient materials available. The transmission system includes six major pumping stations. The CRD is assembling critical parts and repair equipment, such as couplings and valves, to return the large transmission mains to service in the event of damage.

Water then flows from the Goldstream Water Treatment Plant to the Supply Main No. 3. From there water is distributed to the entire community via four pump stations within Oak Bay. Refer to Figure 8 for an overview of the CRD water supply to Oak Bay.

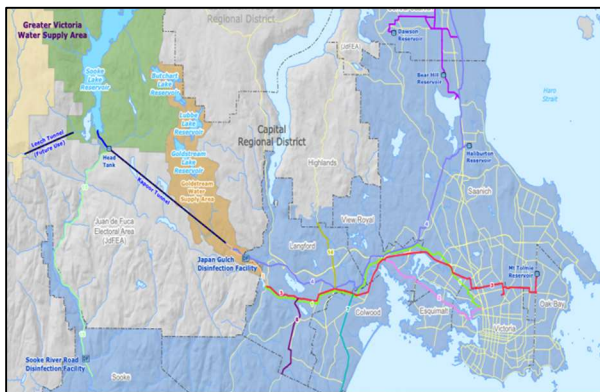


Figure 8. CRD Water Supply to Oak Bay

Currently, the Supply Main No. 3 is the only CRD water connection point for Oak Bay. The District is currently considering the addition of a 12-inch emergency tie-in with City of Victoria, as well as with Saanich, as back-up water suppliers to the community in the event of an emergency.

Nearly half of Oak Bay's water mains are at risk of failure and require replacement. Of the 115 kilometers of pressurized water mains, approximately 14% are more than 100 years old, and 17% are made from vulnerable asbestos cement and are beyond their lifespan. An additional 16% of water mains are undersized and unable to meet today's fire suppression needs.

The District is systematically replacing selected water mains to improve water flows for fire suppression and to reduce susceptibility to damage in an earthquake. However, it will likely require decades to upgrade the entire system.

Water line replacement initiatives (such as a 1.2-km project from Lansdown Road at Foul Bay Road to Cadboro Bay Road) will line water mains with a protective sleeve to make them more seismically sound.

There are few private wells in Oak Bay, and no operational ones in use by the municipality. Virtually all residents receive their water from the CRD. Oak Bay should consider the use of municipal wells as a backup during droughts.

Implications of Water Systems

The community depends on potable water delivered via CRD and District systems. Any significant interruption of safe drinking water would have widespread impacts on public health, community services, and the local economy.

Several hazards threaten water systems. In addition to potential human error and terrorist action, a wildfire within the Sooke Lake watershed could introduce high volumes of ash, sediment, and/or contaminants that could challenge water treatment systems. A severe earthquake may damage CRD and/or municipal distribution systems.

In a water emergency, the CRD, as the water service provider, must have contingency plans to continue to supply water to their clients during emergencies. The District also requires response and contingency plans to receive, stage, and distribute resources and materials to meet water needs of the local population. **Mitigation:** Continue the long-term program to replace vulnerable water mains. Explore 12-inch emergency tie-ins with Victoria and Saanich water mains as an emergency water source. Research the potential for and costs of activating local well systems for use in water shortages.

Wastewater Systems

In 2020, the Capital Regional District began providing tertiary treatment for wastewater as a service to core area municipalities, including Oak Bay. The treatment facility is situated at McLoughlin Point and has been built to post-disaster standards, so that it will remain operational even following a major earthquake. The system is controlled and monitored 24/7.

The CRD currently conveys all sewage from the District to the Wastewater Treatment Plant through regional trunk mains and delivers solids to the Residuals Treatment Facility. The plant treats up to 108 megalitres of wastewater per day, providing capacity to accommodate future population growth.

Wastewater goes through primary, secondary and tertiary treatment and is then discharged into the ocean through a new outfall approximately 2 km from shore and 60 m deep.

As shown in Figure 9, conveyance of wastewater in Oak Bay takes place along Beach Drive, McNeil Avenue, and Bowker Creek. The District's portion of the wastewater system consists of 100 km of gravity mains, including 1.76 kms of pressurized mains and 8 pump stations. Based on modeling, age, material type and size, about 70 % of these municipal wastewater lines require replacement over time.

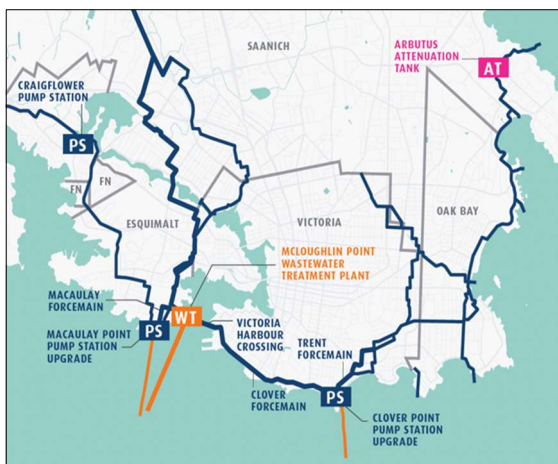


Figure 9. CRD Wastewater Treatment Conveyance Overview Map

The main pump station and marine outfall for Oak Bay is located at Clover Point in an area subject to storm surge and tsunامي. The CRD pump station has a fixed power generator. A single outfall to the marine environment allows for overflow discharge if needed.

Stormwater Systems

Stormwater drainage within the District relies on 140 km of mains. Oak Bay has 39 outfalls to deliver stormwater to the ocean. These outfalls could be damaged in a tsunami, storm surge, or by sea level rise associated with climate change.

Like Oak Bay's sewer system, the District's stormwater system has significant vulnerabilities. Typical of most municipalities in the area, approximately 80 percent of the system is made of vitrified clay piping that is subject to damage in an earthquake. PVC and cement piping is expected to perform better. Current best practices are to use PVC or to install a fiberglass liner in stormwater mains.

Issues persist with storm drain blockages, tree root invasion, and surface collapses. The Engineering & Public Works Department is developing a plan to address as many mains and services as possible each year throughout the District.

Implications of Wastewater and Stormwater Systems

The community relies on underground utilities for daily operation. Failure of the wastewater system, such as following a severe earthquake, could lead to significant environmental impacts, as well as high economic losses. Given the undersized and aging underground infrastructure in Oak Bay, in a large event, causing multiple points of failure is likely. Failure of the stormwater system could lead to localized flooding and significant service interruptions. **Mitigation:** Continue efforts to upgrade wastewater and stormwater main infrastructure.

Road Transportation

The District operates and maintains about 105 kilometres of streets, including the design and construction of roads, sidewalks, and traffic control measures.

The busiest arterial roads are Oak Bay Avenue, Foul Bay Road (maintained by Saanich), Cadboro Bay Road, Lansdowne Road, Cedar Hill Cross Road, north Henderson Road, and Beach Drive/King George Terrace. Key destinations in the area include Oak Bay's main retail area of Oak Bay Avenue, UVic, Oak Bay High School, Foul Bay Road, Estevan Village, and Cadboro Bay.

In addition to vehicles, District streets and sidewalks also enable pedestrians, cyclists, mobility-enhancement equipment, buses, and other modes of transportation.



Active Roadways in Oak Bay

Many Oak Bay residents depend on their vehicles for transportation to work. According to the 2021 Census, nearly 70 percent of District occupants rely on vehicles to access places of work, and 82 percent commute to another municipality for their work. However, some residents either do not drive or lack access to a vehicle that could assist with evacuation.

Most major roads can experience traffic congestion, especially in the summer. Traffic difficulties may arise in area evacuations, such as for a hazardous materials incident, tsunami warning, or wildfire evacuation.

Major east-west cycle commuting routes link Oak Bay to downtown Victoria, along Lansdowne Road, Oak Bay Avenue, Fort Street, and

McNeil/Richardson Street. Several arterial roads have been upgraded with bike lanes and bike route markers. The Municipality has identified the upgrade of municipal infrastructure to support active transportation modes as a strategic priority.

Street redesign intended to calm traffic that rely on choke points or roundabouts can negatively impact response times by impeding fire apparatus for both Oak Bay Fire and mutual aid partners. Additionally, neighborhoods with limited egress and routes hamper area evacuations and access of emergency vehicles.

Public transportation in Oak Bay is provided by the Victoria Regional Transit System, which serves all communities in the Greater Victoria area. BC Transit bus service includes 3 routes and about 20 bus stops connecting Oak Bay with Victoria and Saanich.

Transit currently focuses on connections between Oak Bay, the University of Victoria, and the City of Victoria and not on routes within the community.

Parks and Recreation have two 24-person buses and one 12-person van as assets for use in a variety of emergencies, including evacuations. There are about 10 potential drivers among District staff.

Oak Bay provides snow clearing and salting/sanding of icy roads when needed, based on an established priority for arterial and secondary roads before residential roads. Municipal snow removal equipment is limited.

Implications of Road Transportation

A major disaster, such as typhoon or earthquake, could impact the local road system and lead to a direct impact on the mobility of Oak Bay residents. Roadway clearing and emergency road repairs will be essential in aiding response to public safety needs, in protecting other critical infrastructure, and in enabling community recovery.

Marine Transportation

Oak Bay hosts two large marinas that include hundreds of pleasure boats, listed in Figure 10.

Figure 10. Marinas in Oak Bay

Name	Address	Max. Vessels
Oak Bay Marina	1327 Beach Drive	400
Royal Victoria Yacht Club	3475 Ripon Road	256

Vessel fires can be expected and have the potential to spread quickly to other boats, dock facilities, and fuel sources. Fires can impact people living onboard or in the vicinity.



Oak Bay Marina

Oak Bay Marina lacks a dedicated fire protection system, requiring crews to manually lay water supply line hose from an engine to a location where they can connect fire attack lines. This can significantly impact response time to getting water on a vessel or dock fire.

The Royal Victoria Yacht Club has a more robust level of fire protection. It includes a stand-pipe system that extends to the docks, providing water for crews to directly connect attack lines into in the event of a fire.

Implications of Marine Transportation

A major marine accident, such as a large fire or hazardous spill, could demand support actions by the Oak Bay Fire Department. All marinas are vulnerable to structure or vessel fire, severe winds, storm surge, and tsunami. Marinas will ultimately be affected by sea level rise.

Other Infrastructure

Oak Bay relies on external service providers that are considered “critical infrastructure.”

Telecommunication Systems – Telus, Shaw, Rogers and other communication operators provide residential and commercial telephone, cellular telephone, and high-speed Internet services in Oak Bay. In 2021, Telus installed a gigabit-enabled fibre optic network to increase wireless and Internet speeds in the region.

The District relies on internal support services for all Oak Bay departments, including a municipal network on which most District services depend. The integrated network consists of servers and terminals at Municipal Hall, a backup server at Fire/Police, and an offsite webserver. Backups of all network servers occur daily.

The Information Technology manager routinely maintains the hardware, upgrades the software, and trouble-shoots problems. The municipal information system is vulnerable to a wide range of threats, including:

- Data/systems failure
- Unavailability of critical IT personnel
- Security breaches (theft, vandalism, etc.)
- Virus/hacker/denial of service
- Power failure, air-conditioning failure
- Fire, flooding or structural failure

Because there are currently few redundancies in the District’s network, an interruption of IT services could impair other critical municipal services. These systems are vital in meeting the communication needs of residents, businesses, and institutions.

Natural Gas – FortisBC provides natural gas services to customers in Oak Bay by managing a gas trunk system, distribution services, gas service lines, and regular facilities.

In a natural gas emergency, such as a major gas leak or explosion, FortisBC’s responsibilities include providing information on the location of gas facilities, allocating gas detection equipment,

and mobilizing response teams on a 24/7 basis to manage gas emergencies. A long-term interruption in the flow of natural gas to the community would be a concern for those who rely on gas for cooking and heating under extremely low temperatures.

Solid Waste – Residents and businesses in Oak Bay are served by the Hartland Landfill, operated by Environmental Resource Management (ERM) under contract with the CRD.

The CRD handles solid waste disposal under British Columbia legislation and established the solid waste disposal service in 1973. In 2021, ERM disposed of 166,150 tonnes of waste at Hartland Landfill, 8.1 percent more than in 2020. The landfill is expected to reach its current design capacity in 2049.



Solid Waste Management in Oak Bay

The CRD is currently pursuing a Regional Disaster Debris Framework for managing solid waste generated by a major disaster in the Region, such as a severe wind event or an earthquake.

Implications of Other Infrastructure

The District business continuity planning considers the daily and large-scale risks of interruption of information services. Working with the CRD, Oak Bay intends to develop a local debris management plan that would identify sites for temporary waste handling facilities, estimating the volume, and identifying priority routes for clearing debris.

1.6 Community Services

Schools

A number of public and private schools are situated within the District, as listed in Figure 11. Responsibility for emergency preparedness at school rests with the School District 61 Board, and with the operators of independent daycares.

Figure 11. Schools in Oak Bay

Facility	Enrollment
Oak Bay High School	1,382
St. Michaels University / Junior School	1,013
Glenlyon Norfolk School	800
Willows Elementary	536
Monterey Middle School	432
Gonzales Preschool	-
St. Christopher's Montessori School	-

Oak Bay High School on Cadboro Bay Road serves grades 9-12. In 2015, Oak Bay High School completed renovations to meet the latest seismic construction and environmental standards.



Oak Bay High School

About half of the campus at the University of Victoria (UVic) is located within Oak Bay, with the remainder in Saanich. This regional facility serves more than 20,000 students with over 2,000 staff. UVic is one of the major employers on Southern Vancouver Island and provides a vital employment anchor for current and future District residents.

UVic has a robust emergency management plan and collaborates closely with Oak Bay first responders during an emergency.

Camosun College is located just west of Oak Bay, with a portion of its parking lot extending into the District. This proximity means that Oak Bay also accommodates some of its students.

Other school facilities include several independent daycare operations in Oak Bay, serving infants, toddlers, and preschool-age children.

Many UVic and Camosun College students seek accommodation in Oak Bay. They live in shared rental houses, secondary suites, and likely in a few apartments. Most of UVic's newer development is located on the Saanich portion of the campus.

Implications of Schools

Schools and daycares rank among the most vulnerable properties in Oak Bay due to the age of the students. Schools have multi-hazard emergency response plans that address staff and student safety.

Health Care Facilities

Oak Bay contains no health care facilities or medical clinics. However, many health facilities are situated in neighbouring Victoria, such as the Richmond Road Medical Clinic and the Fairfield Medical Treatment Centre, as well as the Royal Jubilee Hospital.

The Royal Jubilee Hospital holds about 500 beds offering critical-care, surgery, diagnostics, emergency facilities and other patient programs. This hospital includes a focus on cardiac medicine. The hospital also hosts a heli-pad for receiving patients from around the region.

Implications of Health Care Facilities

Health care professionals and facilities must be functional during major disasters to provide emergency care and ongoing public health services. All health care centres require business continuity plans.

First Responders

Professional first-responder organizations provide Oak Bay residents and visitors with direct services.

Fire Department – Oak Bay Fire responds to emergency incidents, such as structure fires and motor vehicle accidents, and provides specialized hazardous material response services, as needed. Through the Medical First Responder Program, the Fire Department has an agreement to respond to medical calls. Fire personnel also assists Oak Bay Police on request.



Oak Bay Firehall and Apparatus

The department currently includes 30 uniformed staff, and 2 civilian staff members. Fire apparatus currently includes a new aerial ladder truck to aid with evacuation from tall residential buildings.

The District's Public Safety Building on Monterey Avenue holds the main fire hall and all fire apparatus, the emergency program, and the Police Department. One floor of the building can serve as an Emergency Operations Centre (EOC), although the structure is not seismically resilient and is subject to damage in a major earthquake.

In 2023, Oak Bay Fire responded to 1,382 calls for service including 27 structure fires and hundreds of requests assistance in medical emergencies, motor vehicle accidents, and public safety incidents.

The District relies heavily on a mutual aid and automatic aid agreements with Saanich and Victoria for day-to-day structure fire support to maintain safe operating levels.

Public Works – Oak Bay’s Public Works Division maintains the District’s infrastructure, including local government buildings, public utilities, and roadways.

Public Works includes 50 regular full-time staff and 22 auxiliary staff and operates from designated facilities located on Elgin Road. The Public Works buildings currently lack seismic protection, and the Yard lacks the storage space needed to stockpile repair parts.



Oak Bay Public Works Yard

Public Works plays a critical role in emergency response and disaster recovery by providing personnel and equipment for incidents affecting municipal infrastructure. Engineering and Public Works may also provide personnel for the District’s Emergency Operations Centre. Public Works managers can call on other municipalities in the Capital Region when needed.

Police Department – The Oak Bay Police Department, located at the Public Safety Building on Monterey Avenue, provides policing services for the community.



Oak Bay Police

The Oak Bay Police Department includes 24 sworn police officers and 4 civilian employees. The Department relies on 4 volunteer reserve constables who support events and patrol duties, as well as Block Watch volunteers.

Uniformed officers are divided into four platoons supplying a 24-hour, 7-days-a-week response to calls for service and emergencies. The Department offers services in municipal traffic control, community policing, and crime investigation. Police respond on average to about 4,000 calls for service each year.

Ambulance Services – BC Emergency Health Services manages the Ambulance Service in the province, providing emergency pre-hospital treatment and transportation to the public and visitors in Oak Bay. As of 1992, there is no longer an ambulance service station operating in Oak Bay. The closest ambulance service is located in the Royal Jubilee Hospital on Richmond Road.

BC Ambulance Service paramedics coordinate with Oak Bay Fire and may activate regional support in large multi-casualty incidents.

Oak Bay Emergency Program – The Oak Bay Emergency Program is managed through the Oak Bay Fire Department. The Fire Chief is the designated Emergency Program Coordinator for the District, with one additional staff position, the Emergency Program Manager.

The Emergency Program manages Oak Bay’s risk through six major objectives, as required by the *BC Emergency and Disaster Management Act*:

- Assess risks
- Mitigate hazards
- Plan for emergency response
- Plan for municipal service continuity
- Plan for disaster recovery
- Prepare for response, continuity, and recovery

The Emergency Program is responsible for working with municipal leaders and staff, as well as Indigenous partners, to ensure they are trained in emergency management practices should a major emergency or disaster occur.

The Emergency Program also sets priorities for projects needed to advance public safety and is actively engaged in regional emergency planning.

Emergency Support Services – ESS supports the District’s legislated duties to provide lodging, food, clothing, and incidentals for those who have been evacuated from their homes and require support. Oak Bay’s ESS Team currently has approximately 10 active members, which is inadequate to provide the community assistance that would be required in moderate or major emergencies.

Search and Rescue – SAR volunteers operate throughout the Capital Region, as needed, and may provide radio communications. Several members are trained in Rapid Building Damage Assessment and Light Urban Search and Rescue.

Communications – Licensed amateur radio operators train regularly and contribute to the Provincial Emergency Radio Communications Service (PERCS) under the BC Ministry of Emergency Management and Climate Readiness (EMCR). They are available to help with emergency communications at the site level and within the Oak Bay EOC organization. There are 12 active members.

Implications of First Responders

First responder organizations work together to reduce the risk of major emergency through coordinated response planning. Response capability could be impaired by the loss of personnel through such hazards as human disease and earthquake.

1.7 Economy

Oak Bay offers opportunities for residential, commercial and economic growth. Oak Bay Village acts as a node to support residential, commercial, employment and community services for local residents.

The District relies primarily on a residential tax base. From 2018 to 2022, the residential sector accounted for 95 percent of municipal taxes, and the business sector accounted for 5 percent. Municipal funds are stretched, particularly due to demands for upgrading the aging infrastructure.

Oak Bay’s employment sector is comprised of a mix of home-based workers, local businesses, and major institutions. Relatively few people (7.5% of residents) work within the District, and most commute to jobs elsewhere in the region.

The largest portions of Oak Bay resident employment fall into two categories: 1) Sales and service occupations and business (accounting for 20%), and 2) Finance and administration (20 % of workers). These employment leaders were followed by 3) education, law, community and government services jobs at 17.4 percent, and 4) health at 12.1 percent.

The largest employers are UVic, the District of Oak Bay, the Oak Bay Beach Hotel, and golf courses. The District of Oak Bay licenses approximately 600 businesses annually that maintain premises within the municipality. Small businesses dominate the District’s economic scene.

Business Centres

Oak Bay Avenue holds the largest density of businesses in the District, with mostly retail, coffee shop, restaurant, and service-oriented operations.

Secondary retail centres are located on Estevan Avenue, Cadboro Bay Road, and Foul Bay Road. Many other small commercial pockets exist throughout the community, all within walking or cycling distance of local homes.

The Oak Bay Business Improvement Association (Oak Bay BIA) represents members from 150 businesses and organizations, and works in partnership with Oak Bay Tourism, the Oak Bay Municipality, and other community groups.



Oak Bay Avenue

Emergencies that interrupt tourism and/or trade, such as a pandemic or earthquake, will directly affect a significant portion of Oak Bay's businesses and their employees. Interruption of transportation modes in the area are likely to affect supplies or deliveries for local manufacturers and retail outlets.

COVID Effects on the Economy

The long-term effects of the COVID-19 pandemic on Oak Bay's economy are still unfolding. However, significant shifts are clear in at least three areas.

First, changes in shopping behavior will likely permanently alter retail operations, particularly the preference for online retail and e-commerce. Increased business reliance on electrical power and telecommunications introduces a new type and degree of vulnerability.

Second, the pandemic exposed the fragility of national and international product supply chains. Reducing these risks for essential items, such as foods and priority consumables, may provide opportunities for local or regional business development.

Third, the COVID-19 pandemic pushed growth in the gig economy, referring to the number of Canadians who participate in short-term contracts or freelance work. This movement emphasizes the importance of the electrical power supply and Internet services to Oak Bay's home businesses and local economy.

Implications of Economy

Small businesses tend to be less resilient than larger ones. The increased adoption of technologies across Oak Bay's businesses means greater dependence on electrical power and telecommunications. This represents a significant and growing vulnerability when such services may be disrupted. Even relatively minor emergencies could cause business interruption and closures over the long term.

A major disaster could disrupt the operations of the dozen or so large businesses and institutions active in the District and threaten long-term economic well-being and the local tax base.

2.0 HAZARDS

Oak Bay's Emergency Program has identified 11 reasonably foreseeable hazards that could affect the District to an extent that might require significant support through an Emergency Operations Centre. These hazards are listed below in relative order of risk magnitude.

Highest Risk	<ol style="list-style-type: none"> 1. Atmospheric Hazards 2. Human Disease 3. Utility Failure
Moderate Risk	<ol style="list-style-type: none"> 4. Earthquake 5. Flooding / Storm Surge 6. Tsunami 7. Wildland-Urban Interface Fire
Lowest Risk	<ol style="list-style-type: none"> 8. Hazardous Materials 9. Major Urban Fire 10. Mass Casualty Incidents 11. Structure Collapse
Not Likely to Require EOC Activation	<ul style="list-style-type: none"> • Active Shooter • Explosion • Landslide • Marine Mammal Disposal • Marine Oil Spill • Social Disturbance • Terrorist / Bomb Threat

In selecting these events for consideration, the Oak Bay Emergency Program acknowledges the potential, however small, that other types of emergencies may demand EOC activation, depending on the circumstances at the time of the incident. Future assessments of risk in the community may revise perceptions of these hazards.

The following sections examine each of the 11 hazards, summarize the relative risks to the community, and identify emergencies in other jurisdictions that highlight the types of impacts that may be expected in Oak Bay. Each section closes with a summary of actions implied by an understanding of the risks, hazards, and vulnerabilities.

1. Atmospheric Hazards

Risk: High

A. Description

The general term “atmospheric hazard” includes the following conditions:

- Drought
- Fog
- Hail
- Heavy Snowfall and Blizzard
- Heavy Rain
- High Winds, Typhoon
- Ice Storm
- Lightning
- Temperature Extremes
- Wildfire Smoke

The District of Oak Bay experiences a wide variety of weather-related situations that could directly impact humans and physical infrastructure. Examples include extreme heat or cold, heavy rainfall, deep snow and blizzards, ice storms, and windstorms. Residents have become familiar with the terms that signal potentially dangerous conditions, such as “heat dome,” “atmospheric river,” and “polar vortex.”

While the Pacific Ocean moderates most weather extremes, it also brings *El Niño / La Niña* conditions that result in events that can impact the community. For example, a meandering polar north jet stream may trigger Arctic outbreak conditions, such as snow or extreme cold in the Capital Region.

Likelihood – Moisture-laden air from the tropics regularly arrives with westerly or south-westerly weather patterns. Occasional winds from the east can bring dry and hot air from interior BC and Alberta, as well as smoke from wildfires. As a recent CRD climate projection highlights, extreme weather such as rainstorms, heat events, and wind incidents in the Capital Region are expected to grow in frequency and intensity in the coming decades.

Consequences – Excess heat or cold can directly affect public health throughout the region. Severe winds, heavy snowfalls, and ice storms may cause temporary electrical power outages. Extreme weather events often impact roads and other infrastructure, leading to economic impacts.

B. Relevant Past Events

Oct 1962 – Typhoon Freda

Remnants of *Typhoon Freda* struck southern BC, causing 7 deaths and more than \$10 million in damage. In Greater Victoria, winds reached sustained speeds of 90 km/h, with gusts to 145 km/h.

Dec 1996 – Heavy Snowfall

The “Pacific Storm of 1996” struck Oak Bay from December 22 to January 3, 1997, bringing 64.5 cm of snow in a single day. The entire southern region of BC was affected.

Dec 2018 – Windstorm

Winds of 94 km/h with gusts up to 118 km/h hit parts of Greater Victoria, snapping power poles and trees, and blocking roads.

Sep 2020 – Wildfire Smoke

Wildfires in Interior BC and Washington State generated enough smoke to trigger air quality alerts for Greater Victoria residents.

Jun 2021 – Heat Dome

A record high of 39.4°C hit the Capital Region during this 5-day heat wave. The BC Coroner reported 619 heat-related deaths in BC between June 25 and July 1, including 24 in Greater Victoria. Most deceased were older adults with health problems who lived alone.

Nov 2021 – Atmospheric River

Severe rainstorms flooded local roads and closed the Malahat Drive. The same storm system drowned BC's Lower Mainland, flooding much of the Fraser Valley, and interrupting the provincial supply chain.

Apr 2023 – Montreal Ice Storm

More than 30 mm of ice froze an area from Montreal to Quebec City. Paramedics responded to 10 calls related to carbon monoxide poisoning. About 200 homes were flooded, while another 10,000 faced overflowing sewers. About 400,000 households remained without power for 4 days. Montreal opened 24-hour emergency shelters in 6 municipal buildings.

Oak Bay

C. Hazard Scale and Scope

Long-term climate characteristics are similar throughout Greater Victoria. Adverse weather events affect all parts of Oak Bay and all population segments to some degree.

Heavy rainfall can lead to localized flooding. Road closures and utility outages due to severe weather could isolate specific neighbourhoods throughout the municipality. Severe weather could significantly impact aging and/or undersized infrastructure in the District.

The Oak Bay Recreational Centre, Oak Bay High School, Henderson Recreational Centre, the Public Works Yard, and some apartment buildings include flat roofs that may be threatened by heavy snowfall.



Monterey Recreation Centre

1. Atmospheric Hazards

D. Vulnerabilities

An increase in the number of days with extreme heat will affect Oak Bay's aging population, especially those in multi-family buildings that are less likely to have air conditioning. The District has previously promoted the Oak Bay Recreation Centre as a cooling location during heat events.

Respiratory illnesses may be aggravated by an increase in smoke from distant wildland fires.

Roadways could be temporarily closed due to severe weather, such as heavy snowfall, ice accumulation, or fallen trees and other debris. Large, aging Garry Oak trees in the District are particularly vulnerable in high winds.

Electrical power transmission lines that serve Oak Bay are vulnerable to high winds, ice storms, and heavy snow. Trees downed or damaged near electrical cables are frequent causes of power interruption. Roadway snow and debris can isolate some residential areas and businesses for several days.

E. Implications for Action

Hazard Mitigation

- Assess extreme heat risks to residents and inform municipal staff, building owners, and the public on readily accessible protection measures.
- Promote neighbourhood resilience for extreme weather events.

Emergency Response

- Inform public on where they can go for heat relief and coordinate community services.
- Identify contractors who can supply backup snow removal equipment and participate in regional resource management.

Municipal Business Continuity

- Ensure backup of municipal information technology in case of prolonged power outage or IT disruption.

Disaster Recovery

- Develop relationships among community groups and businesses to assist with disaster recovery following major storm.

2. Earthquake

Risk: Moderate

A. Description

Oak Bay and the rest of the Capital Region may experience three types of seismic activity. A *crustal* earthquake typically occurs at a depth less than 30 km and lasts less than a minute. A *sub-crustal* earthquake can occur as deep as 80 km, causing less than a minute of shaking with few aftershocks.

The third type is the *subduction* earthquake (referred to as "The Big One") caused when the margin of the North America Plate becomes unstuck and slides over the Juan de Fuca Plate, as in Figure 12. Severe shaking may persist for several minutes.

Likelihood – A large subduction earthquake occurs roughly every 430 years near Victoria, but this can extend plus or minus 160 years. Such an earthquake off the shore of Vancouver Island last occurred in the year 1700. Scientists estimate that the combined likelihood of all three seismic types suggests a 30 percent chance of an earthquake strong enough to cause structural damage within the next 50 years.

Consequences – Most severe impacts from an earthquake are caused by prolonged shaking, such as in a subduction earthquake. Ground shaking that persists for several minutes and aftershocks can directly damage structures over a large area, including residential buildings, commercial shops, schools, roadways, water lines, electrical power transmission, and other utilities. Structural fires and the release of hazardous materials are common secondary events following a severe earthquake.

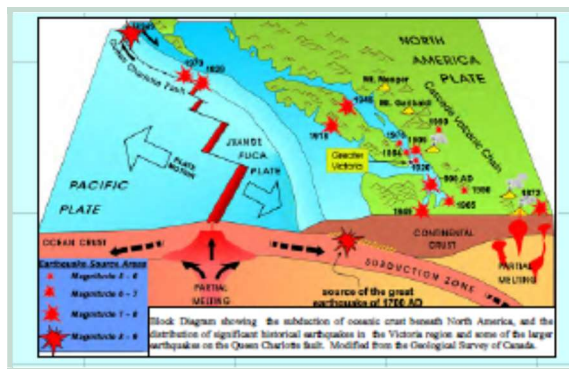


Figure 12. Location of Juan de Fuca Plate
Source: BC Geological Survey Branch

B. Relevant Past Events

Jan 1700 – Cascadia Earthquake

On January 26, Vancouver Island was hit by a major subduction zone earthquake measuring between 8.7 and 9.2 on the Richter Scale. The fault ruptured about 1,000 km and triggered a massive tsunami.

Jun 1946 – Courtenay Earthquake

A major magnitude 7.3 earthquake struck Vancouver Island on June 23. This earthquake caused extensive damage along the east coast of Vancouver Island, including impacts to rail lines, buildings, and schools.

Feb 2001 – Nisqually Earthquake

On February 28, a major earthquake with a magnitude of 6.8 struck 20 km northeast of Olympia, Washington. No injuries were reported in BC.

Feb 2011 – Christchurch Earthquake

On February 22, a magnitude 6.3 earthquake killed 185 people and injured several thousand in Christchurch, New Zealand. The central business district remained closed for more than two years.

Mar 2011 – Tohoku Earthquake and Tsunami

In Japan's powerful earthquake and tsunami, nearly 20,000 people died and 400,000 buildings either collapsed completely or suffered severe damage. The combined earthquake and tsunami generated an estimated 25 million tonnes of debris in Japan alone.

Oct 2012 – Haida Gwaii Earthquake

A major 7.7 Mw earthquake in the Haida Gwaii region on October 27 was felt across much of north-central BC, including Haida Gwaii, Prince Rupert, Quesnel, and Houston. There were no reports of damage.

Dec 2023 – BC Earthquake Reminder

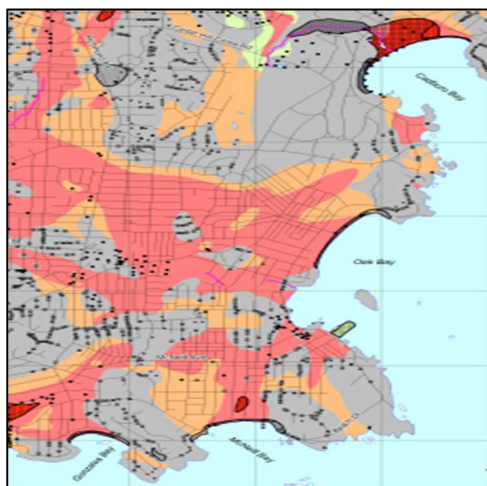
As a reminder of the local seismic risks on Vancouver Island, a shallow earthquake with a magnitude of 4.9 shook a widespread area from Campbell River to Kelowna on a December afternoon. The event struck at a depth of 14 kms and caused buildings to vibrate in Campbell River. A series of minor aftershocks followed.

Oak Bay

C. Hazard Scale and Scope

The District is located within Seismic Zone 5, an area at risk of a damaging earthquake that could threaten critical infrastructure such as water mains, gas mains, power lines, and roads.

Structural fires and the release of hazardous materials are common secondary events following an earthquake. Susceptible areas in Oak Bay include neighbourhoods near Estevan, Foul Bay Road, Beach Drive, and McNeill Bay.



Earthquake Hazard Map for Oak Bay

2. Earthquake

D. Vulnerabilities

Community elements that are most vulnerable in seismic events include high-density buildings, as well as older structures that have not been retrofitted for earthquake protection. There has been limited construction in Oak Bay since the 1970's, and few seismic upgrades have taken place. Examples of vulnerable infrastructure include Municipal Hall, the Public Safety Building, Public Works buildings, and the Henderson and Monterey Recreation Centres.

Critical utilities are also vulnerable to earthquake damage, including:

- Electrical power and telecommunications
- Water services (~82% needs replacement)
- Wastewater (~84% needs replacement)
- Stormwater (~85% needs replacement)
- Natural gas lines
- Roads

Even with seismic improvements in the CRD water transmission system, the District still may be required to distribute water after a disaster. Repairs to an earthquake-damaged infrastructure could take weeks or months.

E. Implications for Action

Hazard Mitigation

- Inform residents of seismic mitigation, such as securing dwellings to foundations.
- Secure furnishings in municipal buildings against seismic shaking.
- Assess seismic safety of municipal buildings for potential retrofitting.

Emergency Response

- Prepare a Debris Management Plan, including priorities for clearing the road network.
- Advance ESS leadership and training, currently underway.
- Identify a location to store equipment for a Fire DOC and emergency supplies.
- Develop a plan for local Community Points of Distribution of public relief supplies.

Municipal Business Continuity

- Develop a plan to test alerting systems for municipal staff and community.

3. Flooding / Storm Surge

Risk: Moderate

A. Description

Several locations in Oak Bay may be subject to water encroachment, flooding, or inundation due to heavy rainfall, rapid snow melt, or storm surge.

Likelihood – In Oak Bay, most localized flooding is caused by excessive rainfall, which occurs every few years during atmospheric river weather systems. Storm drains, drainage ditches, or natural drainage channels can become blocked or overwhelmed by the volume of water, sediment, debris, or snow.

Oak Bay is also subject to storm surge, an abnormal rise in water levels attributed to air pressure differences during intense storms. Sea levels around the world are expected to rise over the next 100 years, leading to an increase in the number of water encroachment emergencies in coastal cities, including Oak Bay.

Consequences – The degree of water encroachment depends on the size of the catchment area, as well as the intensity of individual meteorological events. Storm surges often result in high waves and flooding if concurrent with a high tide. All coastal areas are likely to be impacted by Sea Level Rise.

B. Relevant Past Events

While external to Oak Bay, these events are representative of what could occur locally.

Nov 1990 – Flooding from Rainstorm

On November 23, local flooding in the Greater Victoria area due to heavy rainfall was aggravated by melting snow. Losses were estimated at \$4.6 million.

Oct 2003 – Pineapple Express

On October 16, another Pineapple Express brought record rainfall to the Victoria area. The Region received 169 mm of rain in a 24-hour period, the rainiest day on record to that date.

Nov 2006 – Southern Island Rainstorm

On November 3, a one-day storm brought intense rain to southern Vancouver Island. The amounts of precipitation varied widely. On November 6, downtown Victoria recorded 39 mm of rain, with 70 mm at UVic, 88 mm at Hartland Landfill, and 107 mm in Esquimalt.



2024 Storm Surge in Oak Bay

Jan 2024 – High Winds and High Tide

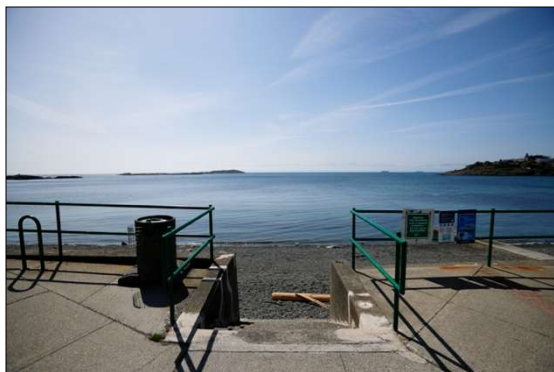
Strong winds blasted the shoreline and huge waves crashed onto Beach Drive at McNeill Bay. Fierce winds flung wood and debris over the seawall, and onto the sidewalk and roads. Pedestrian walkways and roads were closed in Oak Bay due to the unsafe conditions.

Oak Bay

C. Hazard Scale and Scope

Bowker Creek, Hobbs Creek, and coastal areas are prone to water encroachment from heavy rainfall, high water table or high tide, and storm surge or a combination of these hazards. Past water intrusion events have been noted in McNeill Bay and Gonzalez Bay, where high winds, high tides and heavy rain have caused flooding.

With the forecasted Sea Level Rise, ocean levels near Oak Bay are expected to rise 0.8 m in the next 50 years. The hazard areas for storm surge are similar to the tsunami hazard zones. These include shoreline frontage and lowlands located below the 4 m elevation.



Beach Access at McNeill Bay

3. Flooding / Storm Surge

D. Vulnerabilities

Flooding typically impacts individual housing units and roadways. Heavy and persistence rainwater flooding can erode soils, impacting underground infrastructure, such as water and stormwater lines. Indigenous monuments may be damaged by runoff during a heavy rainfall event.

Shoreline dwellings are particularly susceptible to damage from storm surge and water encroachment. Points of vulnerability from water encroachment and Sea Level Rise include South Oak Bay, especially McNeill Bay, and Gonzales Bay. Flooding may require residents to move to temporary accommodations.



Shoreline Dwellings at McNeill Bay

Continuing effects of global warming are likely to trigger more frequent and more intense storm activity in coming years.

E. Implications for Action

Hazard Mitigation

- Develop mitigation plans, such as additional pumpstations at outfalls, to safeguard stormwater infrastructure from storm surge and higher sea levels.

4. Hazardous Materials

Risk: Low

A. Description

A hazardous material is any substance that may be explosive, flammable, poisonous, corrosive, reactive, or radioactive. A hazardous materials incident involves the uncontrolled release of a dangerous substance during transportation, storage, or use. Effects from hazardous materials range from road obstructions to widespread evacuation, injury, and death.

Five different modes may present risk of hazardous material spills in Oak Bay: 1) Road transport, 2) Pipelines 3) Fixed facilities, 4) Marine transport, and 5) Air transport.

Likelihood – Although uncommon, there is a chance of hazardous material release in the community. Rapid emergency response plays a vital role in minimizing the likelihood of injury or damage. Solid materials are relatively easy to control unless fire is involved. Liquid hazardous materials that enter storm drains can quickly spread to other locations.

The most dangerous types of hazardous materials include toxic gases, such as ammonia, that are heavier than air, can travel with the wind, and can cause harm at very low concentrations. Flammable gases, such as propane and natural gas, can cause “fireball” situations if ignited in large volumes.

Consequences – Consequences from hazardous material release range from roadway disruption to widespread evacuation, injury, and death. Spilled petroleum products, such as heating fuel oil or marine crude oil, can result in widespread damage to the environment, including wetlands, soils, surface waters, and aquifers.

B. Relevant Past Events

While external to Oak Bay, these events are representative of what could occur locally.

Jan 1989 – Toxic Leak from Tanker Truck

Families in Quesnel were forced from their homes when sodium hydrosulphide leaked from a tanker-truck.

May 1994 – Toxic Gas Release

An explosion at a Port Moody resin-making factory released 10,000 kg of a potentially toxic chemical into the air. Fortunately, wind conditions dispersed the gas and smoke quickly into the atmosphere.

Aug 1996 – Toxic Gas at Factory

On August 4, a toxic gas hazard and risk of explosion was created at a Vancouver Plating Factory after caustic soda was added to a tank of trichloroethylene. Sixteen workers were hospitalized and 16 city blocks were on standby for evacuation.

Jun 2004 – Break in Natural Gas Line

A ruptured natural gas line caused the evacuation of about a hundred people from a commercial area in Fernie. Gas began pouring from the line when it was ruptured by a contractor mid-afternoon.

Jun 2015 – Ammonia Leak at Recreation Centre

On June 11, toxic fumes from an ammonia leak forced the evacuation of a Nanaimo recreation centre and sent three employees to hospital. The ammonia is used to disinfect the recreation pool.

Oct 2017 – Ammonia Leak Fatalities

On October 17, two City of Fernie workers and a contractor were killed by exposure to ammonia in the community's memorial arena while they worked on the ice rink's refrigeration unit. The facility was evacuated and remained closed for months while the Royal Canadian Mounted Police, WorkSafe BC and Technical Safety BC completed investigations.

Oak Bay

C. Hazard Scale and Scope

Road – At any given time, a wide variety of hazardous substances can be present and in transportation in Oak Bay. Neighbourhoods near main throughfares are at risk, although the chance of a dangerous incident is low.

Pipeline – FortisBC operates numerous natural gas transmission and delivery pipelines throughout the community. The greatest threat to pipeline safety involves excavation and construction activities at or near a pipeline right-of-way.

Fixed Facilities – Several facilities in and bordering Oak Bay store and use hazardous materials, including the Royal Jubilee Hospital, the University of Victoria, fertilizer at the golf courses, ammonia and chlorine at the Oak Bay Recreation centre, Public Works yard, and fuel at both marinas.

Marine – Oak Bay has marinas that serve hundreds of pleasure watercraft and fishing vessels, all of which carry petroleum fuel. Large tankers carry crude oil through Haro Strait.

Air – Dangerous goods, including small quantities of radioactive substances, are sometimes carried by aircraft to and from the Victoria International Airport passing overhead or near Oak Bay.

4. Hazardous Materials

D. Vulnerabilities

High density occupancies are more vulnerable to toxic and flammable hazardous materials due to the potential number of people exposed. In Oak Bay, these include the recreation centres, businesses, apartment buildings, care homes, and schools.

Boat marinas are also vulnerable to hazardous materials, specifically boating fuels and repair chemicals and materials that can lead to fire and water pollution. There have been recent incidents of derelict abandoned or liveaboard boats sinking, leaking fuel, or suffering an onboard fire.



Uplands Golf Course in Oak Bay

The shorelines and marine areas of Oak Bay are sensitive and highly valued by local and regional residents.

Marine environments sensitive to spills of fuel, oil, and other chemicals include the entire Oak Bay shoreline along Haro Strait and Salish seashore.

E. Implications for Action

Emergency Response

- Develop a functional exercise for chlorine/ammonia response.

5. Human Disease

Risk: High

A. Description

Emergencies caused by human diseases include a large array of parasitic, bacterial, and viral agents. Most notable among these threats are the respiratory viruses that transmit easily from person to person, such as high-mortality influenza, the Severe Acute Respiratory Syndrome (SARS) coronavirus, and the related virus that caused the COVID-19 pandemic. Medical experts warn that the COVID virus may continue to mutate into a more dangerous disease in the coming years.

Water-borne diseases, such as the parasite *Giardia lamblia*, regularly affect urban areas throughout North America. The risk for disease outbreaks is greater following natural disasters where drinking water can be contaminated. Food-borne disease outbreaks, such as those caused by *Salmonella enterica* or *Escherichia coli* bacteria, while dangerous to individuals, rarely result in full emergencies.

Likelihood – Canada experiences human disease outbreaks very rarely. When they occur, such events usually result from a failure in an urban potable water or wastewater system or procedure. The COVID-19 pandemic represents an ongoing threat of emergency proportions in Oak Bay. Climate change will likely increase the chance of infectious epidemics through world-wide travel connections.

Consequences – Direct health threats and economic obstacles tend to generate fear and social distancing that can adversely affect the mental health of individuals in ways that are difficult to observe and quantify. Health care services may be overwhelmed and unable to serve large numbers of expected patients. In addition, health measures to prevent disease spread, such as closures of public spaces and tourist-related businesses, may impose secondary impacts on the local economy.

B. Relevant Past Events

While external to Oak Bay, these events are representative of what could occur locally.

Oct 1918 – Influenza Pandemic

The “Spanish Flu” rapidly spread across the country along the railway lines, arriving in Vancouver in October, 1918. A second wave arrived in 1919. This pandemic resulted in 50,000 fatalities in Canada, and more than 2,000,000 Canadians became ill.

May 2000 – Walkerton, Ontario

An outbreak of *E. coli* in the public water supply hit Walkerton, Ontario, following failures in the water treatment process. Seven people died from this disease, and more than 2,300 people suffered health problems.

Apr 2003 – SARS Outbreak

An outbreak of the SARS virus spread by air travelers from China to Canada, first affecting residents in Toronto, where 43 people died. Only 4 probable and 46 suspect cases were reported in BC, and all cases recovered.

Jun 2009 – H1N1 Pandemic Influenza

Public Health Agency of Canada received reports of a total of 40,185 laboratory-confirmed cases of H1N1, of which 8,678 people were hospitalized and 1,473 of these were admitted to intensive care. Overall, 428 Canadians died due to H1N1 illnesses.

2015-2017 – Zika Pandemic

An epidemic of Zika fever spread from Brazil to other parts of South and Central America, eventually appearing in the USA. In Canada to date, 558 Zika cases have been reported, mostly due to travel to affected countries. Risks are low currently.

Mar 2020 Ongoing – COVID-19 Pandemic

Canada reported its first COVID-19 fatality at a senior care home in North Vancouver on March 8. By March 20, the Prime Minister of Canada had advised all Canadians abroad to return home. The World Health Organization officially declared the end of the COVID-19 world-wide pandemic on May 5, 2023. As of April, 2024, federal officials report more than 4,950,000 cases and 59,100 deaths in Canada with COVID-19 as a contributing factor.

Oak Bay

C. Hazard Scale and Scope

For respiratory diseases, high-hazard areas include those with dense concentrations of people. In Oak Bay, these include a few facilities for public gatherings, such as municipal buildings, the Windsor Pavilion, recreation centres, and schools. The Victoria International Airport may become a point of entry for respiratory disease, such as COVID variants, transmitted from other countries.

All residents draw daily potable water from a common source and, therefore, most would be affected by contamination of the CRD water system. Outside of the local care homes, few facilities serve food to large gatherings of people.



Windsor Park Pavilion

5. Human Disease

D. Vulnerabilities

Populations of particular concern for the transmission of human diseases in Oak Bay include the immune-compromised and frail elderly in the community. More than 3,700 residents in Oak Bay are 75 years or older.

Children may also suffer more from illness than adults because of under-developed immune systems. Oak Bay residents include 2,300 children under the age of 15. Schools can be particularly vulnerable during outbreaks of communicable diseases.

District staff members who deliver essential services are also vulnerable to disease. For example, the Oak Bay Fire Department includes 30 firefighters. If a substantial percentage became ill, fire services in the community could be affected. The same holds true for Public Works, Parks and Recreation, and the Police Department, as well as other District employees.

E. Implications for Action

Hazard Mitigation

- Promote CDC educational material for municipal staff and public.

Emergency Response

- Update the municipal Pandemic Plan to include learnings and recommendations from COVID-19.

Municipal Business Continuity

- Support staff with PPE, vaccination opportunities, working with OHS on hazard-specific issues.

6. Major Urban Fire

Risk: Low

A. Description

The threat of structure fire in Oak Bay ranks among the most dangerous types of emergencies. Although severe fires are rare with today's fire prevention and suppression measures, fire in a residential, commercial, or institutional building could result in catastrophic impacts, especially among high-density occupancies, such as schools, care homes, hotels, condos, and apartment buildings.

Fire ignition is commonly caused by faulty electrical wiring or construction, smoking, industrial activity such as welding, cooking, or arson (singular or serial). Fire may spread rapidly due to the types of materials used in construction, building design, and access to oxygen sources. Smoke often presents an immediate threat to occupants and radiant heat may block exits and cause direct injury.

Likelihood – In 2023, the Oak Bay Fire Department responded to 1,382 calls for service, including 27 structure fires. Due to fire prevention efforts, the number of structure fires in Canada have decreased in past decades.

Consequences – Smoke from any fire is toxic and poses a danger to occupants. Persons at risk may be advised to evacuate or shelter-in-place, depending on the circumstances. A fire at an industrial building with dangerous goods such as the Public Works yard or Oak Bay Marina would release highly toxic smoke and gases and may require the evacuation of the surrounding area and temporary closure of some roadways. Fire damage to some residential units can require urgent shelter of residents through the Oak Bay Emergency Program.

B. Relevant Past Events

While external to Oak Bay, these events are representative of what could occur locally.

Jan 1996 – Fire in Care Home

About 120 bed-ridden residents were rescued from a burning extended care home in Duncan.

Nov 2001 – School Evacuation

On November 6, a fire burning in a nearby industrial area forced an evacuation of Fairview Junior High School and Roi Daniels Elementary in Calgary. Advanced planning allowed more than 800 students and staff to move to safety within 30 minutes.

May 2016 – Townhouse Fire

A major urban fire ignited at Shelbourne and Cedar Hill in a townhouse development under construction. \$6-7 million in losses. Mutual aid call with Victoria and Saanich. More than 40 firefighters responded.

Nov 2017 – Fire at Nursing Home

Fire at an assisted living home in Pennsylvania killed 4 residents, injured at least 20 others, and forced more than 140 residents and staff to evacuate.



2016 Shelbourne Fire

Jun 2019 – Richmond Apartment Fire

A persistent structure fire at an apartment building on Richmond Road produced heavy smoke and flames. Oak Bay Fire Department was first on scene. The incident resulted in one fatality and two injured persons that required hospitalization.

Feb 2023 – Vancouver Marina Fire

A fire destroyed three boats on Vancouver's Granville Island's Pelican Bay Marina early Sunday morning on February 12. No injuries were reported.

Oak Bay

C. Hazard Scale and Scope

Major fires are more likely to occur in the built-up neighbourhoods of Oak Bay, including the Oak Bay Avenue business district.

A fire in the Public Works yard or Oak Bay Recreation Centre could release highly toxic smoke and gases and may require the evacuation of the surrounding neighbourhood.

Risk is increasing in Oak Bay due to the changing climate, and as the population and density of the community grows. The recent addition of 3- to 5-storey buildings in the District, infilling of private lots, and the expansion of student housing at UVic, will further challenge fire suppression teams.



2019 Richmond Apartment Fire

6. Major Urban Fire

D. Vulnerabilities

Some elements of the Oak Bay community are more vulnerable to fire than others. Structural fires in high density buildings in the community, such as apartment buildings or care homes, would present immediate life-safety, and stretch Oak Bay Fire resources. Currently, Oak Bay is heavily reliant on fire mutual aid from Victoria and Saanich.

Due to the steady rise in medical aid calls, Fire crews are often split with limited availability. Mutual aid partners are also busy, their assistance cannot be guaranteed.



Carlton House for the Elderly

A major fire at a boat marina could spread quickly to other boats. Impacts to live-aboard vessels, may require temporary accommodation.

E. Implications for Action

Emergency Response

- Develop marina evacuation plans where fire protection systems are not in place.

7. Mass Casualty Event

Risk: Low

A. Description

Road, air, and marine events can require coordinated emergency response action when accidents involve large numbers of casualties in a single incident such as a bus accident, crash of a large commercial aircraft, or grounding of a passenger ferry. Initial responders are typically overwhelmed, requiring support from multiple agencies, including Fire, Police, Public Works, and BC Ambulance, alongside EOC support.

Such incidents tend to unfold suddenly and without warning. Factors that may contribute to the risk of mass casualty accidents include congestion and conflicts between multiple users in limited road or water ways, operator inexperience and/or intoxication, mechanical failure, and hazardous weather. Adverse conditions such as high winds, rough waters, and poor visibility are common contributors.

Likelihood – The chance of a mass casualty incident in Oak Bay is low. Bus incidents are more likely during severe weather, such as heavy snowfall and icy road conditions.

Consequences – Most occurrences result in property damages that require site clean up. Bus, boat, or plane accidents could result in dozens of injuries, simultaneously requiring on-site emergency care and overloading nearby medical facilities, paramedic and ambulance services, and coroner services and morgues. Crashes typically require localized response to fuel spills and/or fire, and may result in traffic congestion and detours. Following a mass casualty incident, it is common to see families and friends seeking access to the incident site to gather information or remember and honour lost loved ones.

B. Relevant Past Events

Mar 2003 – School Bus Topples in Snow

A bus carrying Pacific Christian School's senior boy's basketball team crashed on the Trans-Canada Highway in Langley in poor winter conditions. There were no serious injuries.

Mar 2006 – Ferry Runs Aground, Sinks

The *Queen of the North* sank on March 22 after running aground on Gil Island in Wright Sound, 135 kilometres south of Prince Rupert. Two passengers are presumed to have drowned in the incident.

Aug 2014 – Tour Bus Crash

On August 27, 43 people were injured, several critically, in a tour bus crash on the Coquihalla Highway, 30 kilometres south of Merritt, BC. The bus was on a tour with passengers from Hong Kong, China, Taiwan, and other locations.

Dec 2017, West Wind Crash in Saskatchewan

A flight by West Wind Aviation carrying 22 passengers and 3 crew crashed shortly after takeoff from Fond-du-Lac, Saskatchewan. All occupants survived, although several were seriously injured.

Apr 2018 – Humboldt Broncos Crash

Sixteen people were killed and 13 injured when a bus carrying a sports team was struck by a semi-trailer truck on a remote highway in Saskatchewan.

Sep 2019 – Bus Crash en route to Bamfield

Two were killed and 17 injured when a bus carrying UVic students to the Marine Sciences Centre rolled over after running off the road. Risk factors involved the meeting of 2 vehicles at a narrow point in the roadway.



Bamfield Bus - Source: CBC News

Oak Bay

C. Hazard Scale and Scope

Oak Bay has 105 kms of local roads. Some of the more significant roadways used for bus travel include:

- Beach Drive
- Cadboro Bay Road
- Foul Bay Road
- Oak Bay Avenue

Bus routes in the community accommodate transit buses, school buses, and double-decker tourist buses.



Boating in Oak Bay

The ample shoreline could be the site of a marine vessel grounding. Response to all marine incidents would be coordinated through the Joint Rescue Coordination Centre (JRCC) located in Victoria.

7. Mass Casualty Event

D. Vulnerabilities

School-age children using bus transportation are among the most vulnerable groups affected by road accidents. Tourist buses and airplanes can carry dozens of visitors who lack English as their first language, which could challenge first-responders and site support efforts to inform family members.



Sightseeing Victoria Bus

Closure of any main thoroughfare in Oak Bay for a substantial time due to a mass-casualty vehicle accident would challenge residents and business operators in the community.

E. Implications for Action

Emergency Response

- Develop and host a functional exercise for response to MCI.

8. Structure Collapse

Risk: Low

A. Description

Structure collapse refers to any failure in the integrity of a designed building, walkway, or community infrastructure. Structure collapse may be caused by engineering or construction problems, metal fatigue, severe weather events, or changes to the load bearing capacity of the structure.

Likelihood – Although uncommon events, the collapse of structures may occur at any time. Factors that may contribute to structure collapse include building age, design, time of year, use levels, weather conditions, and seismic forces.

Consequences – When buildings collapse, there may be a significant number of injuries or fatalities, and fire may result. Such events may also cause damage to support infrastructure, such as gas lines, electricity, water, sewer, and telephone lines. The collapse or partial instability of taller buildings tend to threaten neighbouring structures, forcing temporary evacuations.

B. Relevant Past Events

While external to Oak Bay, these events are representative of what could occur locally.

Apr 1988 – Food Store Collapse

The Metrotown Save-on-Foods roof collapsed during opening ceremonies, only minutes after Mayor Bill Copeland, who was presiding over the grand opening, directed the evacuation of about 1,000 people. There were no fatalities. Fifteen people were briefly hospitalized.

Nov 1992 – School Collapse

On November 12, a school roof at Cedar Drive elementary school in Port Coquitlam collapsed and destroyed one classroom and damaged another. Fortunately, the collapse occurred on a Sunday when no students were in the classroom.

Jan 1997 – Arena Collapse

On January 8, the 3,000 sq m Memorial Arena in Dawson Creek housed a hockey rink, permanent bleacher seating, and dressing areas. The entire roof structure collapsed within minutes on an unusually windy night, with less than the design snow load on the structure.

Dec 1996 – Snow Causes Collapse

As a result of heavy snowfall in December of 1996, some roofs and sun decks collapsed, and structural damage occurred to a few large buildings in the Greater Victoria area. Roofs caved in at James Bay Thrifty Foods, Panorama Leisure Centre, and Glen Meadows curling club.

June 2021 – Condominium Collapse

A 12-story Condominium in Miami collapsed, causing 98 casualties and injuring 12. It collapsed due long-term degradation and structural failure.



Surfside Condominium Collapse – Miami, Florida

Oak Bay

C. Hazard Scale and Scope

Buildings of concern in Oak Bay include older structures that may have been poorly designed or maintained. Buildings in Oak Bay constructed before the 1950's are more susceptible to structural damage in an earthquake.

Industrial buildings with tilt-up construction performed poorly in the 1989 Loma Prieta earthquake. Engineering guidelines call for firm connections between walls and roof sections.

Buildings with large roof spans, such as theatres, warehouses, shopping complexes, and gymnasiums, are more susceptible to weather effects, such as heavy snow falls and high winds.

Boat marina facilities in the Capital Region have suffered structure collapse in past heavy snowfall events.



Oak Bay Marina

8. Structure Collapse

D. Vulnerabilities

Buildings that are more vulnerable to collapse include aging structures and locations where large numbers of people may be present at any given time.

In Oak Bay, aging buildings of concern include Monterey Recreation Centre, Municipal Hall, Public Safety Building, Public Works buildings, and the Oak Bay Marina structures.

Structures containing higher density of people include: Schools, apartment buildings, recreation complexes, and the Windsor Pavilion.



Oak Bay Fire Hall

Buildings that collapse, especially multi-level structures, could injure and trap occupants.

E. Implications for Action

Hazard Mitigation

- Develop an asset management plan to address replacement and upgrades to aging infrastructure.

Emergency Response

- Identify options for accessing structural engineers and canine support in response.

9. Tsunami

Risk: Moderate

A. Description

A tsunami is caused by the sudden vertical displacement of large masses of water by an earthquake, volcanic eruption, or landslide. The impulse energy transforms into several water waves that could affect Oak Bay's coast in a series of tsunami waves arriving over several hours.

A subduction zone earthquake of magnitude 8 or 9 would likely generate a tsunami that could affect the Greater Victoria area. Ocean scientists predict it would take roughly an hour for such a tsunami to reach Oak Bay, with a maximum water level of about 2.0 m above normal high water. Government officials may not be able to warn residents because electrical power and communication systems may be damaged by the earthquake. District properties are protected by Vancouver Island and the Olympic Peninsula from tsunamis produced elsewhere in the Pacific Ocean.

Likelihood – The main tsunami threat to Oak Bay and the rest of the Capital Region comes from a Cascadia Subduction Zone earthquake off Vancouver Island. Such major earthquakes occur roughly 430 years apart (plus or minus 160 years), with the last one occurring in the year 1700. Closer earthquakes may also generate tsunami, although unlikely.

Consequences – Within the foreshore area exposed to the series of tsunami waves, unprotected individuals could be swept away and drowned or injured by impact. Floating objects, such as boats and wharves, can be moved by strong water currents. Tsunamis typically generate massive amounts of debris.

B. Relevant Past Events

While external to Oak Bay, these events are representative of what could occur locally.

Mar 1964 – Port Alberni Tsunami

On March 27, a major earthquake in Alaska generated tsunami waves that hit Vancouver Island. The shape of Alberni Inlet amplified the 3 waves that struck the town between 12:20 am and 3:30 am on March 28. The event damaged 260 homes and resulted in economic losses of about \$10 million.



Port Alberni Tsunami 1964

Dec 2004 – Indian Ocean Tsunami

On December 26, a major subsurface earthquake off Sumatra, Indonesia, generated a massive tsunami that killed more than 300,000 people in 14 countries. Wave energy affected all world oceans.

Mar 2011 – Tsunami Hits Japan

The Tohoku earthquake that hit Japan on March 11 triggered powerful tsunami waves that caused 15,889 deaths, 6,152 injuries, and 2,601 people missing, as well as damage to more than 1 million buildings.

Jan 2018 – Tsunami Alert

A 7.9 magnitude earthquake in Alaska triggered a tsunami warning for British Columbia. Municipalities warned the public to avoid beaches and marine infrastructure. No damage was reported.

Jan 2022 – Tonga Volcano Tsunami

When the Hunga Tonga Hunga Ha'apai volcano erupted on January 15, tsunami waves flooded Tonga, about 70 km away. Tsunami impacts were felt as far as New Zealand and the USA.

Oak Bay

C. Hazard Scale and Scope

Natural Resources Canada recommends that Oak Bay residents living within 4 metres elevation above the normal highest tide prepare for evacuation and other tsunami controls. This elevation allows for the potential run-up of tsunami waves on the shore, and accounts for other unknown factors.

Although most of Oak Bay is a relatively elevated municipality, local areas of low elevation, at risk of tsunami inundation are homes and facilities located between McNeill Bay and the Oak Bay Marina / Turkey Head.



Oak Bay Tsunami Inundation Zone

9. Tsunami

D. Vulnerabilities

Tsunami risks are enhanced by regional use of beaches in the summer months, with some limited use in winter. Several beaches in the area are at risk of tsunami.

- Cattle Point
- Flotsam Cove
- Funnel Cove
- Gonzales Bay
- Harling Point
- Kitty Islet
- Loon Bay
- Mary Tod Island
- McMicking Point
- McNeill Bay
- Spoon Bay
- Turkey Head
- Willows Beach

Oak Bay's secondary EOC at Windsor Park is located within the potential inundation zone following a subduction zone earthquake. Response plans include a step to confirm the safety of all potential EOC locations.

E. Implications for Action

Emergency Response

- Develop a repeated cycle of public information on tsunami hazards and response.

10. Utility Failure

Risk: High

A. Description

Utilities include a range of infrastructure-based services that support community standards of living. Possible utility failures include:

Power Failure – Public safety is threatened when the community experiences prolonged outages or when power is lost when ambient temperatures are extremely high or low.

Communications Failure – Windstorms, ice storms, earthquakes, and system failures can lead to loss of the communications infrastructure, a necessity in today's world.

Fuel Shortage – Fuels include natural gas and fuel oil, which are subject to shortages for various reasons. Fuels are essential for transportation, heating, and cooking.

Water System Failure – Interruption of potable water can occur due to many factors, including contamination of source waters, turbidity, broken water main, pump failure, or power failure. Water outages can affect the health of residents and lead to economic impacts.

Sewer System Failure – As with potable water, most of Oak Bay depends on sewer systems. Prolonged outages could lead to health impacts and business interruption.

Solid Waste System Failure – Solid waste disposal that includes the CRD Hartland Landfill and contractor services are subject to failure due to strike, earthquake, fire, and other causes.

Likelihood – Power outages are the most likely type of utility failure and have the potential to impact more residents simultaneously. They can be caused by heavy winds, ice storms, snowstorms, fallen trees or other debris, and vehicle impacts. Other underground utilities may fail at times due to maintenance issues or accident, or due to seismic forces on vulnerable infrastructure.

Consequences – Depending on the type and duration of infrastructure affected, utility failure could threaten human life, immediate economic impacts, and environmental damage. Power failure is especially dangerous in sub-zero conditions or extreme heat where lives depend on temperature controls.

B. Relevant Past Events

While external to Oak Bay, these events are representative of what could occur locally.

Feb 2011 – Sewer System Damage

The Christchurch earthquake crippled the wastewater treatment plant serving the community. At one point, about 40 million litres a day of raw sewage leaked from broken pipes.

Nov 2014 – Windstorm Cuts Power

Violent winds knocked trees onto power lines across southern Vancouver Island, cutting power to thousands of homes and businesses.

Jan 2019 – Nanaimo Water Shortage

After a powerful windstorm swept through Nanaimo, the city's water treatment plant failed during a power outage, affecting 105,000 residents.

Feb 2021 – Texas Cold Freezes Power Grid

More than 4.5 million homes and businesses in Texas State caused by severe winter storms. Nearly 150 residents died from hypothermia and frostbite, mostly people aged 60 years or older. Carbon monoxide poisoning caused an additional 19 deaths.

Sep 2022 – Wildfire Cuts Power Supply

A wildfire 15 kms away knocked out the main power grid serving Jasper, Alberta. The town reverted to backup generators to service critical infrastructure such as the wastewater treatment plant and hospital.

Oak Bay

C. Hazard Scale and Scope

Water supply systems represent a combination of CRD water collection and treatment, followed by municipal delivery. The water system in the CRD is particularly exposed to risk from earthquake. The CRD is currently engaged in a Post Disaster Emergency Water Supply and Supply System Vulnerability Assessment Project.

Similarly, sewer sanitation systems are underground and may be affected by shaking, subsidence, and liquefaction caused by earthquake.

Oak Bay receives power transmitted via several lines managed by BC Hydro. Prolonged power outages can be caused by heavy winds, ice storms, snowstorms, falling trees or other debris, vehicle impacts, and earthquakes.

Nearly the entire community receives natural gas via FortisBC Gas, Ltd., the only pipeline gas system available in the community. Interruptions of piped natural gas are most often caused by digging during building or road construction, but may also result from a seismic event.

10. Utility Failure

D. Vulnerabilities

The entire population is heavily dependent on the supply of potable water by combined CRD and Oak Bay services. All facilities, especially elderly care homes rely on water, sewer, power, and communications for operation. A prolonged power outage at a time of extreme heat would threaten the vulnerable. A prolonged outage during extreme cold spells could result in frozen and broken interior water pipes.

Schools are likely to be closed without access to electricity or water. Power and water interruptions can cause businesses to close temporarily, and result in economic hardships for business owners and employees.

Prolonged communication failures are likely to impact sales for Oak Bay businesses, including home-based business sector. As a result, economic impacts may be immediate and wide spread.



Water Line Repair

E. Implications for Action

Hazard Mitigation

- Continue to replace underground infrastructure by priority to improve community resilience.

Emergency Response

- Update emergency response and contingency plans for municipal critical infrastructure.

11. Wildland-Urban Interface Fire

Risk: Moderate

A. Description

From May to October of most years, parts of the community face the threat of wildfire (known as Wildland-Urban Interface Fire or WUI). The changing climate has increased drought in Southern Vancouver Island, and the presence of homes near large parks or heavily forested areas has created a growing risk of WUI fires in Oak Bay. The presence of people living near and visiting Oak Bay parks increases the chance of human-caused ignition. This risk will grow with Oak Bay's densification plans bringing more people into the community leading to heavier impacts on wildland parks.

Likelihood – There have been a number of significant fires in Uplands Park, Trafalgar Park, and Anderson Hill usually triggered by weather events causing downed power lines. Oak Bay is now experiencing extreme weather year round. Periods of drought and high winds exacerbate the risk of a WUI fire, conditions that are increasing with climate change.

Consequences – In addition to direct property damage that comes with wildfire, lives are at risk. Many properties in the wildland-intermix zone can only be accessed by narrow roads, making evacuation more challenging. Wildfire can damage electrical transmission lines and substations and interrupt power to parts of the District. Smoke can lead to decreased air quality and have health impacts, especially among those with respiratory challenges. This risk will increase with population growth.

B. Relevant Past Events

Aug 1987 – Prospect Lake Fire

A small brush fire near Prospect Lake expanded into 18 hectares, drawing fire crews from across southern Vancouver Island. About 70 homes were evacuated as water bombers dropped fire retardant.

Jul 2015 – Sproat Lake Wildland Fire

In a suspected human-caused fire, the Dog Mountain area of Sproat Lake BC erupted in an inferno that destroyed one uninhabited cabin. The Alberni-Clayoquot Regional District issued an evacuation order due to slope stability issues.

Aug 2021 – Mount Hayes Wildfire

Sudden growth of a wildfire near Ladysmith, BC, prompted evacuation alerts for about 20 residential properties. The Cowichan Valley Regional District declared a state of local emergency as the wildfire grew from 20 to 70 hectares overnight.

Jun 2021 – Lytton Heat Dome Fire

After three days as the hottest place in Canada, the Village of Lytton, BC, burned within minutes on June 30. The village was 90% destroyed by the fire, leaving two dead. Between 1,500 and 2,000 First Nation residents on nearby reserves were also impacted.

Dec 2021 – Marshall Fire near Denver

A rare winter wildfire struck a suburban area in Colorado, USA, burning about 1,000 homes and forcing the evacuation of tens of thousands of residents. Fire officials linked the disaster to the combined effects of drought and severe winds, under the influence of climate change.

Aug 2023 – BC Wildfires and Evacuations

Several intense and fast-changing wildland fires in BC prompted evacuation orders for 35,000 residents, with an additional 30,000 were under evacuation alert. Fires centred around Kelowna destroyed many properties and partially closed some sections of routes to the rest of western Canada. The Province issued a state of emergency in BC's worst-ever wildfire season.

Aug 2023 – Lahaina Wildfire

A wildfire driven by extreme winds claimed 100 lives and destroyed more than 3,000 homes in one of the worst wildland-urban interfaces fires in US history. Although the fire originated with downed power lines among native vegetation, flying embers from burning structures contributed to rapid fire spread.

Oak Bay

C. Hazard Scale and Scope

Residential areas immediately adjacent to large, forested areas and parks represent higher wildfire risk zones, such as those near Uplands Park and Mystic Vale.

These areas are particularly at risk because of the limited emergency vehicle access.

The area impacted by wildfire can quickly expand beyond the forest interface when strong winds spread burning embers from structure to structure. Response may include both Evacuation Alerts and Evacuation Orders.



Trafalgar Park

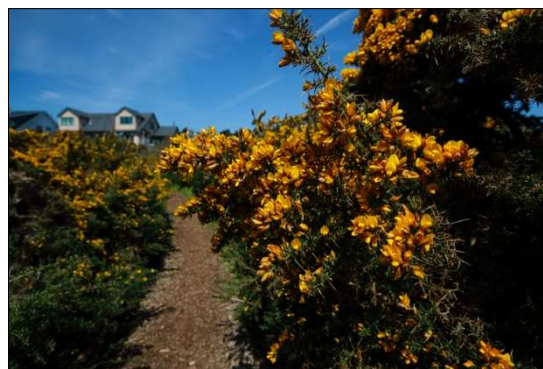
11. Wildland-Urban Interface Fire

D. Vulnerabilities

Residential properties and occupants are most directly threatened by wildfire. Even low-intensity surface fires can lead to home damage, depending on the degree of protection in building design and materials.

Wildland-urban fires could also damage the Indigenous monuments in Oak Bay.

Wildfires that enter the built environment commonly result in damage to above-ground utilities, such as electrical power lines and telecommunications.



Build-up of Vegetation Near Oak Bay Homes

E. Implications for Action

Hazard Mitigation

- Investigate mitigation options with OB Parks and community stakeholders, considering a Community Wildfire Protection Plan.
- Explore risks of urban canopies and consult with Coolkit on program of heat and wildfire risk mitigation.

Emergency Response

- Train Oak Bay Police personnel and EOC staff in evacuation policies and procedures.

3.0 PRIORITY CONCERNS

One purpose of assessing community risks is to identify priorities for municipal action. The Oak Bay Emergency Program considers all risk information to focus on events most likely to result in large losses for the community.

Risk values represent the potential for loss and are composed of two components: Probability and consequence. The greater the probability of an adverse event, the greater the risk. Also, the larger the magnitude of potential consequences of an incident, the larger the risk.

Considering both components of risk becomes important when allocating time and effort for emergency management, which addresses hazard mitigation, emergency response, continuity of District services, and disaster recovery. The highest priority is given to events that are both probable and likely lead to severe consequences. Low priority events represent low probability occurrences of little consequence.

Charting Priority Hazards

With these considerations in mind, a review of the primary hazards presented above yields the hazards and priorities shown in Figure 13.

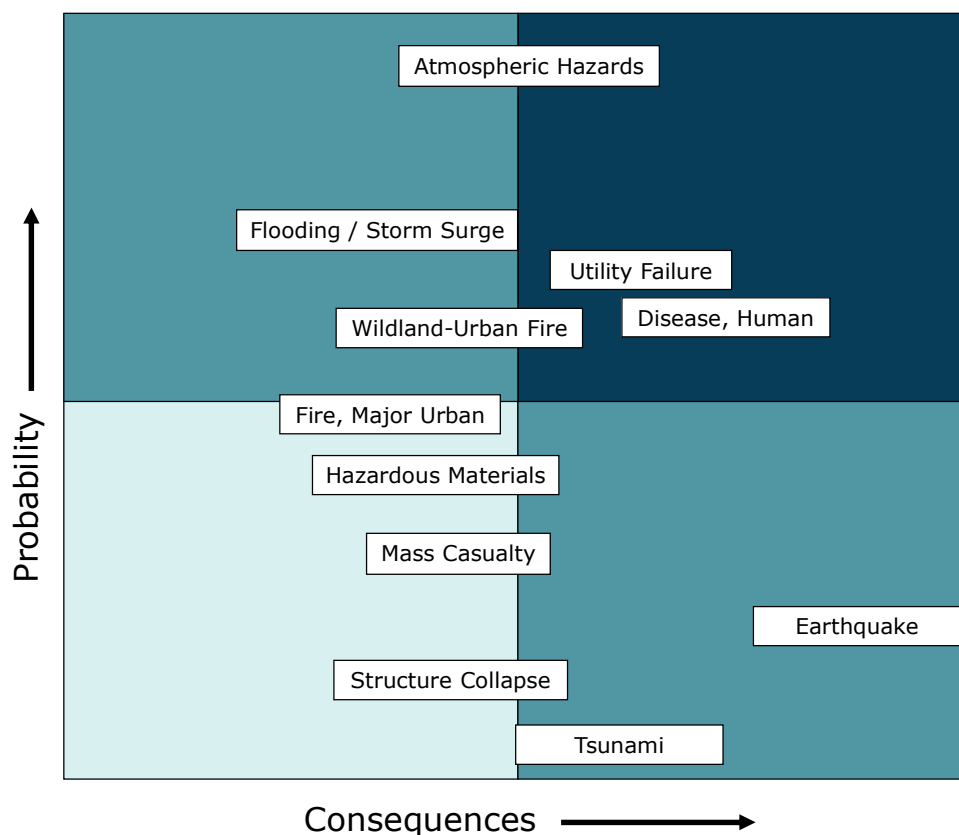


Figure 13. Priority Hazards for the District of Oak Bay, 2024

4.0 NEXT STEPS

The Community Risk Assessment serves to identify potential actions that can be taken to manage the risks of major emergencies and disaster.

Among the 11 hazards identified, the Community Risk Assessment identifies 45 possible actions for consideration in four categories: 1) Hazard Mitigation, 2) Emergency Response, 3) Municipal Business Continuity and 4) Disaster Recovery.

While the Community Risk Assessment focuses on major emergencies, Oak Bay's Emergency Program supports collaboration among all District departments as the model for collective risk control. Progress on public safety and community well-being requires the entire municipality and key community elements, such as residents, businesses, and Indigenous partners to work together on behalf of all.

The Oak Bay Emergency Program will update this Community Risk Assessment at regular intervals to incorporate new findings and to revise implications for action.

5.0 REFERENCES

- American Lifelines Alliance. 2005. *Seismic Guidelines for Water Pipelines*. January.
- BC Coroner's Office. 2022. *Extreme Heat and Human Mortality: A Review of Heat-Related Deaths in BC in Summary 2021*. Report to the Chief Coroner of British Columbia. December 12.
- BC Government. 1995. *Local Authority Emergency Management Regulation*, BC Reg. 380/95.
- BC Government. 2021. *BC School Seismic Mitigation Program Online Report*. January
- BC Government. 2021. *BC Storm Surge Forecasting System*. December 15.
- BC Ministry of Environment and Climate Change Strategy. 2019. *Preliminary Strategic Climate Risk Assessment for British Columbia*. January.
- BC Ministry of Environment. 2016. *Indicators of Climate Change for British Columbia, Update*.
- BC Ministry of Health. 2016. *Emergency Response and Contingency Planning for Small Water Systems*. Health Protection Branch. January.
- Canada, Government of. National Risk Profile. May 2023
- Capital Regional District. 2021. *Capital Region Coastal Flood Inundation, Mapping Project Summary, Version 2.0*. January.
- Capital Regional District. 2021. *Hartland Landfill Tonnage Report - 2023*.
- Capital Regional District. 2021. *Task 2 – Sea Level Rise Modelling and Mapping Report*. Capital Region Coastal Flood Inundation Mapping Project, Version 2.0. January.
- Capital Regional District. 2021. *Task 3 - Tsunami Modeling and Mapping Report*. Capital Region Coastal Flood Inundation Mapping Project Summary, Version 2.0. January.
- Capital Regional District. 2022. *Greater Victoria Drinking Water Quality - 2021 Annual Report*.
- Capital Regional District. 2022. *Solid Waste Annual Report – 2022*.
- Capital Regional District. 2024. *Climate Projections for the Capital Region*. April.
- District of Oak Bay. 2022. *Annual Report*.
- District of Oak Bay. 2022. *Coolkit Program Year 1 Evaluation Report*.
- District of Oak Bay. 2022. *Fire Department Master Plan*.
- District of Oak Bay. 2020. *Housing Needs Report*.
- District of Oak Bay. 2020. *Official Community Plan*.
- Emergency Management BC. 2020. Hazard, Risk And Vulnerability Analysis (HRVA) for Local Authorities And First Nations Companion Guide for the HRVA Tool
- Environment Canada. 2014. *The Georgia Basin-Puget Sound Airshed Characterization Report*.
- Federal Emergency Management Agency. 2022. Community Resilience Indicator Analysis: Commonly Used Indicators from Peer-Reviewed Research. Sep 2022
- Garis, Len, Joe Clare, Chris Biantoro. 2019. *Structure Fires in British Columbia*. University of the Fraser Valley. December.
- Government of Canada. ND. *Federal Terrorism Response Plan: Domestic Concept of Operations*.
- Halchuk, Stephen, Trevor Allen, John Adams, and Tuna Onur. 2019. "Contribution of the Leech River Valley - Devil's Mountain Fault System to Seismic Hazard in Victoria, BC," in the *12th Canadian Conference on Earthquake Engineering*, June 17-20, 2019, Quebec, QC.
- Heirdorn, Keith C. 2005. *Weather Events. Victoria's Blizzard of 1996*.
- Intergovernmental Panel on Climate Change. 2022. *Climate Change Impacts, Adaptation and Vulnerability, Summary for Policymakers*.
- Kolaj, Michal, John Adams, and Stephen Halcuk. 2020. "The 6th Generation Seismic Hazard Model of Canada.," Presented at the *17th World Conference of Earthquake Engineering* at Sendai Japan on December 13.
- Natasha Bulowski. 2022. "Council of Canadian Academies Report – Adapting Climate Change and Disaster Response Key Resilience." *National Observer, Ottawa Insider*. January 13.

- Onur, Tuna and Mark Seemann. 2004. "Probabilities of Significant Earthquake Shaking in Communities across British Columbia: Implications for Emergency Management," in *13th World Conference on Earthquake Engineering*, Vancouver, BC, Canada, August 1-6. Paper No. 1065.
- Porter, Keith A. 2016. *Damage and Restoration of Water Supply Systems in an Earthquake Sequence*. Civil Environmental and Architectural Engineering, University of Colorado.
- Seemann, Mark, et al. 2011. "Earthquake Shaking Probabilities for Communities on Vancouver Island," in *Natural Hazards*, DOI 10.1007/s11069-011-9727-6.
- The United Nations Office for Disaster Risk Reduction (UNDRR). 2015. *Sendai Framework for Disaster Risk Reduction*. 2015-2030.
- Toprak, S. 2020. *Pipe Type and Seismic Performance in Christchurch, New Zealand*. IOP Conf. Ser.: Mater. Sci. Eng. 800 012042
- US Environmental Protection Agency. 2016. *Excessive Heat Events Guidebook*. EPA 430-B-16-001, Updated Appendix A. March.

Internet Resources

BC Government

- www.bcehs.ca/about/who-we-are/bc-ambulance-service.
- www.seniorsadvocatebc.ca/quickfacts/location/vancouver-island-health-19/

BC Hydro

- www.bchydro.com/energy-in-bc/operations/dam-safety/seismic-hazards/jordan-river-options.html
- www.bchydro.com/energy-in-bc/operations/distribution-system.html.

BC Ministry of Environment and Climate Change Strategy

- www.env.gov.bc.ca/cas/impacts/

BC Ministry of Energy, Mines, and Low Carbon Innovation

- www.empr.gov.bc.ca/mining/geoscience/naturalhazards/victoriaearthquakemaps/pages/seismic.aspx

BC Transit

- www.bctransit.com/victoria/schedules-and-maps/route-overview?route=1

British Columbia Hydro Corporation

- www.bchydro.com/energy-in-bc/operations/our-facilities/vancouver-island.html

Building Resilient Neighbourhoods

- www.resilientneighbourhoods.ca/

Canada Government

- www.climate.weather.gc.ca/climate_normals/
- www.earthquakescanada.nrcan.gc.ca/info-gen/prepare-preparer/eqresist-en.php
- www.csis-scrs.gc.ca/ththrtvnmnt/trrrsm/index-en.php
- www.bst-tsb.gc.ca/eng/stats/aviation/2020/ssea-ssao-2020.html#1.0

Capital Regional District

- www.crd.bc.ca/about/news/article/2022/09/20/capital-region-tsunami-information-portal-launch
- www.crd.bc.ca/service/drinking-water/systems/regional-water-supply-system
- www.crd.bc.ca/docs/default-source/water-pdf/water-service-areas/greatervictoriadrinkingwatersupplysystem_11x17.pdf?sfvrsn=1f5c35ca_2
- www.crd.bc.ca/education/protection-stewardship/watersheds/watershed-maps-flow-diagrams/watershed-land-cover-maps
- www.crd.bc.ca/prepare-yourself/hazards-in-our-region/tsunami
- www.crd.bc.ca/service/waste-recycling/hartland-landfill-facility/overview.

Climate Data

www.climatedata.ca/explore/location/
www.en.climate-data.org/north-america/canada/british-columbia/oak-bay-8656/

District of Oak Bay

www.oakbay.ca/our-community/reconciliation-oak-bay
www.oakbay.ca/municipal-hall/departments
www.oakbay.ca/municipal-services/planning/heritage-conservation-area
www.oakbay.ca/municipal-services/planning/housing-oak-bay
www.oakbay.ca/public-safety/emergency-program/contact
www.oakbay.ca/public-safety/emergency-program
www.oakbay.ca/public-safety/fire-department/fire-safety
www.oakbay.ca/our-community/business/business-improvement-assoc
www.oakbay.ca/our-community/business/business-environment
www.oakbay.ca/our-community/about
www.oakbay.ca/our-community/about/community-maps
www.oakbay.ca/our-community/heritage
www.oakbay.ca/our-community/about/history
www.oakbay.ca/our-community/history/heritage/heritage-sites/tour-other-historic-sites
www.oakbay.ca/our-community/about/statistics-facts
www.oakbay.ca/municipal-hall/plans-and-reports
www.oakbay.ca/parks-recreation/parks-playgrounds

Island Health

www.islandhealth.ca/our-locations/hospitals-health-centre-locations/royal-jubilee-hospital-rjh

Legislative Assembly of British Columbia. Bill 31 – 2023 Emergency and Disaster Management Act

www.leg.bc.ca/Pages/BCLASS-Legacy.aspx

Oak Bay Annual Weather Averages

www.climate.weather.gc.ca/climate_normals/results_1981_2010_e.html

Oak Bay High School

www.news.gov.bc.ca/releases/2013

Point 2 Homes

www.point2homes.com/CA/Demographics/BC/Oak-Bay-Demographics.html

Statistics Canada

www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/details/page.cfm

The Weather Network

www.theweathernetwork.com/en/news/weather/severe/this-day-in-weather-history-december-20-2018-most-destructive-storm-bc-hydro-history-british-columbia

United Way

www.uwsvi.ca/help-a-neighbour/

Victoria News

www.vicnews.com/news/fatal-morning-fire-under-investigation-with-police-fire-and-coroner-services-57324

www.vicnews.com/news/tsunami-risk-presentation-exposes-oak-bays-vulnerability-100919

Wikipedia

www.en.wikipedia.org/wiki/Surfside_condominium_collapse