

Review of the CRD Plans and Priorities  
contained in the 2022 Regional Water  
Supply Master Plan

## 2022 Regional Water Supply Master Plan Review

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Commissioned by the Urban Development Institute –  
Capital Region, Victoria Residential Builders Association,  
West Shore Developers Association and the Sooke  
Builders Association

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## Executive Summary

The 2022 Regional Water Supply Master Plan was adopted by the Capital Regional (CRD) Regional Water Supply Commission on 10 August 2022. The plan details the current state of the water supply system, long-term planning to address future water needs, environmental considerations, and infrastructure upgrades. The CRD and its member municipalities have a duty to proactively plan for the future of the Capital Region's Water Supply by continuing to invest in capital improvements, upgrades and expansion. They must also ensure that they adhere to project management best practices, fiscal prudence, and ensure that the plan and its implementation is based on science-based principles that stand up to 3<sup>rd</sup> party scrutiny.

The 2022 Water Supply Master Plan presents historical data and trends, it makes assumptions based on that data, and then provides conceptual level engineering schematic plans, and conceptual engineering cost estimate for those large scale items. It does not provide an implementation plan, and does not address climate impact assessment, or reliable cost estimates.

Of note, the entire Plan rests on the core assumption that a 25-year trend of declining water consumption is reversed, and will now start increasing at the rate of population growth. There is no data or other evidence presented by the CRD within the Master Plan itself or made publicly available to support this assumption, and appears to be without foundation.

In July, 2022, a limited two-week public consultation was completed during the adoption of this Plan by the Board. It is not clear there is broad public awareness of this plan which would dramatically impact the cost of living to current and future residents. Given past public and media scrutiny of the CRD capital projects, the CRD Staff must demonstrate a high standard of public consultation before embarking on a multi-billion dollar adventure.

Despite the significant faults of the Master Plan, and potentially vastly understated costs of their project, CRD staff have now advanced directly to the implementation process for a new Development Cost Charge bylaw to fund the Water Master Plan. Staff have initiated consultation with its member municipal Councils to bring forward this plan to the CRD Board for bylaw implementation.

The new DCC would fund a new \$1.1 billion dollar water filtration plant that the CRD Staff intend to start designing in the next few years. The Master Plan does not demonstrate either compelling scientific rationale for the filtration plant, and its stated implementation date is not supported by the data presented in the Plan. The treatment plant is approximately half of the total cost of the forecast 2 billion dollar cost, and is driving half of the expected 500%+ increase (as the capital cost budget expectedly grows) in the cost to the CRD's water customers. Everyday residential water users in Greater Victoria are not aware that the CRD Plan will result in unprecedented rate increases that will greatly impact the bottom line on their municipal water bills.

The following is a summary of the key issues recommended to be considered in more detail before major expenditures are implemented:

1. Water demand and population projections, fire and regulatory risks;
2. Phase 2 seismic assessment of proposed supply routes;
3. Climate change risks including the potential for watershed erosion;
4. Proposed strategy and investment in watershed management;
5. Water quality and compliance with Canadian Drinking Water Guidelines;
6. Meaningful and comprehensive public consultation.

The seismic stability of the CRD water transmission tunnels is a critical aspect. Ensuring these tunnels can withstand seismic events is vital for maintaining a reliable water supply during and after such incidents. Phase 1 seismic assessment identified facilities that will require further study.

Climate change impacts have not been adequately considered. There are undesirable climate impacts of the plan resulting from unnecessarily increasing energy demands to run pumps and mechanical equipment at all times, and to supply and operate backup diesel generators, all of which would generate significant greenhouse gas emissions over and above the direct impacts from construction of potentially un-necessary capital projects.

Sound fiscal management must be a priority. Numerous public projects undertaken within the Capital Region in the past 10 years have greatly exceeded cost estimates, resulting in a loss of public trust for large capital projects. Based on recent experience it is likely that much of the costing of the capital projects listed in the master plan will be wildly inaccurate. In one recent example the Metro Vancouver North Shore wastewater project has gone from an initial \$525 million when awarded to unofficial estimates approaching \$4 billion.

Finally, the Province of British Columbia has identified five key priorities for government policy:

1. Housing and Affordability
2. Healthcare System
3. Economic Growth and Fiscal Management
4. Climate Change and Environmental Management
5. Social Development and Poverty Reduction

Bulk water rate price quintupling, and large new Development Costs Charges on new housing are required to fund the large and unsubstantiated capital projects, which works against all of the Province's initiatives.

### Conclusions

1. The CRD's "Total Annual & Summer Demand 2020 – 2100" which is the foundation of the assumptions of the Master Plan, assumes rates of increase that are not supported by data

trends. A Comprehensive Water Demand Study is required to better forecast water consumption trends, factoring in the impacts to the water demand curve resulting from significant increases to bulk water supply rates. There is a large body of scientific knowledge around water demand sensitivity to higher rates.

2. Technical rationale for the filtration plant is lacking. Comparison to Vancouver and Seattle watersheds indicate that the CRD Watershed is a vast and protected greenspace with limited human impact. The rationale for the plant:
  - a. Appears to be driven by a date-certain, near-term Leach River Diversion, in turn driven by un-substantiated assumed water demand escalation;
  - b. Wildfire/Climate Change Risk Profile for Catastrophic Risk into the Future – there is an un-qualified assumption that filtration is required to address future forest fire and climate change risks, however given our coastal climate with many watchful eyes on the watershed, it's not clear that out of control wildfire risk is a concern. Development of a Watershed Wildfire Management Strategy may be an effective and cost-efficient alternative to a capital and energy intensive filtration plant.
3. Detailed Review of Climate Change Risks, including a GHG Impact analysis of the proposed pumped water flows and filtration plant. The CRD's GHG mitigation strategies related to a significant change to the CRD water system, will have a major impact to the member municipalities GHG strategy.
4. Seismic Phase 2 Risk Assessment of existing and planned tunnels must be completed to enable more accurate and up to date cost estimates and route feasibility.
5. The CRD Water Master Plan should be brought into alignment with the Province's five strategies related to housing affordability, attracting health care providers, poverty reduction, climate change and fiscal management. The current Master Plan potentially conflicts with all of them.
6. The fiscal management of the plan is inadequate. The cost estimates are likely to be grossly understated given recent experience and a full risk management is missing.

## 2022 Regional Water Supply Master Plan

### Introduction

The CRD supplies bulk drinking water for residential, commercial, institutional, and agricultural uses to approximately 400,000 people throughout the Greater Victoria area by the Regional Water Supply (RWS) service. The RWS operates the watersheds, dams, reservoirs, treatment (disinfection) and transmission systems which supply municipal water systems at metered transfer points to each municipality and sub-regional water services. The CRD supplies water to sub-regional water services, including the Juan de Fuca Water Distribution Services, Saanich Peninsula Water Service, bulk water municipal customers, and eight First Nation communities.

The primary water supply source for the RWS is the Sooke Lake Reservoir (SLR). The Sooke watershed supply is a high-quality, low turbidity source which enables the RWS to currently operate as an unfiltered source. Advanced disinfection facilities consisting of UV, chlorine and ammonia are used for treatment. The water produced by the RWS meets all Provincial and Canadian guidelines for drinking water quality.

The last Long Term Water Supply Plan for the Regional Water Service was completed in 1994 by Montgomery Watson and Dayton & Knight Ltd. (1994 Plan). The 1994 Plan outlined recommended improvements to increase the capacity and resiliency of the water supply and treatment facilities. Many of the critical improvements such as raising of the Sooke Lake Reservoir Dam, replacement of critical transmission mains, and installation of UV disinfection facilities to improve treatment were completed. The 2022 Master Plan for the Regional Water Service has been completed to update the 1994 Long Term Water Supply Plan, address key objectives identified in the 2017 Strategic Plan for the Regional Water Supply Service and sets out requirements for service upgrades based on a 2050 planning horizon.

### 2017 Strategic Plan

The CRD's 2017 Strategic Plan for Regional Water Service identified three primary commitments as follows:

1. To provide high quality, safe drinking water
2. To provide an adequate, long-term supply of drinking water
3. To provide a reliable and efficient drinking water transmission system

The Strategic Plan also identified Areas of Focus, strategic priorities, and actions including:

- CRD Board Priorities – Sustainable and Livable Region
- Climate Change Impacts – Mitigation and Adaptation
- Preparation for Emergencies and Post-Disaster Water Supply
- Supply System Infrastructure Investment – Renewing Existing and Preparing for New Infrastructure

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- Planning for the Future Use of the Leech Water Supply Area
- Demand Management – Addressing Changing Trends in Water Demand

The 2022 Master Plan has been prepared to address the primary objectives and strategic priorities outlined in the 2017 Strategic Plan.

### Concurrent Studies Informing the Master Plan

The 2017 Strategic Plan focuses on providing high-quality drinking water, ensuring a long-term supply, and maintaining an efficient transmission system. The current 2022 Master Plan addresses these goals and includes findings from three concurrent studies completed by Stantec:

1. **Deep Northern Intake, Transmission and Treatment Study:** Investigating a second intake in the Sooke Lake Reservoir to improve system resiliency against natural occurrences like wildfires, and outlining the necessary transmission and treatment facilities.
2. **Supply System Risk and Resiliency Study:** Assessing potential risks and threats to the water supply system, including those from natural disasters and equipment failure.
3. **Seismic Assessment of Critical Facilities (Phase 1):** A preliminary assessment to evaluate the seismic vulnerability of key CRD water supply facilities, identifying those requiring further detailed evaluations and potential seismic improvements.

Population growth projections within the CRD range from 1% to 1.5% annually, with a mid-range growth rate of 1.25% used for planning. The RWS has a successful water demand management program, with demands among the lowest in British Columbia for a major metropolitan area, decreasing from 559 liters per capita per day in 1998 to 337 liters per capita per day currently. If this demand is further reduced and water conservation is promoted, the Sooke watershed is expected to meet demand until 2060. However, if the demand continues at the current rate, the SLR will reach capacity by 2045. Therefore, the CRD is advised to commence planning for the diversion of Leech River to SLR within the next decade to ensure a sustainable water supply. The Master Plan recommends continued demand management and conservation efforts across the region, involving all RWS member municipalities, including industrial, commercial, and agricultural customers.

As part of the RWS 2022 Master Plan, three concurrent studies were completed by Stantec to inform the report. Key findings from these studies have been considered in the 2022 Master Plan. The studies and their content are summarized as follows and have been published by Stantec as stand-alone documents for use by the CRD.

**Study 1 – Deep Northern Intake, Transmission and Treatment Study** This study investigated the option of installing a second intake to access deeper water in the north basin of the Sooke Lake Reservoir. The deeper intake would improve overall system resiliency and provide a more

robust system in the event that the watershed is impacted by natural occurrences such as wildfires. Even though the proposed Deep Northern Intake would improve overall water quality, the deep intake would not enable the SLR to be drawn down below elevation 177m during a 1:50 year drought conditions without diversion of the Leech River to the SLR. Future diversion of Leech River water to SLR would assist in filling of the Sooke Lake Reservoir and reducing potential for water supply shortages during drought conditions. Excessive drawdown of SLR would also likely lead to water quality issues. The study also investigates transmission facilities necessary to connect the second intake to the existing RWS transmission system and outlines water treatment requirements.

**Study 2 – Supply System Risk and Resiliency Study** Using the AWWA J100 methodology, the RWS has been assessed to determine potential vulnerabilities, risks, and threats to the water supply system associated with natural disasters, climate change, failure of equipment and other considerations such as damage to water supply infrastructure from seismic events.

**Study 3 – Seismic Assessment of Critical Facilities (Phase 1)** A Phase 1 seismic assessment was completed for critical CRD water supply facilities. This study was a high-level screening assessment to evaluate the vulnerability of a limited number of priority CRD water supply facilities consistent with screening level assessment. The Phase 1 seismic assessment identified facilities that will require further Phase 2 detailed seismic evaluations and likely future seismic improvements pending the outcome of the Phase 2 evaluations.

**Population Growth, Projected Water Demands, and Demand Management** Future population, within the CRD, has been projected using annual growth rates ranging from a low 1% annual growth to a high of 1.5% annual growth from the current population. The projections to 2050 planning horizon have assumed a mid-range 1.25% annual population growth rate for the purposes of planning future water supply facilities.

The CRD has a very successful water demand management program. RWS water demands are amongst the lowest in British Columbia for a major metropolitan area. Per capita demands have declined from 559 L/c/d in 1998 to the current per capita demand of 337 L/c/d (combined residential, ICI and agricultural). There are significant benefits of targeting even lower demand rates. With a modest reduction to 300 L/c/d, the Sooke watershed could supply enough water to meet demand until 2060.

The CRD should make new and enhanced strategies to promote water conservation throughout the region and strive to lower per capita demands from current levels. Given the finite capacity of the Sooke watershed, planning for the future diversion of Leech River to SLR should commence within the next 10 years. Recommendations arising out of the Master Plan include continued demand management and conservation programs on a regional basis with all RWS member municipalities including ICI and agricultural customers served by RWS.

There are nine recommended projects as follows:

<b>Project</b>	<b>Estimated Cost</b>
<b>Goldstream Water Filtration Plant</b>	\$1.07 Billion
<b>East – West Connector</b>	\$77.64 million
<b>Smith Hill Tank and Pump Station</b>	\$41.75 million
<b>Deep Northern Intake- Floating Pump Station and Transmission Main to Head Tank</b>	\$135.41 million
<b>Third Main: SLD to Head Tank</b>	\$9.13 million
<b>Goldstream Reservoir Connector Including Stage 1 Balancing Tank</b>	\$89.82 million
<b>Jack Lake Raw Water Transmission Main</b>	\$284.96 million
<b>Leech River Diversion and Sooke Lake Saddle Dam Hydraulic Upgrades</b>	\$41.9 million
<b>Treated Water Transmission Main Upgrades (Phases 1-4.2)</b>	\$295.42 million
<b>Total Cost</b>	<b>\$1.997 billion</b>

Concerns have been expressed regarding the proposed expenditures of \$2 billion for the regional water supply system, emphasizing the need to base capital investments and Plan implementation on actual water demand rather than projected calendar dates. Proceeding without considering these factors would transform the regional water supply system into one with higher costs and higher energy demands.

Key points from a community perspective:

1. **Demand and Population Growth Assumptions:** The Master Plan is based on assumptions that may not hold true, such as steady demand increase in line with population growth, despite a 25-year trend of declining per-capita water demand. The expenditures could be deferred if demand reduction continues.
2. **Water Quality and Filtration:** The current water quality meets legal requirements, and it appears that a proposed \$1 billion filtration plant, scheduled for construction by 2037, may not be economically justified at present, particularly given the low risk of water quality issues due to wildfires or drought, as historically, there have been no quality impacts during extreme conditions.
3. **Fire Risk Mitigation:** The Master Plan does not address fire risk mitigation strategies that could avoid costly infrastructure investments. It would seem that forest management practices could be adopted to reduce fire risk, at nominally low cost.
4. **Economic Impact of Rate Increases:** The projection of wholesale rate increases assumes that water demand will remain unaffected, which is unrealistic. Rate increases are likely

to result in reduced discretionary water use, further decoupling demand from population growth.

5. **Energy Requirements:** The Plan would change the water delivery system from a gravity-based (zero energy) to an electric pump-based system, increasing energy demands and requiring backup generators, which contradicts the low-energy nature of the current system and increases carbon footprint.

## Risks to the CRD Regional Water Supply

Risks to the CRD regional water supply involve a variety of factors, primarily influenced by the region's unique geography and climate. Here are some key risks:

1. **Climate Change:** As global temperatures rise, the patterns of precipitation and snowmelt in coastal British Columbia are changing. This can lead to altered river flows, affecting the availability of water. In addition, warmer temperatures may increase the frequency and severity of droughts.
2. **Heavy Rainfall and Flooding:** The region is known for heavy rainfall, which can cause flooding. This not only disrupts water supply systems but can also lead to contamination of water sources with pollutants and pathogens.
3. **Landslides and Erosion:** The coastal terrain, often mountainous and forested, is prone to landslides, especially during periods of heavy rain. Landslides can damage infrastructure and lead to sedimentation in water bodies, affecting water quality.
4. **Earthquakes:** The CRD is in a seismically active region, which poses a risk to water supply infrastructure such as dams, reservoirs, and pipelines. Earthquakes can cause immediate disruption and long-term damage to these systems.
5. **Pollution:** Industrial, agricultural, and urban runoff can contaminate water sources.
6. **Aging Infrastructure:** Many of the water supply systems may be outdated and in need of upgrades. Aging infrastructure is more susceptible to failure and less efficient in water delivery and treatment.
7. **Forest Fires:** In recent years, forest fires have become a significant concern. These fires can compromise water quality by increasing sediment and pollutant runoff into water bodies.

Addressing these risks involves a combination of policy measures, infrastructure investment, and community engagement to ensure the sustainability and resilience of water resources in the CRD.

The AWWA J100 methodology refers to the "Risk and Resilience Management of Water and Wastewater Systems" standard developed by the American Water Works Association (AWWA). This standard provides guidelines for water utilities to assess and manage risks to their water and wastewater systems from malevolent acts and natural hazards.

The methodology typically involves the following steps:

1. **System Characterization:** This involves defining and understanding the water system, including its components, functions, and interdependencies.
2. **Threat Identification:** Identifying potential threats that can affect the water system, such as natural disasters, contamination, cyber-attacks, and infrastructure failure.
3. **Consequence Analysis:** Evaluating the potential impacts of identified threats on public health, economic operations, and the ability to provide critical services.
4. **Vulnerability Assessment:** Determining how susceptible the system is to various threats by evaluating existing safeguards and identifying weaknesses.
5. **Risk Assessment:** Combining the consequence and vulnerability analyses to determine the overall risk for each threat scenario.
6. **Risk Management:** Identifying, evaluating, and selecting risk mitigation options to reduce the risks to an acceptable level.
7. **Emergency Response Planning:** Developing or updating plans to respond effectively to incidents and emergencies to ensure continuity of service and quick recovery.
8. **Resilience Enhancement:** Implementing strategies to improve the system's ability to withstand and quickly recover from disruptive events.
9. **Monitoring, Review, and Revision:** Regularly reviewing and updating the risk and resilience assessments and plans to reflect changes in the system or threat environment.
10. **Communication and Consultation:** Engaging with stakeholders, including the public, government agencies, and employees throughout the process for transparency and collaborative improvement.

This methodology helps utilities prepare for and respond to emergencies, ensuring reliable service and protection of public health and the environment. It also aligns with the requirements of the America's Water Infrastructure Act (AWIA) of 2018, which requires water systems to conduct risk and resilience assessments and update emergency response plans.

## Watershed Management

Regarding raw water quality, turbidity in a watershed can be caused by a variety of factors. Here are some of the primary causes:

1. **Soil Erosion:** This is one of the most common causes of turbidity. When soil is eroded due to rain, wind, or human activities like deforestation and construction, it gets carried into streams and rivers, increasing the turbidity.
2. **Urban Runoff:** In urban areas, the runoff from streets and storm drains can carry a mix of pollutants, including sediments, into water bodies. This runoff can increase turbidity, especially after heavy rains.
3. **Agricultural Runoff:** Similar to urban runoff, agricultural runoff can carry soil, fertilizers, and pesticides from fields into water bodies. This not only increases turbidity but can also lead to other water quality issues.
4. **Disturbances to the water source:** Activities like excavation in water bodies can stir up sediments, increasing turbidity.

5. **Deforestation and Land Use Changes:** Removing vegetation cover through deforestation or changing land use patterns can lead to increased soil erosion and, consequently, higher turbidity levels.
6. **Algal Blooms:** In some cases, excessive growth of algae can contribute to turbidity. When algae die and decompose, they can cloud the water and increase its turbidity.
7. **Industrial Discharges:** Some industrial activities can release particulate matter into water bodies, which can increase turbidity.
8. **Natural Causes:** Natural events like landslides, earthquakes, or heavy rainfall can also contribute to increased turbidity by disturbing the soil and other materials.

Each of these factors can affect the water quality in a watershed, impacting not just clarity but also the health of aquatic ecosystems and the suitability of water for various uses. Managing these causes often involves a combination of conservation practices, regulatory measures, and community engagement.

## Comparing the CRD Watershed to Vancouver and Seattle

The turbidity in Seattle's watersheds, specifically the Cedar River Watershed and the Tolt River Watershed, can be attributed to several historical and environmental factors:

1. **Logging and Deforestation:** Historically, extensive logging activities and deforestation in the Cedar River Watershed had a significant impact on the environment. Between 1900 and 1924, nearly 30,000 acres of forest were removed, often in a haphazard manner. This led to denuded hillsides, increased fire hazards, and the destruction of potential for second-growth forests. The lack of forest cover contributed to soil erosion, which in turn increased the turbidity in the watershed.
2. **Soil Runoff:** Both the Cedar River and Tolt River watersheds experience turbidity mainly due to soil runoff. This is a common issue in many watersheds and is often exacerbated by factors such as deforestation, urban development, and agricultural activities.
3. **Environmental Management and Conservation Plans:** The City of Seattle has implemented various management and conservation plans to protect and restore habitats in these watersheds. These efforts are aimed at mitigating the impacts of human activities and natural processes on the water quality, including measures to reduce turbidity.

The turbidity in Vancouver's watersheds has been influenced by several historical and environmental factors:

1. **Historical Logging Activities:** In the early 20th century, logging operations had a significant impact on Vancouver watersheds, particularly the Capilano watershed. Extensive logging, including clear-cutting at high elevations and steep slopes, raised concerns about water quality. The practices led to soil erosion, which can increase turbidity in water bodies. Efforts were later made to gain complete control over the watersheds to prevent further damage from logging activities.

2. **Urban and Residential Land Use:** In watersheds like Burnt Bridge Creek within Vancouver, a significant portion of the land is used for residential purposes. Urban development and residential areas can contribute to increased runoff and pollution, leading to higher turbidity levels in the water. Stormwater management strategies are focused on reducing stream temperatures and nutrient levels, which are also essential for controlling turbidity.
3. **Water Quality Monitoring and Protection Measures:** Vancouver's drinking water is regularly monitored to ensure it meets quality standards and is safe to drink. Measures include filtering and disinfecting the water and monitoring for physical and chemical contaminants. Although the city's water distribution system does not contain lead pipes and maintains compliance with health standards, water quality concerns such as turbidity can arise from factors like water main leaks or breaks and annual flushing of the water distribution system.

## Water Demand Implications

### Population Growth versus Water Demand

Water demand and population projections are closely related, as the growth and distribution of the population directly impacts the demand for water. The relationship between these two factors should consider:

1. **Population Growth:** As the population increases, the demand for water for domestic, agricultural, and industrial purposes also rises. Areas with rapid population growth, especially urban areas, often face significant challenges in managing water resources.
2. **Urbanization:** The shift from rural to urban areas affects water demand. Urban areas typically have higher per capita water usage due to factors like more extensive municipal water supply systems and different lifestyles.
3. **Agricultural Demand:** Population growth can lead to increased demand for food, which in turn increases the need for water in agricultural settings. Irrigation is a major consumer of water globally.
4. **Industrial Use:** Economic development, often linked to population growth, increases the demand for water in various industries.
5. **Climate Change Impacts:** Changing climate patterns can affect the availability of water resources, making it more challenging to meet the demands of a growing population. Some regions may experience more severe droughts or changes in rainfall patterns.
6. **Water Efficiency and Conservation:** Advances in water-saving technologies and increased emphasis on conservation can help manage the growing demand.
7. **Policy and Management:** Effective water resource management and policies are crucial to ensure sustainable water supply in the face of population growth. This includes investment in infrastructure, regulation of water use, and promotion of sustainable practices.

8. **Regional Variations:** The impact of population growth on water demand can vary significantly by region, depending on factors like climate, existing water resources, and the state of development.
9. **Social-Economic Factors:** Economic status, lifestyle, and cultural practices also play roles in determining water use patterns in different populations.
10. **Future Projections:** Demographic models and water usage trends are used to forecast future water demands, helping in planning and resource allocation.

Understanding and planning for the relationship between population growth and water demand is essential for sustainable water management and ensuring that future water needs can be met.

### Water Usage Policy

Water demand per household doesn't necessarily change directly with increasing population, but various factors associated with population growth can influence it. The following factors impact water demand:

1. **Technological and Efficiency Improvements:** As technology advances, new water-saving appliances and fixtures become more common in households. This can lead to a decrease in per household water use, even as the population grows.
2. **Changes in Household Size and Composition:** The average number of people per household can affect water demand. In regions where households are becoming smaller, the per household water demand might increase, as smaller households often have less efficient water use patterns compared to larger households.
3. **Urbanization and Lifestyle Changes:** As populations grow, especially in urban areas, lifestyle changes can impact water use. In urban settings, people might use more water for activities like gardening, swimming pools, or maintaining lawns. Conversely, urban areas might also adopt more water-efficient practices and infrastructure.
4. **Water Pricing and Policy Measures:** In areas facing water scarcity, policies such as increased water prices or restrictions on certain types of water use (like watering lawns) can lead to reduced water consumption per household.
5. **Climate and Environmental Factors:** The local climate and availability of water resources also play a significant role. In arid regions, for example, water conservation becomes more critical, and households may be more mindful of their water use.
6. **Economic Factors:** The economic status of a region can influence water demand. Wealthier areas might have higher per household water use due to activities that consume more water, like filling swimming pools or maintaining extensive gardens.
7. **Cultural Practices:** Cultural norms and practices in a region can also influence water use. Some cultures emphasize water conservation more than others, leading to variations in water demand.

In summary, while population growth can lead to increased overall water demand, the per household demand is influenced by a mix of technological, economic, cultural, and

environmental factors. This means that in some cases, even with a growing population, per household water demand could stabilize or even decrease due to factors like improved water-use efficiency and changes in household composition and lifestyle. Higher density housing generally reduces outdoor water usage.

The plan assumes that there will be no further declines in demand but that it will increase at the same rate as the population growth, ignoring the experience of the past 25 years. A similar approach was taken with the 1994 Strategic Plan.

As a result of the very successful demand management program, with the introduction of low water use appliances, and with changes to the plumbing code in 2005 and 2018, total water demand and per-capita demand has been in decline for the last 25 years. During the same period the population has grown by over 30%. During this period water demand has been decoupled from population growth.

Per-capita winter day demand reflecting indoor water use, has been in continuous decline since 1995 to 250 l/c/c in 2019. The plan used a 10-year average of 274 l/c/c for the future projection. An average is only appropriate when there are high and low values in the data set, which is not the case here. Indeed, the value that was used for future projections is 8% higher than the actual average winter per-capita demand of 2019. While 2020 and 2021 data were not presented, it is reasonable to assume that the decline continued. As the proportion of new homes constructed with water efficient appliances including 4.6 litre toilets (not 6 litre as stated in the report) increases, per-capita demand will continue to decline. The Plan projections assume that increasing the wholesale rate (from \$0.77 per cubic metre to approximately \$3.5 per cubic metre) will not affect water demand.

For example, for a resident in Saanich using 150 cubic metres in a billing period, the water charge would increase from \$274 to \$689 a 250% increase (using the current Saanich water rate). Homeowners will reduce discretionary water use (e.g., lawn watering) and may install low water use fixtures in older homes. Typically, discretionary water use is more price sensitive than essential water uses (e.g., food preparation and hygiene). Reduced demand will also put upward pressure on water rates to maintain revenue requirements for committed expenditures.

To provide a detailed understanding of water usage versus cost, it's essential to consider several factors. Water cost varies greatly depending on the region, the source of water (like municipal supply, groundwater, or desalinated water), and the scale of usage (residential, commercial, or agricultural):

1. **Region:** In different parts of the world, the cost of water can vary significantly. Developed countries often have higher water prices due to more extensive treatment and distribution infrastructure. In contrast, in developing countries, the cost might be lower, but accessibility and quality can be major issues.
2. **Source of Water:** The source of the water plays a significant role in determining its cost. Groundwater is generally cheaper but can have sustainability and contamination issues.

Desalinated water, common in arid regions like the Middle East, is much more expensive due to the energy-intensive process required to produce it.

3. **Scale of Usage:**
  - **Residential:** Household water usage typically includes drinking, cooking, bathing, and gardening. The cost here can depend on local tariffs and the amount of water used, with many areas using tiered pricing to encourage conservation.
  - **Commercial:** Businesses often pay higher rates than residential users, especially if they use water for industrial processes or require water of a higher quality.
  - **Agricultural:** Agriculture is a major consumer of water, and in many areas, it's subsidized or priced lower to support food production. However, this can lead to overuse and sustainability issues.
4. **Conservation and Efficiency:** Investments in water-efficient technologies and practices can reduce water use, thus lowering costs. This is particularly significant in areas with high water scarcity or high water prices.
5. **Policies and Subsidies:** Government policies and subsidies can dramatically affect water costs. In some regions, water is heavily subsidized, keeping prices artificially low, which can lead to overuse and wastage.
6. **Environmental Impact:** The environmental cost of water use, such as the impact on local ecosystems and the carbon footprint of water treatment and transportation, is often not reflected in the direct monetary cost but is an important consideration in the broader context of water usage.

Understanding water usage versus cost requires a comprehensive approach, considering these varied and region-specific factors.

## Water Quality Issues

As stated in the Plan, the Sooke Lake and Goldstream Reservoirs water quality and the CRD's primary and secondary disinfection practices currently meet the requirements of the Provincial Drinking Water Protection Act and associated Regulation as well as Health Canada's Guidelines for Drinking Water Quality.

The Plan clearly states 'The CRD drinking water quality from the Sooke Lake Reservoir is very good and it is difficult to provide economic justification for construction of filtration at this time.' Despite this fact, the Plan recommends design to be completed by 2032 to enable the plant to be constructed by 2037. The justification for this schedule appears to be the possibility that drought and wildfires may adversely impact water quality, and that regulations may change.

The Plan does not address risk mitigation to avoid the \$1 billion expenditure. Key facts to consider:

- In the drought of 2001, the drawdown of the reservoir was so extreme that the 1915 intake was reactivated. There was no impact on water quality.

- The Plan raises the potential for large-scale catastrophic wildfires in the water supply lands by referencing wildfires in the interior of BC and the Pacific Northwest. Humidity levels are higher in coastal areas, and this area is less prone to lightening strikes, a source on many of the fires in the Interior. Public access to the water supply area is prohibited virtually eliminating the risk of a human caused fire. Finally, the area is patrolled during fire season ensuring a quick response in the event of a fire. Even with very dry summers, for example, 2021 and 2022 catastrophic fires have not occurred on Vancouver Island.
- When the Greater Victoria Water District conducted a commercial logging operation in the water supply lands, harvested areas were replanted with a view to future harvesting. Several thousand trees per hectare were planted resulting in a very dense, unnatural forest cover. Fires in such plantations can spread rapidly. By comparison, old growth tree stands typically have a density range of 125 to 375 trees per hectare. The forest canopy is layered, with openings that allow light, encouraging the growth of understory vegetation such as ferns, shrubs, mosses and lichens, all of which reduces the potential for catastrophic fires. Implementing a programme to recreate old growth characteristics could mitigate the fire risk. This will take time and need to be adequately resourced.

## Pumped versus Gravity fed Regional Water Systems

Pumped and gravity-fed are two primary methods used for distributing water in regional water systems. Each system has its own advantages and challenges:

### 1. Pumped Water Systems:

- **Operation:** These systems use pumps to move water from the source to the treatment plant and then to the consumers. Pumps are essential to overcome elevation differences and to maintain adequate pressure in the system.
- **Advantages:** Pumped systems are highly versatile and can be used in varied topographies. They are essential in flat or uneven terrain where gravity alone cannot ensure water flow. These systems can maintain consistent pressure and are often used in urban areas.
- **Challenges:** The main challenge is the dependency on electricity or other power sources, which can lead to higher operational costs. There's also a need for regular maintenance of the pumps and associated infrastructure.

### 2. Gravity-Fed Water Systems:

- **Operation:** These systems rely on gravity to transport water from the source to the treatment plant and consumers. Typically, the water source is located at a higher elevation than the rest of the system.
- **Advantages:** Gravity-fed systems are generally more cost-effective in terms of operation and maintenance, as they require no energy input for the movement of water. They are also more reliable in areas with frequent power outages.
- **Challenges:** The major limitation is the dependence on topography. These systems are only feasible where there's a sufficient elevation gradient.

Additionally, maintaining water pressure can be challenging, especially for consumers at higher elevations or far from the source.

Both systems might be used in combination in some regional water supply networks to optimize efficiency and reliability. The choice between a pumped and gravity-fed system often depends on the regional topography, the location of water sources, and the specific needs of the area being serviced.

With implementation of the Plan, all water delivered to member municipalities will no longer be delivered by gravity (zero energy). One hundred percent of the region's water will be delivered by electric motor driven pumps.

Because of the dependence on electricity, back-up generators will be needed to continue service during power outages. If all the pumping stations included in the Plan were constructed, 24 MW in standby power would be required to ensure continuity of service.

## Financial Risk Management

Financial risk management in a Regional Water System Master Plan involves a systematic approach to identifying, analyzing, and addressing the financial challenges and uncertainties associated with managing a regional water system. This process is critical for ensuring the long-term financial sustainability of the water system. Key aspects of financial risk management in this context include:

1. **Cost Estimation and Budgeting:** Accurately estimating the costs associated with building, operating, maintaining, and upgrading the water system is crucial. This includes both capital expenses (CAPEX) for infrastructure development and operational expenses (OPEX) for day-to-day operations.
2. **Revenue Generation and Tariff Setting:** Developing a sustainable revenue model is essential. This often involves setting tariffs for water usage, connection fees, and other services. Tariffs must be carefully calculated to cover costs while remaining affordable and equitable for consumers.
3. **Financial Forecasting and Modeling:** Creating financial models that project future revenues, expenses, and cash flows is important for long-term planning. These models should account for various factors like population growth, economic changes, and potential impacts of climate change.
4. **Risk Assessment and Mitigation Strategies:** Identifying financial risks such as fluctuating demand, rising operational costs, natural disasters, and regulatory changes is crucial. Mitigation strategies might include diversifying revenue streams, establishing reserve funds, and obtaining insurance.
5. **Funding and Financing Options:** Exploring various funding and financing options is critical. This can include government grants, loans, public-private partnerships, bonds,

and other financing mechanisms. The plan should aim for a balanced mix that minimizes debt burdens while securing necessary capital.

6. **Cost Recovery and Efficiency Measures:** Implementing cost-recovery mechanisms and efficiency measures ensures that the water system is financially sustainable. This might involve water conservation programs, reducing non-revenue water (like leaks and unauthorized usage), and implementing efficient technologies.
7. **Contingency Planning:** Developing contingency plans for financial shocks or unforeseen expenses is essential. This could involve setting aside emergency funds or having flexible credit facilities.
8. **Stakeholder Engagement and Transparency:** Engaging stakeholders, including customers and investors, in the financial planning process is important. Transparency in financial matters builds trust and ensures community support.
9. **Regulatory Compliance and Reporting:** Ensuring compliance with all relevant financial regulations and standards, and maintaining accurate financial reporting, is essential for legal and operational reasons.
10. **Monitoring and Evaluation:** Continuously monitoring financial performance against the plan and adjusting strategies based on actual performance and changing conditions is vital.
11. **Sustainability and Environmental Considerations:** Incorporating sustainability and environmental considerations can have long-term financial benefits, such as reduced operational costs and increased funding opportunities from environmentally focused investors and grants.

Effective financial risk management in a Regional Water System Master Plan ensures that the water system remains robust and capable of meeting the region's water needs sustainably and efficiently, even in the face of financial uncertainties and challenges.

## Provincial Government Policy

The top issues for the government of British Columbia in 2023 revolve around addressing significant social, economic, and environmental challenges, as well as managing the impact of global economic conditions. Key areas of focus include:

1. **Housing and Affordability:** Sky-high rents and the need for more affordable housing are major concerns. The government is working on providing more homes for different income groups and tackling homelessness. There's also a focus on introducing a renter's tax credit and improving housing affordability.
2. **Healthcare System:** The healthcare system is under considerable strain, with efforts being made to improve health and mental health care. This includes investing in the health care workforce, improving cancer care, and expanding mental health and addictions services.
3. **Economic Growth and Fiscal Management:** Economic forecasts suggest a period of slower growth due to global inflation and higher interest rates, but steady growth is

expected in the medium term. The government aims to use its resources to support people and address key issues, including building a sustainable economy.

4. **Climate Change and Environmental Management:** Climate disruption is a significant challenge. The government's actions include managing and caring for natural resources like old-growth forests and investing in infrastructure for climate resilience. There's a push for more action in areas like clean technology and energy efficiency.
5. **Social Development and Poverty Reduction:** Addressing poverty and improving social welfare are critical. This includes raising welfare and disability assistance rates, enhancing employment standards, and investing in public child care and education.

The government's approach involves balancing the need for fiscal prudence with the imperative to make critical public investments to address these challenges. This balance is essential to ensure sustainable growth and the well-being of British Columbians in the face of global economic shifts and domestic challenges.

### Impacts on the BC Housing Crisis

The impact of water supply costs on housing development is multifaceted, influencing various aspects from the planning stage to the long-term sustainability of the development. Here's a breakdown of these impacts:

1. **Initial Development Costs:** The cost of integrating a water supply system into a new housing development can significantly affect the overall budget. This includes the expense of connecting to existing water infrastructure, installing pipelines, pumps, and possibly building new water treatment facilities. Higher water supply costs can lead to increased initial investment requirements for developers.
2. **Housing Prices and Affordability:** The cost of providing water supply infrastructure is often passed on to homebuyers or renters. If these costs are high, it can increase the price of homes or rental units, potentially making housing less affordable for consumers. This situation can particularly impact lower-income areas or regions where water resources are scarce or require significant treatment.
3. **Development Location and Feasibility:** The availability and cost of water supply can influence the location of new housing developments. Areas with limited or expensive water resources might be less attractive to developers, leading to a concentration of development in areas with more abundant or cheaper water supplies. This could impact urban sprawl and the distribution of population.
4. **Sustainable Development and Design:** High water supply costs can encourage the incorporation of water-efficient designs and technologies in new housing developments. These might include water-saving fixtures, rainwater harvesting systems, and wastewater recycling. While these features can increase upfront costs, they can lead to long-term savings and more sustainable water use.
5. **Regulatory Compliance and Impact Fees:** In many regions, developers are required to pay impact fees to fund the expansion of water infrastructure to accommodate new

developments. Higher water supply costs can lead to increased impact fees, which can further raise the cost of housing development.

6. **Long-term Operational Costs:** The cost of water supply affects not just the initial development but also the long-term operational costs of housing. Developments that incur higher costs for water supply may face increased maintenance and utility costs over time, impacting the affordability and attractiveness of the housing units.
7. **Financing and Investment Decisions:** The cost of water supply can influence investment decisions in housing projects. Higher costs might deter investment in certain areas or lead to a preference for developments with lower water supply costs. This can affect the availability of housing and the type of developments that are prioritized by investors and developers.
8. **Community and Economic Growth:** The cost of water supply can impact the broader economic growth and community development. Regions with high water supply costs might see slower growth in housing and population, which can affect local economies, employment opportunities, and community services.

In summary, water supply costs play a significant role in housing development, influencing decisions on location, design, pricing, and sustainability. Balancing these costs with the need for affordable, sustainable housing is a critical challenge for developers, planners, and policymakers.

## Options Analysis

Options analysis for regional water system upgrades typically involves evaluating various strategies to improve the water supply, distribution, and treatment systems. This kind of analysis would consider the following factors:

1. **Current System Assessment:** Evaluating the current state of the water system, including infrastructure age, capacity, reliability, and any existing issues.
2. **Demand Forecasting:** Projecting future water needs based on population growth, industrial development, and environmental considerations.
3. **Upgrade Options:** Identifying potential upgrades, which can range from repairing and replacing aging infrastructure to implementing new technologies for water treatment and distribution.
4. **Cost Analysis:** Estimating the costs associated with each option, including initial investment, operational costs, and long-term maintenance.
5. **Environmental Impact:** Assessing the environmental implications of each upgrade option, including potential effects on local ecosystems and water sources.
6. **Regulatory Compliance:** Ensuring that all proposed upgrades comply with local, regional, and national water quality and safety regulations.
7. **Stakeholder Input:** Gathering feedback from various stakeholders, including the public, industry experts, and government officials.

8. **Risk Management:** Evaluating the risks associated with each option, such as potential for system failures or vulnerability to climate change impacts.
9. **Sustainability:** Considering the sustainability of each option, including resource conservation and long-term viability.
10. **Implementation Timeline:** Developing a timeline for the implementation of chosen upgrades, including phases of construction and integration into the existing system.
11. **Funding and Financing:** Exploring options for funding the upgrades, which may include government grants, loans, public-private partnerships, or rate increases.
12. **Technological Innovations:** Exploring the integration of advanced technologies like smart water meters, leak detection systems, and advanced water treatment methods.
13. **Emergency Preparedness:** Planning for contingencies such as droughts, floods, or other emergencies that could impact water supply and distribution.
14. **Public Education and Engagement:** Implementing programs to educate the public about water conservation and the importance of the upgrades.

This comprehensive approach ensures that the chosen upgrades are cost-effective, environmentally friendly, sustainable, and meet the future needs of the region.

The current plan does not objectively evaluate the various options for improvements. Rather it simply proposes \$2 billion in infrastructure improvements and it's hard to believe that this is the only viable option.

## Value for Money Proposition

Conducting a value for money assessment for a regional water system upgrade involves several key steps:

1. **Cost Analysis:** The initial step is to understand the total cost of the project. This includes not only the upfront capital costs but also long-term operating and maintenance expenses. It's crucial to get detailed estimates from contractors and suppliers and consider potential cost overruns.
2. **Benefit Analysis:** Assess the benefits the upgrade will bring. This includes improved water quality, increased water supply reliability, and potential reductions in water loss. Quantify these benefits as much as possible, such as estimating the economic value of water saved or the health benefits of improved water quality.
3. **Risk Assessment:** Identify and evaluate risks associated with the project. This includes construction risks, environmental risks, and the risk of cost overruns or project delays. Assess how these risks might impact the cost and benefits of the project.
4. **Comparative Analysis:** Compare the proposed upgrade with alternative solutions. This could involve different technical approaches or varying scales of the upgrade. Evaluate each alternative based on cost, benefits, and risks.

5. **Stakeholder Consultation:** Engage with stakeholders, including local communities, government agencies, and environmental groups. This helps in understanding the broader impact of the project and may reveal additional benefits or concerns.
6. **Financial Analysis:** Conduct financial analyses like Net Present Value (NPV) and Internal Rate of Return (IRR) to evaluate the financial viability of the project. These analyses help in understanding the long-term financial returns relative to the investment.
7. **Environmental and Social Impact Assessment:** Evaluate the environmental and social impacts of the upgrade. This includes assessing the project's footprint on local ecosystems and its social implications on local communities.
8. **Regulatory Compliance:** Ensure that the project complies with all relevant local, regional, and national regulations. This includes environmental regulations, water use permits, and construction codes.
9. **Sustainability Assessment:** Assess how the upgrade contributes to sustainable water management. This involves considering the long-term viability of the water source and the adaptability of the system to potential future challenges such as climate change.
10. **Reporting and Documentation:** Finally, compile a comprehensive report that summarizes the findings from the above assessments. This report should provide a clear rationale for the investment decision, backed by data and analysis.

Throughout this process, it's important to maintain transparency and involve a range of experts including engineers, financial analysts, environmental scientists, and community representatives. This multidisciplinary approach ensures a thorough and balanced assessment.

## Determination of Science Based Options

A science-based evaluation of options to upgrade a regional water system involves a systematic approach that considers various technical, environmental, and economic factors. This process often includes the following steps:

### 1. Needs Assessment

- **Demand Analysis:** Evaluate current and projected water demand based on population growth, industrial needs, and environmental factors.
- **System Evaluation:** Assess the current state of the water system, including infrastructure age, capacity, and efficiency.

### 2. Option Identification

- **Technological Innovations:** Research the latest technologies in water treatment, distribution, and conservation.
- **Best Practices:** Review case studies or models from similar regions that have successfully upgraded their water systems.

### 3. Environmental Impact Analysis

- **Resource Sustainability:** Analyze the sustainability of water sources and potential impacts on ecosystems.

- **Climate Change Adaptation:** Consider future climate scenarios and their potential impact on water availability and infrastructure resilience.

#### 4. Economic Assessment

- **Cost Analysis:** Estimate the capital and operational costs of different upgrade options.
- **Funding and Financing:** Explore funding sources, including government grants, public-private partnerships, and rate adjustments.

#### 5. Risk Assessment

- **Infrastructure Risks:** Evaluate risks related to aging infrastructure, including pipe failures and system inefficiencies.
- **External Risks:** Consider risks from natural disasters, climate change, and external contamination sources.

#### 6. Technical Feasibility

- **Engineering Analysis:** Conduct technical assessments of proposed upgrade options to ensure they are technically feasible and meet regulatory standards.
- **Capacity Planning:** Ensure that the system can handle current and future demands, including peak loads.

#### 7. Public Health Considerations

- **Water Quality:** Assess the ability of different upgrade options to meet or exceed water quality standards.
- **Public Health Impacts:** Evaluate the potential health impacts of different water sources and treatment methods.

#### 8. Regulatory Compliance

- **Legal Standards:** Ensure that all options comply with local, regional, and national water regulations and standards.
- **Permitting:** Identify any necessary permits or approvals required for different upgrade options.

#### 9. Stakeholder Input

- **Community Engagement:** Involve local communities and stakeholders in the decision-making process.
- **Expert Consultation:** Seek input from engineers, environmental scientists, and public health experts.

#### 10. Comparative Analysis

- **Option Comparison:** Weigh the pros and cons of each option based on the above criteria.
- **Decision Matrix:** Use a decision matrix or similar tool to objectively compare different options.

#### 11. Pilot Projects and Testing

- **Feasibility Testing:** Implement pilot projects or small-scale tests for promising options.
- **Monitoring and Evaluation:** Continuously monitor and evaluate the performance of these pilot projects.

#### 12. Final Recommendation

- **Best Option:** Based on the evaluation, recommend the most viable option for upgrading the water system.

- **Implementation Plan:** Develop a detailed plan for implementing the chosen option, including timelines, budgeting, and project management strategies.

It is critical to ensure a comprehensive and objective evaluation of different options for upgrading a regional water system, taking into account the diverse and complex factors that influence such decisions.

## Public Process

Creating a public consultation strategy for proposed upgrades to a regional water system involves a series of steps designed to engage various stakeholders effectively. The strategy should aim to gather input, address concerns, and ensure transparency throughout the project. The following is an outline for a comprehensive public consultation strategy:

### 1. Project Introduction

- **Objective:** Introduce the project, outlining its goals, scope, and potential impacts.
- **Background Information:** Provide context on why upgrades are necessary (e.g., aging infrastructure, increasing demand, environmental compliance).

### 2. Stakeholder Identification

- **Primary Stakeholders:** Residents, local businesses, environmental groups, indigenous communities.
- **Secondary Stakeholders:** Regulatory bodies, non-local entities potentially impacted by the project.

### 3. Information Dissemination

- **Communication Channels:** Utilize websites, social media, press releases, local media, and community newsletters.
- **Information Packages:** Develop clear, concise materials explaining the project, including FAQs, visual aids, and impact assessments.

### 4. Engagement Activities

- **Public Meetings:** Host town hall meetings and information sessions in various locations.
- **Workshops and Focus Groups:** Conduct targeted sessions with specific stakeholder groups.
- **Online Platforms:** Create a dedicated website and social media presence for ongoing updates and feedback collection.

### 5. Feedback Mechanisms

- **Surveys and Questionnaires:** Distribute both online and in-person to gather structured feedback.
- **Comment Forms:** Available at public meetings and online for unstructured feedback.
- **Public Hearings:** Formal opportunities for stakeholders to present their views.

### 6. Accessibility and Inclusivity

- **Language and Accessibility:** Ensure materials and meetings are accessible, including language translation and accessibility for people with disabilities.
- **Cultural Sensitivity:** Respect cultural practices, especially in communications with indigenous communities.

## 7. Analysis and Reporting

- **Feedback Analysis:** Compile and analyze all feedback to identify key themes and concerns.
- **Public Reporting:** Release a report summarizing the consultation outcomes and how feedback will influence the project.

## 8. Regulatory Compliance and Environmental Assessment

- **Legal Requirements:** Ensure the consultation process meets all legal and regulatory requirements.
- **Environmental Impact Assessment:** Share findings and how environmental concerns will be mitigated.

## 9. Ongoing Communication

- **Updates:** Regularly update stakeholders on project progress and how their input is being considered.
- **Responsive Communication:** Address new concerns or queries as the project progresses.

## 10. Evaluation and Adaptation

- **Consultation Evaluation:** After initial rounds of consultation, evaluate the effectiveness of the strategy.
- **Adaptation:** Adjust the strategy based on feedback and effectiveness.

## 11. Documentation and Record Keeping

- **Transparency:** Keep detailed records of all consultation activities and feedback received.
- **Accessibility:** Make these records available to the public where appropriate.

## 12. Timeline and Milestones

- **Schedule:** Outline key dates for consultations, feedback deadlines, and reporting milestones.

The strategy should be flexible enough to adapt to changing circumstances and stakeholder needs. It's important to approach the consultation process with a commitment to transparency, inclusivity, and responsiveness.

## Recommendations

1. The CRD's "Total Annual & Summer Demand 2020 – 2100" which is the foundation of the assumptions of the Master Plan, assumes rates of increase that are not supported by data trends. A Comprehensive Water Demand Study is required to better forecast water consumption trends, factoring in the impacts to the water demand curve resulting from significant increases to bulk water supply rates. There is a large body of scientific knowledge around water demand sensitivity to higher rates.
2. Technical rationale for the filtration plant is lacking. Comparison to Vancouver and Seattle watersheds indicate that the CRD Watershed is a vast and protected greenspace with limited human impact. The rationale for the plant:

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- a. Appears to be driven by a date-certain, near-term Leach River Diversion, in turn driven by un-substantiated assumed water demand escalation,
  - b. Wildfire/Climate Change Risk Profile for Catastrophic Risk into the Future – there is an un-qualified assumption that filtration is required to address future forest fire and climate change risks, however given our coastal climate with many watchful eyes on the watershed, it's not clear that out of control wildfire risk is a concern. Development of a Watershed Wildfire Management Strategy may be an effective and cost-efficient alternative to a capital and energy intensive filtration plant.
3. Detailed Review of Climate Change Risks, including a GHG Impact analysis of the proposed pumped water flows and filtration plant. The CRD's GHG mitigation strategies related to a significant change to the CRD water system, will have a major impact to the member municipalities GHG strategy.
  4. Seismic Phase 2 Risk Assessment of existing and planned tunnels must be completed to enable more accurate and up to date cost estimates and route feasibility.
  5. The CRD Water Master Plan should be brought into alignment with the Province's five strategies related to housing affordability, attracting health care providers, poverty reduction, climate change and fiscal management. The current Master Plan potentially conflicts with all of them.
  6. The fiscal management of the plan is inadequate. The cost estimates are likely to be grossly understated given recent experience and a full risk management is missing.

## Appendix A- Fire Risk mitigation Strategies in a Watershed

When the City of Victoria decided to develop Sooke Lake as its source of drinking water in the early 1900's, it purchased land around the lake and prohibited public access. The water from the lake was untreated until the 1940's when the American soldiers stationed in Victoria required a minimum of disinfection. Chloramine disinfection was added, and remained the only form of treatment until the late 1990's. That was only possible because of the owned and protected watershed. Land deals in the late 1990's and early 2000's secured additional land in the Sooke Watershed so that more than 95% of the watershed is controlled by the CRD, over 20,000 hectares. The Leech watershed was also purchased at that time.

Fire risk mitigation strategies in a watershed are critical for preserving the natural resources and protecting the communities living within and around these areas. The only human habitation near the CRD watersheds is along Shawnigan Lake road. Here are some strategies that are typically used to reduce the risk of fire in watershed areas with examples of the probable relevance to the CRD watershed:

- **Fuel Management:** This includes reducing the amount of flammable material, such as dead trees, brush, and organic debris, which can fuel a fire. Techniques include controlled burns, mechanical thinning, and the removal of invasive species that may contribute to the fuel load. Revenue could be generated from the sale of the thinned trees. Several thousand trees per hectare would have to be removed from plantation forest areas. The last commercial logging and reforestation took place in the early 1990's.
- **Creating Fire Breaks:** Fire breaks can be natural or man-made barriers that prevent the spread of fire. These can include rivers, roads, or cleared strips of land. The existing road network does provide some fire break but may not be wide enough to be useful.
- **Reforestation and Afforestation:** Planting fire-resistant species in areas prone to wildfires can create a more resilient landscape. These species are less likely to ignite and can help slow the spread of fires. Presently the whole area is already forested and this issue requires further careful thought.
- **Water Resources Management:** Maintaining healthy water levels in rivers, lakes, and wetlands can help to provide natural fire breaks. Additionally, ensuring that water resources are readily available for firefighting efforts is vital. Given that the Reservoir is drawn down during the fire season and only on creek (Rithet) flows year-round this maybe challenging to achieve.

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- **Community Fire Plans:** Developing community-wide plans that include evacuation routes, communication strategies, and emergency preparedness can help mitigate risk to human life and property.
- **Building and Infrastructure Regulations:** Implementing building codes that require fire-resistant materials and designs, especially for structures in close proximity to wildland areas.
- **Public Education and Awareness:** Informing the public about fire risks and prevention methods can help reduce human-caused fires. This includes promoting safe campfire practices, proper disposal of smoking materials, and awareness of local fire restrictions. While there is no public access to the watersheds, fires spreading from adjacent areas or trespass is still an issue.
- **Early Detection and Monitoring Systems:** Using technology such as satellite imagery, drones, and lookout towers to detect fires early can be crucial in quickly responding and containing them. The CRD Watershed management team are trained in fire fighting, monitors lightning strikes, employs daily patrols during fire season, has fire suppression equipment (pumps, hoses, reservoirs, etc.) strategically located, and responds to any evidence of fire on CRD or adjacent lands. The density of lightning strikes on southern Vancouver Island compared to the Interior should be part of the risk assessment.
- **Integrated Land and Vegetation Management:** Managing the land for multiple uses, such as grazing, timber, and recreation, in ways that also reduce fire risk. The CRD land is managed exclusively for protection of the water source. In doing so also it protects ecological values. The primary invasive species is broom. Gravel used for roads maintenance contained seeds which germinated. This is very difficult to eradicate, but does present a fire risk.
- **Climate Change Adaptation:** As climate change increases the risk and intensity of wildfires, strategies need to incorporate predictive models and long-term planning to adapt to changing conditions. Historically wildfires have occurred in the area but were not devastating because of the low density of the natural forest cover, hence the need to restore natural forest characteristics. Fire suppression has increased fuel accumulation on the forest floor.
- **Cooperation and Partnerships:** Fire mitigation is most effective when multiple stakeholders, including federal, provincial, and local governments, as well as private landowners and indigenous communities, work together. The CRD still has a reciprocal mutual aid agreement with the Province to respond to wildfires.

These strategies often require a coordinated effort between various government agencies, non-profit organizations, and community members to be effectively implemented and managed.

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The specific approaches taken can depend greatly on the local ecology, climate, and socio-economic factors of the watershed in question.

## Appendix B- Seismic Risk to Tunnels constructed through Rock

Seismic risk to tunnels constructed through rock is an important consideration in geotechnical and structural engineering. The design and construction of tunnels in seismic regions require careful analysis and implementation of safety measures to ensure structural integrity and public safety during and after an earthquake. Here are some key points to consider:

1. **Rock Type and Quality:** The type of rock through which the tunnel is constructed can significantly affect its seismic performance. Hard, intact rock is generally more resistant to seismic shaking than fractured or weak rock.
2. **Depth of the Tunnel:** Generally, tunnels at greater depth are less affected by seismic waves compared to shallow tunnels because the rock mass at depth tends to dampen the seismic energy more effectively.
3. **Tunnel Lining Design:** The design of the tunnel lining must be able to accommodate the deformations induced by seismic waves. Flexible lining systems can absorb and distribute seismic forces better than rigid ones.
4. **Geological Features:** Fault zones, shear zones, and other geological discontinuities can be weak points that may fail during seismic events. Tunnel alignment should avoid these features when possible or be designed to mitigate their potential impact.
5. **Seismic Load Analysis:** The use of dynamic analysis methods to simulate the response of the tunnel to different seismic loads. This includes both ground shaking and potential fault displacement at the site.
6. **Construction Method:** The New Austrian Tunneling Method (NATM) and the Tunnel Boring Machine (TBM) are popular choices. NATM, in particular, is designed to use the inherent strength of the surrounding rock mass to support the tunnel, which can be beneficial in seismic areas.
7. **Segmental Linings:** For tunnels constructed with TBMs, segmental linings with gaskets can be designed to accommodate seismic movements without significant loss of support or water tightness.
8. **Seismic Joints:** Including seismic joints at regular intervals can help to isolate sections of the tunnel, preventing cracks from propagating along the entire length.
9. **Redundancy and Robustness:** The tunnel design should incorporate elements of redundancy and robustness, ensuring that if one part of the structure fails, the overall integrity of the tunnel is maintained.
10. **Monitoring and Maintenance:** Installation of monitoring equipment to detect seismic activity and the structural response of the tunnel over time. Regular maintenance can also identify and repair minor damages before they become serious issues.
11. **Emergency Preparedness:** Developing emergency response plans specifically for seismic events, including evacuation routes, communication systems, and safety measures for occupants.
12. **Adherence to Standards and Guidelines:** Following regional and international guidelines, standards, and best practices for tunnel construction in seismic areas to ensure the highest safety levels.

13. **Research and Development:** Keeping abreast of the latest research and technological developments in seismic risk mitigation for tunnels and implementing new findings and technologies where applicable.

Engineers must integrate these considerations into the design and construction process to ensure the resilience of tunnels during seismic events. This involves a multidisciplinary approach, combining geological assessments with advanced engineering design and construction techniques.

Tunnel failures in earthquakes are often due to several factors, including the intensity of the earthquake, the depth and construction of the tunnel, and the geological conditions surrounding it. Here are some notable instances where tunnels have failed or been significantly damaged during earthquakes:

1. **Great Hanshin Earthquake, Japan (1995):** The Kobe earthquake caused significant damage to several tunnels. The damage ranged from minor cracks to collapses, especially in older tunnels. This earthquake highlighted the vulnerability of tunnels to seismic activity and led to improvements in Japanese tunnel design standards.
2. **Wenchuan Earthquake, China (2008):** This devastating earthquake caused collapses and severe damage to numerous tunnels in the Sichuan province. The earthquake's intensity, combined with the mountainous terrain, led to significant challenges in tunnel stability.
3. **Christchurch Earthquakes, New Zealand (2010-2011):** While Christchurch itself does not have major tunnels, the earthquakes caused landslides and rockfalls in surrounding areas, which affected road tunnels and led to closures and repairs.
4. **Northridge Earthquake, USA (1994):** In Los Angeles, the Northridge earthquake caused damage to several freeway tunnels, mainly due to ground shaking. The damage was mostly to tunnel linings and support structures.

One important issue to consider is that upgrading the seismic stability of a tunnel may have limited ability if the connections on each side of the tunnel are damaged during a seismic event.

## Appendix C - References

1. 2022 Regional Water Supply Master Plan Presentation
2. 2022 Regional Water Supply Master Plan Executive Summary
3. Treated Water Transmission Main Upgrades (Phases 1-4.2) – May 2022 – Stantec
4. 2022 Regional Water Supply Master Plan Engagement Summary
5. "Risk and Resilience Management of Water and Wastewater Systems" standard developed by the American Water Works Association (AWWA)

## Appendix D - Jonathan Huggett Resume

<b>1. Contact Information:</b>
<ul style="list-style-type: none"><li>Jonathan R Huggett P.Eng (BC, AB, Ont) Principal of J R Huggett Company Corp. <a href="mailto:jhuggett@jrhugettco.com">jhuggett@jrhugettco.com</a></li></ul>
<b>2. Summary:</b>
<p>Jonathan Huggett is a registered Professional Engineer in BC, Alberta and Ontario with extensive experience in public sector projects from concept, through business planning, delivery models, design, construction, operation and maintenance.</p> <p>He has over 40 years extensive experience in a very wide range of project types including:</p> <ul style="list-style-type: none"><li>Water, wastewater and storm drainage projects</li><li>Highways, fixed and moveable bridges and transportation modelling</li><li>Rapid transit including bus systems and the Skytrain Project in Vancouver BC</li><li>Sport and Entertainment complexes</li><li>Fire Stations</li><li>Municipal offices</li><li>Specialist public buildings including rehabilitation of the CN Tower in Toronto</li><li>Real estate development</li></ul> <p>The services he provides are also wide ranging including:</p> <ul style="list-style-type: none"><li>Governance and organizational reviews</li><li>Project business planning</li><li>Project delivery methods evaluation</li><li>Structuring of partnerships</li><li>Preparation and review of business plans</li><li>Project management of design and construction</li><li>Analysis of operation and maintenance requirements</li></ul>

3. Professional Experience:

Highlights of some recent projects relevant to the assignment include the following:

1. Project Director for completion of the Johnson Street Bridge
2. Project Consultant for the recent City of Victoria Fire Station No. 1 partnership project
3. Project advisor on various aspects of the CRD Wastewater Project
4. Project Consultant for the CRD Japan Gulch water treatment upgrade
5. Project Consultant for a large number of water, wastewater and storm drainage projects in BC, Alberta and Ontario

4. Education:

- Imperial College, London UK – B.Sc(Eng), ACGI – Civil Engineering
- University of Warwick, UK – Graduate studies in Project Management
- P.Eng (BC, Alberta, Ontario)
- C.Eng – Institution of Civil Engineers, London, UK