APPENDIX C

CRD/IWS REPORT NO. 1186

Capital Regional District | Regional Water Supply 2022 Master Plan

MAY 2022

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APPENDIX C

Capital Regional District
Regional Water Supply Service

2022 Master Plan

IWS Report No. 1186

Stantec

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APPENDIX C

Sign-off Sheet

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ABBREVIATIONS

AC	Asbestos Cement
ACH	Aluminum Chlorohydrate
ADD	Average Day Demand
AEP	Annual Exceedance Probability
ALA	American Lifelines Alliance
AWWA	American Water Works Association
BC	British Columbia
BCBC	British Columbia Building Code
CDA	Canadian Dam Association
CFU	Colony Forming Units
CIP	Clean-in-place
CRD	Capital Regional District
CWH	Coastal Western Hemlock
DAF	Dissolved Air Flotation
DCS	District of Central Saanich
DGR	Deception Gulch Reservoir
DMF	Devil's Mountain Fault
DNS	District of North Saanich
DOC	Dissolved Organic Carbon
DWOs	Drinking Water Officers
DWOG	Drinking Water Officers' Guide
DWPA	Drinking Water Protection Act
DWPR	Drinking Water Protection Regulation
ECCC	Environment and Climate Change Canada
EDGM	Earthquake Design Ground Motion
EFNP	Environmental Flow Needs Policy (BC Water Sustainability Act)
EGBC	Engineers and Geoscientists BC
FCM	Federation of Canadian Municipalities
FLNRORD	Forests, Lands, Natural Resource Operations and Rural Development
FUS	Fire Underwriters Survey
GAC	Granular Activated Carbon
GDS	Goldstream Disinfection Facility
GVWSA	Greater Victoria Water Supply Area
GVWD	Greater Victoria Water District

HGL	Hydraulic Grade Line
HP	Horsepower
ID	Identification
IHA	Island Health Authority
ICI	Industrial/Commercial/Institutional
IESWTR	Interim Enhanced Surface Water Treatment Rule
IWS	Integrated Water Services
JDFWD	Juan De Fuca Water Distribution
JGDF	Japan Gulch Disinfection Facility
JGR	Japan Gulch Reservoir
KWL	Kerr Wood Leidal Consulting Engineers
L/c/d	Litres /capita/day
LRVF	Leech River Valley Fault
LOS	Level of Service
L/S	Litres Per Second
1994 Plan	Long Term Water Supply Plan (Greater Victoria Water District, Long Term Water Supply Plan, Montgomery Watson, and Dayton & Knight, 1994)
MAC	Maximum Acceptable Concentration
MAMP	Municipal Asset Management Program
MCL	Maximum Contaminant Level
MDD	Maximum Day Demand
MF	Microfiltration
ML	Million Litres
MLD	Megalitre Per Day (million litres per day)
MMCD	Master Municipal Construction Documents
MoE	Ministry of Environment
Mm^3Y	Million cubic metres Per Year
MTBM	Micro Tunnel Boring Machine
NBC	National Building Code
NOM	Natural Organic Matter
NPV	Net Present Value
NTU	Nephelometric Turbidity Unit
OD	Outside Diameter
ORP	Oxidation-Reduction Potential
OTC	Once-Through Cooling
PCIC	Pacific Climate Impacts Consortium – University of Victoria

PCS	Pressure Control Station
PCCP	Prestressed Concrete Cylinder Pipe
PHD	Peak Hour Demand
PRV	Pressure Reducing Valve
PS	Pump Station
PSHA	Probabilistic Seismic Hazard Analysis
PVC	Polyvinyl Chloride
QMRA	Quantitative Microbial Risk Assessment
RCP	Relative Concentration Pathway
RFP	Request for Proposal
RISC	Resources Information Standards Committee
RWS	Regional Water Supply
RWSC	Regional Water Supply Commission
SCADA	Supervisory Control and Data Acquisition
SDWA	Safe Drinking Water Act
SHR	Smith Hill Reservoir
SLR	Sooke Lake Reservoir
SRRDF	Sooke River Road Disinfection Facility
SUVA	Specific Ultraviolet Absorbance
SWTR	Surface Water Treatment Rule (USEPA)
TAD	Total Annual Demand
TBD	To Be Determined
TBM	Tunnel Boring Machine
TCU	Temperature Control Unit
TDH	Total Dynamic Head
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TP	Total Phosphorus
TSD	Total Summer Demand
TWL	Top Water Level
UF	Ultrafiltration
US	United States
USEPA	United States Environmental Protection Agency
UV	Ultraviolet
UVIC	University of Victoria

UVR	Ultraviolet Radiation
UVT	Ultraviolet Transmittance
WDD	Winter Day Demand
WFT	Water Filtration Plant
WSA(s)	Water Supply Area(s)
WTP	Water Treatment Plant

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EXECUTIVE SUMMARY

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 overall organization of the RWS service and their major customers is shown in **Figure E.1.**

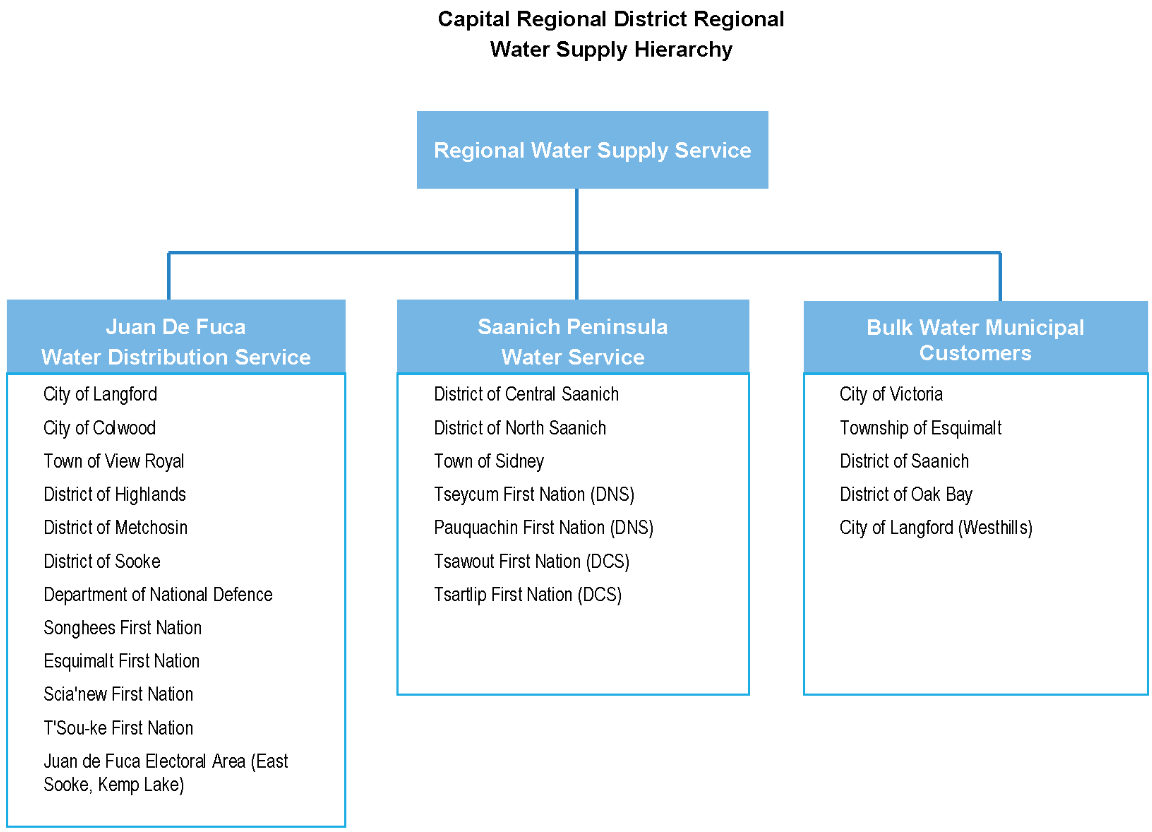

Figure E.1: Regional Water Supply Hierarchy

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. **Figure E.2** illustrates the components and service area of the RWS.

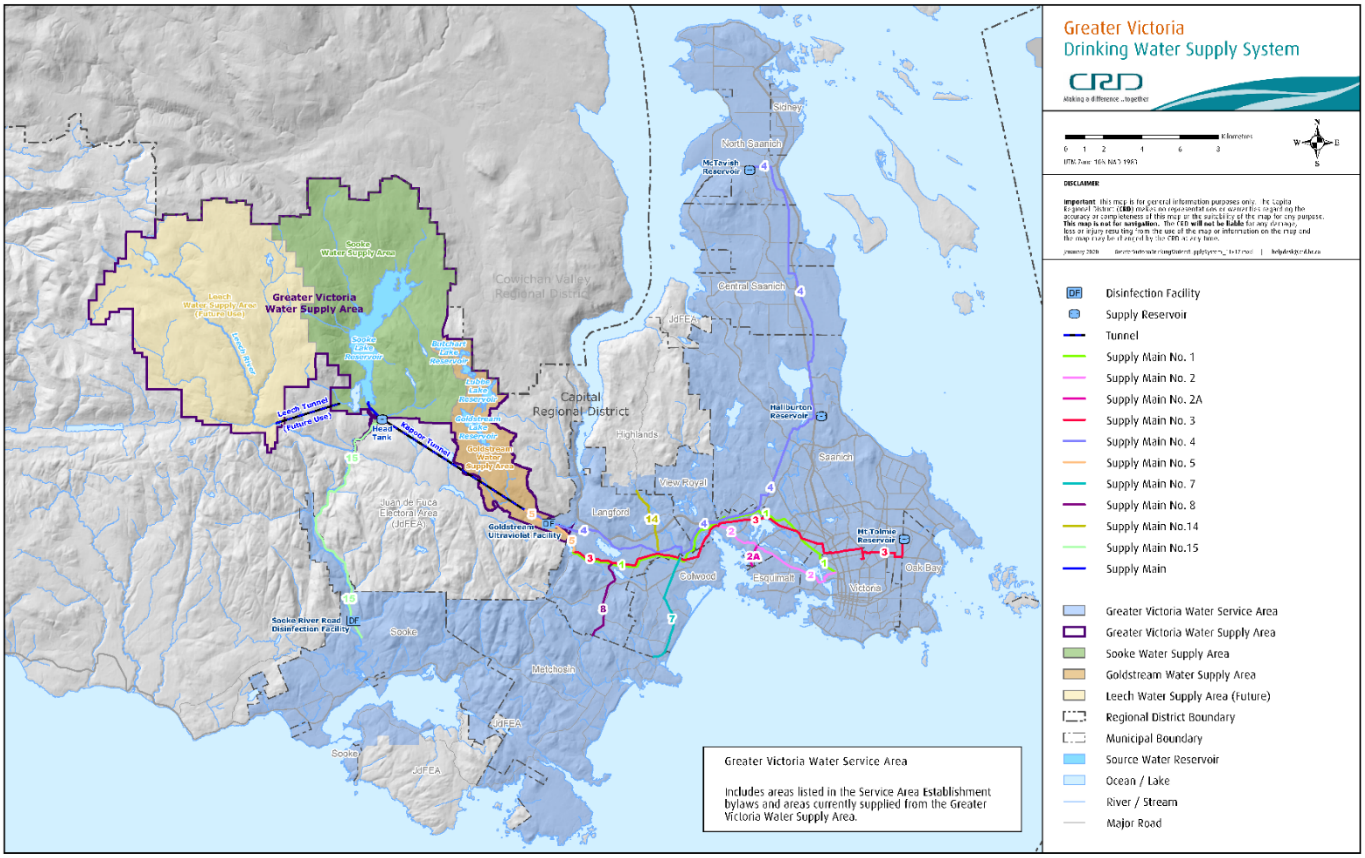

Figure E.2: RWS Water Service Area

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

This 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

As part of this RWS 2022 Master Plan, three concurrent studies were completed by Stantec to inform this report. Key findings from these studies have been considered in this 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 are outlined in **Table E.1**. A mid-range 1.25% annual population growth rate was selected for the purposes of planning future water supply facilities.

Table E.1: Projected Population of Regional Water Supply Service Area for Three Population Growth Scenarios

Year	Low (1.00%)	Med (1.25%)	High (1.50%)
2030	432,000	444,000	456,000
2050	527,000	569,000	615,000

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). **Figure E.3** illustrates the benefit 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 red dashed line in **Figure E.3** depicts an estimate of the safe 1:50 year drought yield (67Mm^{3}Y) of SLR and illustrates the impact of different consumption levels on extending the life of the SLR. If demand continues at the current rate (no decline curve), the SLR source will be at its capacity limit by 2045. The CRD should continue 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 this 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.

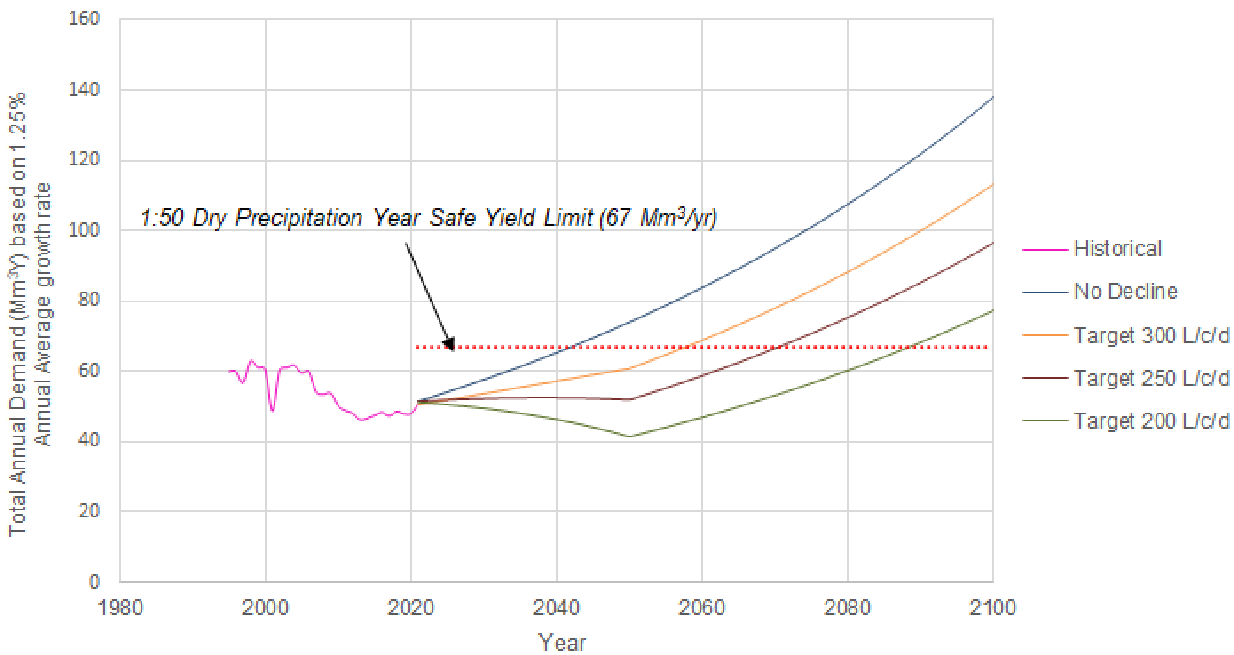

Figure E.3: Water Demand Projections

Water Quantity

A hydrological assessment has been completed for the Sooke and Leech watersheds. It is estimated that the Sooke watershed has the capability to supply an additional 40% increase in annual demand (up to 67 Mm^3 Y) over the current demand of 48 Mm^3Y. Projecting from the current annual demand level using a population growth rate of 1.25%, the Sooke watershed safe yield capacity will be reached before the 2050 planning design horizon in the year 2045. **Figure E.4** illustrates the Sooke Lake Reservoir water level response to varying increases in annual demand ranging from a 10 to 50% increase over current annual demand levels for a 1:50 year drought precipitation year followed by a year of normal precipitation.

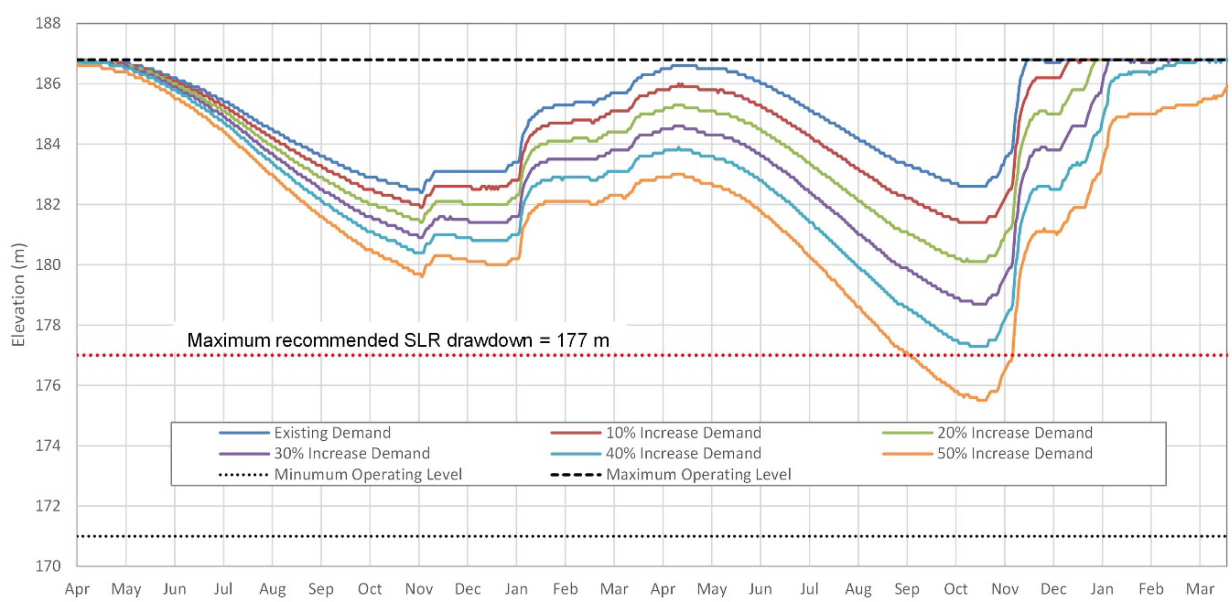

Figure E.4: Simulated Water Level in Sooke Lake Reservoir for a 1:50 Dry Precipitation Year

The SLR response assumes there is no multi-year drought condition experienced, which is consistent with historical records for this source. This figure indicates that an increase of 40% over current annual demand is the maximum that can be sustained without impacting the ability of the SLR to fill during a normal precipitation year following a 1:50 drought year.

Leech Watershed

The Leech watershed has been identified as a possible long-term additional supply for the RWS. The Leech watershed has a large catchment area of 9,600 hectares in comparison to Sooke watershed with 8,862 hectares. The Leech watershed has the capability of producing significant flows in the winter months. However, during the summer months the Leech River inflows are negligible. Development of storage on the Leech River or direct diversion will be required to augment flows to SLR. The amount of water that can be diverted to Sooke Lake will depend on the outcome of a further detailed hydrology and water balance model as well as discussions with the Province on the Environmental Flow Needs Policy requirements under the Water Sustainability Act. In lieu of construction of a dam, another possibility is a direct intake into Leech River and diverting flows to SLR via the Leech tunnel during periods of higher flow in the shoulder seasons depending on SLR water levels. Direct diversion would also improve SLR resiliency during drought conditions and assist in refilling of the SLR to protect against multi-year drought conditions impacting SLR water levels. This would require development of a reservoir water balance and operating model to determine the optimal operation of the combined SLR and Leech River diversions. This model would also assist in managing water levels in SLR for dam safety. The Deception Gulch Reservoir could be used to transfer flows to SLR, but upgrades to Deception Gulch Dam and spillway would be required as well as improvements to the Sooke Lake Reservoir Saddle Dam.

As population grows in the CRD water demands will also increase to a threshold limit and ultimately the finite capacity of the Sooke watershed will be reached and the Leech watershed will have to be brought into service. At a mid-range demand growth of 1.25% annually it is projected that the Leech water supply would have to be in service by the year 2045. This is the approximate year when demands will reach the 1:50 year safe drought yield of the Sooke watershed.

Planning for diversion of the Leech River should commence by 2032 as it can take some time to conduct the required planning, environmental studies, permitting, design, and construction of works necessary to develop this source. The Leech River source should be in service no later than 2042 several years ahead of time when the safe yield of the Sooke watershed is reached.

Goldstream Watershed

The Goldstream watershed and the series of upland lakes serve as a valuable secondary source with an available storage of 10 Mm^3. This storage is suitable for suppling RWS when the Kapoor Tunnel must be taken out of service for inspection and maintenance. Potential landslides in the Goldstream Canyon limit the use of this source during wet weather but if an intake to Goldstream Lake and a transmission main are constructed to Japan Gulch then this source could serve as a year-round supply and provide up to 20% of the current annual demand. Detailed hydrology was not completed for the Goldstream watershed as it primarily serves as a secondary supply for RWS.

Deep Northern Intake and Transmission

The possibility of installing an intake to extract water from the deeper basin of the SLR has been investigated and is discussed in detail in the *Deep Northern Intake, Transmission and Treatment Study* (Stantec 2021). Major findings of the study indicate that a deeper intake would be useful to provide a second redundant intake into the SLR which would improve system resilience and enable extraction of water below the existing intake tower low port elevation of 169 m. While the Deep Northern Intake provides improved water quality and resiliency during drought conditions, reservoir operation below levels of 177 m would make it more difficult to replenish the reservoir during average winter precipitation periods following a 1:50 year drought condition unless water from Leech is diverted to the SLR. In addition, drawing the SLR below 177 m could also lead to water quality issues from low water levels in some areas of the reservoir and siltation associated with shore erosion. The deeper intake does provide added benefits of better water quality, more stable temperature, and less likelihood of algae related water quality concerns. It would also serve as a redundant supply if the existing intake tower were to fail during a seismic event or if an extended multi-year drought condition is experienced.

A preliminary location has been identified for the deep northern intake approximately 2 km north of the boat launch. This intake location will be confirmed by further investigations including geotechnical, and further water quality sampling.

Connection of a proposed Deep Northern Intake could be made in a staged approach by connecting to the existing Head Tank downstream of Sooke Lake Dam. This would enable the CRD to draw from deeper sections of the SLR to better manage water quality as well as provide improved resiliency during emergency conditions or drought periods. Ultimately, the intake could be connected to a second transmission system (1994 Jack Lake alignment) connecting to Japan Gulch Reservoir to provide redundancy to the Kapoor Tunnel.

A variety of options have been investigated for connection of the proposed Deep Northern Intake to a secondary transmission system for Kapoor Tunnel. These include a second intake and gravity conveyance tunnel, pumped overland transmission mains along different alignments, a floating pump station and submerged marine pipeline, or a hybrid tunnel and pumped transmission system. The final selection of the preferred option can be made at the preliminary design phase, but all options are feasible. A lower level of service suitable to supply the year 2100 ADD would be suitable for sizing of this transmission main and reducing the overall pumping power required to deliver water via a transmission main corridor which was referenced in the 1994 Plan as the Jack Lake alignment. The intake, pump station, and transmission main for delivery of flows to the Head Tank would be sized for the year 2100 MDD so the pump station can serve as a complete redundant intake serving the Head Tank and Kapoor Tunnel. The second phase of the project would involve construction of additional booster pumping stations and the transmission main following the Jack Lake alignment.

A floating pump station is an option that could be considered for the Deep Northern Intake. A similar size facility was constructed for Seattle Public Utilities Chester Morse Lake pump station and large capacity facilities have been built overseas. The decision on which option to pursue, a fixed land-based pump station and micro tunneled intake or a floating pump station can be made at the preliminary design phase.

The Kapoor Tunnel has sufficient hydraulic capacity to convey demands to the year 2100. IWS has been effective in managing this critical asset through regular inspections and maintenance repairs.

One of the recommendations of this 2022 Master Plan is to complete a seismic assessment of the tunnel to assess its vulnerability to seismic events.

Water Quality and Treatment

The RWS currently operates as an unfiltered system with advanced disinfection. Water quality from SLR with UV, chlorine and chloramine disinfection meets current provincial *Drinking Water Treatment Objectives for Surface Water Supplies* and Health Canada's *Guidelines for Canadian Drinking Water Quality.* The current practice of advanced disinfection using Ultraviolet light, chlorine, and ammonia provides an acceptable level of protection for RWS water customers. However, the disinfection systems can become compromised if turbidity, colour, and organic levels increase due to wildfires in the watershed or other environmental factors including climate change.

Many previously unfiltered sources serving large populations across North America are now considering or have installed filtration. These include the Portland Bull Run source and the New York Croton source. The Comox Valley Regional District also recently commissioned a new water filtration facility in July 2021. The long-term plan for Metro Vancouver's unfiltered Coquitlam source is to install filtration. With the trend to more stringent water quality requirements, it is likely just a matter of time before provincial or federal health authorities will be requiring filtration on all surface waters serving major population centres. Filtration has other benefits including improving overall water quality consistency, improvements in transmission system water quality and providing operational resiliency during periods of changing raw water quality. Filtration will also be required once Leech River water is brought online. A recommendation of this 2022 Master Plan is to plan for construction of filtration by the year 2037.

Several feasible multi-barrier filtration and disinfection process options have been identified and evaluated including direct filtration, DAF plus filtration and membranes. Based on the existing SLR raw water quality and life cycle cost evaluation direct filtration is a viable option for filtration of Sooke Lake Reservoir water. Further evaluation including filtration pilot studies is required to confirm the process selection. If Leech River water is used in the future it may require the addition of a sedimentation, flotation, or other clarification process to treat elevated turbidity, organics, and colour. A recommendation is that a filtration piloting program be completed for Sooke Lake and blended Leech River and Sooke Lake Reservoir water.

Three sites were evaluated for future filtration facilities. A potential water filtration site has been identified adjacent to the Japan Gulch Reservoir. This site offers advantages as it is central to CRD operations, readily accessible, and the plant can easily be connected to Kapoor Tunnel and the RWS transmission system. Further refinement of the final filtration plant location will depend on a variety of factors including geotechnical investigations and preliminary design details. The final site can be determined once further investigations are completed. Under the current configuration of the water transmission system, the Japan Gulch location would be unable to provide filtered water for the District of Sooke. Providing filtered water for the District of Sooke would require the construction of a new east – west transmission main, or a second filtration plant could be constructed at the Sooke River Road Disinfection Facility.

Planning for filtration and pilot investigations should commence in the next several years with a goal to having new filtration plant online by 2037. This timeline will provide sufficient time for the CRD to complete the necessary studies, investigations, and preliminary designs for the proposed facilities.

Water Storage Tanks

Water storage is required in a regional transmission system to balance peak hour demands and to provide for discretionary emergency storage. Currently there are only three in-service storage tanks (Head Tank, McTavish and Mount Tolmie) in the RWS system and most of the system operates as an on-demand system providing flows for peak hour balancing and fire protection via the RWS transmission system from Sooke Lake Reservoir. This operational approach places significant hydraulic capacity demands on the CRD transmission system and consumes residual hydraulic capacity for future growth. Balancing storage for the transmission system combined with distribution system balancing and fire storage is the recommended approach to reduce hydraulic demands on the RWS transmission system and defer future capacity improvements in the transmission system. The Mount Tolmie storage tank does not have sufficient capacity to meet the peak hour balancing demands of the service areas. It is recommended that an additional peak hour balancing tank and pump station be constructed at Smith Hill to serve major demand areas including the City of Victoria, District of Oak Bay, and District of Saanich. This tank will conserve the RWS transmission system capacity and enable the system to operate at the same or higher HGL with pumping and defer future capital investments in transmission mains as well as water filtration plant capacity expansion. A second clearwell equalization storage tank is also recommended immediately downstream of a proposed future water filtration plant at Japan Gulch. This clearwell will balance flows through the filtration plant so the plant is only sized to provide maximum day demand rather than peak hour demand. Elevated balancing storage or service pumping at the proposed Japan Gulch Filtration Plant site could be constructed at an HGL of 169 m (same as Head Tank) so filtered water could be pumped to this TWL so the transmission system hydraulic operation would be the same as current operations.

The provision of transmission system balancing storage has mutual benefits for treatment. The filtration plant can be “downsized” to supply the maximum day demand rather than the peak hour demand. The future water filtration facilities would have to be built with an additional 35% capacity without the installation of balancing storage on the transmission system.

Options Screening and Alternatives Evaluation

The development of Alternatives for this 2022 Master Plan used a similar methodology to the 1994 Plan, but the methodology employed was more complex. The principal considerations for this 2022 Master Plan are:

1. Security of supply (i.e., redundancy)
2. Conveyance of water between SLR and Japan Gulch
3. Siting of the Filtration Treatment Plant

Eighteen (18) options were identified for infrastructure improvements (see **Table E.2)** that support the principal considerations shown above. These options were evaluated with advantages and disadvantages summarized for each option and a numerical scoring was applied to each option to result in an initial screening of the preferred alternatives for further evaluation including cost considerations.

Table E.2: Master Plan Options Evaluation

Category	Component	Option	Description
Supply	Sooke Lake Reservoir (Intake)	S1	Deep Northern Intake
		S2	Lake Bottom Marine Intake
		S3	Floating Pump Station Intake
	Leech River (Intake)	S4	Leech River Diversion Intake to Leech Tunnel
		S5	Leech River Dam
Raw Water Transmission	Leech River to Sooke Lake Reservoir	RWT1	Leech Tunnel to Deception Gulch Reservoir
		RWT2	Leech Tunnel to Sooke Lake Reservoir deep basin
	Sooke Lake Reservoir to Japan Gulch	RWT3	Sooke Lake Reservoir to Japan Gulch tunnel
		RWT4	Hybrid pumping/tunnel alternative
		RWT5	Overland route through Leechtown and Jack Lake – 3 PS (DNI PS + 2 PS)
		RWT6	Overland Council Lake Alignment – 3 PS (DNI PS + 2 PS)
		RWT7	Overland Malahat Alignment - 3 PS (DNI PS + 2 PS)
Filtration	Filtration Plant Sites	T1	Sooke Lake Reservoir site
		T2	Japan Gulch site
		T3	Japan Gulch site + Sooke River Road site
	Filtration Technology	T4	Direct Filtration with granular media filtration
		T5	Dissolved Air Flotation (DAF) with granular media filtration
		T6	Membrane Filtration

The 18 options were evaluated and scored for alignment with the 2017 Strategic Plan Commitments and Areas of Focus. Each option was evaluated and then scored based on meeting the three primary objectives outlined in the 2017 Strategic Plan, including:

1. Level of Service Maintenance/Improvement
2. Resolving a RWS infrastructure improvement needs gap
3. Redundancy and security of supply

The results of the options scoring evaluations are shown in **Table E.3.**

Table E.3: Options Scoring Evaluation

Option	Description	Raw Score	Weighted
S1	Deep Northern Intake	37	80
S2	Lake Bottom Marine Intake	33	73
S3	Floating Pump Station Intake	33	69
S4	Leech River Diversion Intake to Leech Tunnel	27	57
S5	Leech River Dam / Storage	32	67
RWT1	Leech Tunnel to Deception Gulch Reservoir	29	60
RWT2	Leech Tunnel to Sooke Lake Reservoir deep basin	31	66
RWT3	Sooke Lake Reservoir to Japan Gulch tunnel	36	75
RWT4	Hybrid pumping/tunnel	31	64
RWT5	Overland route through Leechtown and Jack Lake – 3 PS	30	62
RWT6	Overland Council Lake Alignment – 3 &1 PS	30	62
RWT7	Overland Malahat Alignment - 3 &1 PS	28	56
T1	Sooke Lake Reservoir site	31	68
T2	Japan Gulch site	36	78
T3	Japan Gulch site + Sooke River Road site	30	66
T4	Direct Filtration	32	68
T5	Dissolved Air Flotation (DAF) with granular media filtration	32	68
T6	Membrane Filtration	33	70

This assessment resulted in a recommended priority capital improvement program which is outlined in **Table E.4.** The major capital works included in recommendation include a proposed Deep Northern Intake and pump station on the SLR, a transmission main sized for ADD to supply water from SLR to Japan Gulch in the event of an outage of Kapoor Tunnel and a direct filtration water filtration plant at Japan Gulch. Transmission mains to improve the hydraulic level of service as recommended in the 2018 GeoAdvice report and a new balancing storage tank and pump station at Smith Hill are also included in the recommended capital works plan. **Figure E.5** illustrates the recommended plan of improvements.

Table E.4: Capital Works Recommendations

	Option	2022$	Mid-Point of Construction	Inflated $
Supply				
Deep Northern Intake/Floating Pump Station	S3	$72,505,000	12/31/2031	$87,929,000
Leech River Diversion	S4/RWT1	$16,700,000	12/31/2044	$26,204,000
Sooke Lake Saddle Dam Hydraulic Improvements	M1	$10,000,000	12/31/2044	$15,691,000
Water Treatment				
Japan Gulch Dam Decommissioning	T2/T4	$10,256,000	12/31/2033	$12,940,000
Direct Filtration	T2/T4	$736,155,000	12/31/2035	$966,353,000
Clearwell	T2/T4	$23,999,000	12/31/2036	$32,134,000
Treated Water Pump Station	T2/T4	$29,780,000	12/31/2036	$39,873,000
Japan Gulch Water Filtration Plant Stage 2 Balancing Tank	M2	$15,384,000	12/31/2036	$20,599,000
Raw Water Transmission Mains				
DNI Transmission Main to Head Tank	M3	$38,768,000	06/30/2032	$47,483,000
3rd Main - Sooke Lake Dam to Head Tank	M4	$7,384,000	12/31/2032	$9,134,000
Jack Lake - Head Tank to Japan Gulch + 2 PS @ 2100 ADD	RWT5*	$208,649,000	12/31/2037	$284,959,000
Goldstream Reservoir Connector				
Goldstream Dam to Japan Gulch	M5	$67,075,000	12/31/2030	$82,971,000
Stage 1 Balancing Tank	M6	$5,538,000	12/31/2030	$6,850,000
Treated Water Transmission Mains				
Phase 1 Upgrades	M7	$7,499,000	6/30/2024	$7,838,000
Phase 2 Upgrades	M8	$38,204,000	6/30/2029	$44,085,000
Phase 3 Upgrades	M9	$55,293,000	6/30/2039	$77,792,000
Phase 4.1 Upgrades	M10	$47,670,000	6/30/2049	$81,771,000
Phase 4.2 Upgrades	M11	$48,928,000	6/30/2049	$83,930,000
East-West Connector				
Option 2 Transmission Main	M12	$58,562,000	6/30/2036	$77,639,000
Storage Tank				
Smith Hill Tank	M13	$12,820,000	12/31/2038	$17,859,000
Smith Hill Tank Pump Station	M14	$17,148,000	12/31/2038	$23,887,800
Total Estimated Cost		**$1,528,000,000**		**$2,048,000,000**

*Jack Lake alignment with Pump Stations and transmission main sized for 2100 ADD Level of Service flow ~375 MLD

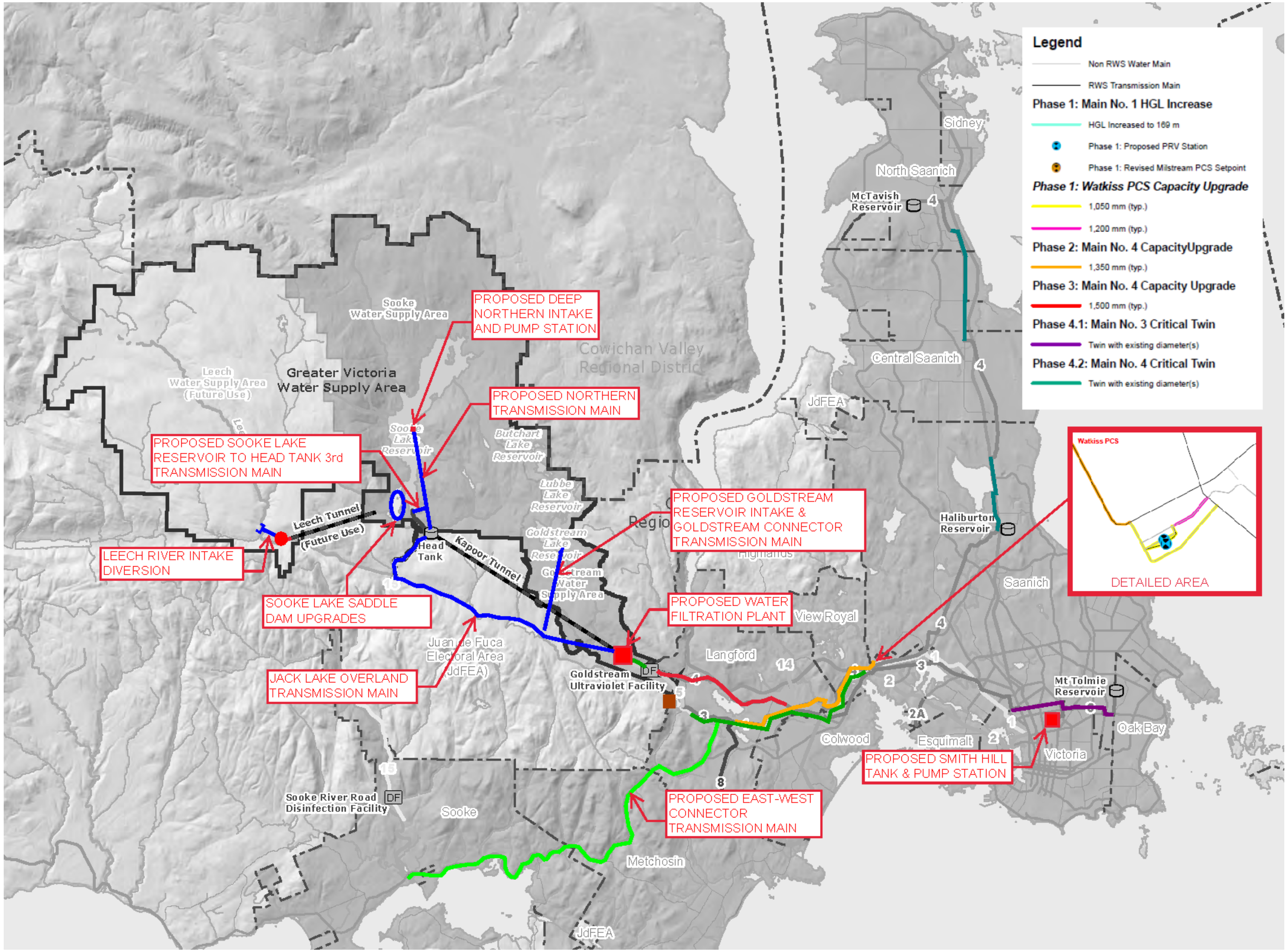

Figure E.5: Recommended RWS Capital Improvement Program