REPORT

District of Ucluelet

Ucluelet Water Demand Evaluation

AUGUST 2022

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1 INTRODUCTION

The District of Ucluelet (District) water system currently draws water from two sources: Lost Shoe Creek Aquifer (LSCA) groundwater source and Mercantile Creek surface water source. The LSCA is the primary source for the District, while Mercantile Creek is used as a supplemental source to meet high seasonal demands and industrial (e.g. fish processing) demands during summer months. Treated groundwater from the LSCA is stored at the Highway Reservoir while water from Mercantile Creek is sent to the Matterson Reservoir. Additional flows of treated groundwater water are stored at the Matterson Reservoir to meet peak demands when the Mercantile Creek source is not running.

The District has recently secured funding for upgrading their existing water system under the Investing in Canadian Infrastructure Program (ICIP) federal grant funding program. Upgrades to the water system include treatment improvements for the two existing water sources: LSCA and Mercantile Creek in addition to increasing storage at the existing Highway Reservoir. The District retained Associated Engineering (Associated) to verify the existing water system source and storage capacity and the District's projected water demands. The aim is to confirm the design capacities for upgrades to the water system through a desktop study of existing water system information, including water production data, operational records, maintenance records, and monitoring activities. The results will inform the design criteria, sizing and phasing of the water system upgrades. This is further to the proposed conceptual design presented by Associated in the 2020 Feasibility Study for Water Treatment Upgrades for Mercantile Creek and Lost Shoe Creek Wellfield (Associated Engineering, 2020), completed as part of the ICIP grant funding application, as well as prior work done by others.

The purpose of this report is to re-evaluate the projected water demand for the District of Ucluelet over a 30-year horizon based on current information. The projected demands will then be compared to the capacity of the existing water infrastructure, specifically the flows available from the raw water sources and the existing storage capacity. If it is determined that there is excess (unused) source and/or storage capacity, the next step will be to approximate which future demands (i.e. what horizon) can be met by part or all of the existing system, and to estimate a timeline for when expansion system components will be required.

The scope of this assessment data from the wellfield (LSCA source), groundwater pumping system, storage (reservoirs), and water meter infrastructure (water consumption data), as provided by the District. This data was used to estimate the current water demands in the District. Additional information was collected from external sources to evaluate both population and industrial/commercial growth within the District to estimate future water demands.

A review of the hydraulic capacity of the existing distribution system was outside of the scope of this evaluation; it would require water system modelling. Also excluded was a detailed evaluation of the Mercantile Creek source and Bay Street Water Treatment Plant, as both are currently offline and limited data was available. However, some discussion of the Mercantile Creek source capacity (e.g. water license) is included in the overall evaluation. The evaluation outlined herein excludes discussion of the treatment requirements for both sources, as those are addressed in other technical memoranda.

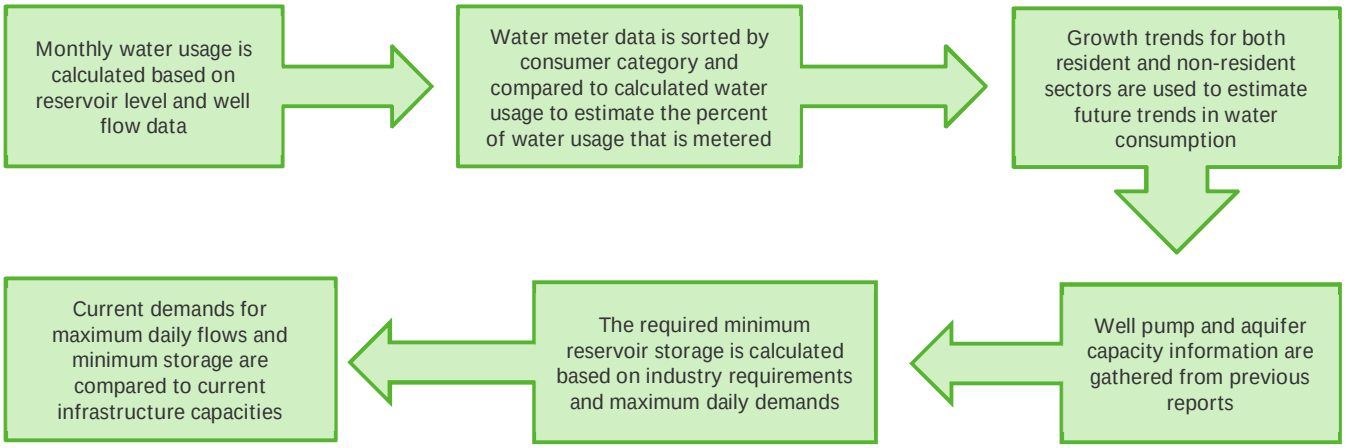
1.1 Methodology

Associated's evaluation consists of three main components:

1. Water demand
2. Water source capacity of the LSCA and wells
3. Reservoir storage

The water demand for the district was projected over the 30-year horizon using a combination of currently available water meter readings, well pumping data, reservoir outlet data, population trends, and expected industrial and commercial growth rates. The next step involved determining the capacity of the Lost Show Creek Aquifer, specifically the pumping capabilities of the well pumps alongside potential raw water volumes available from the aquifer. These values were then compared to the projected water demand to determine an anticipated timeline for when the District's demands will exceed the supply capacity. Lastly, the minimum reservoir volume needed for the District was calculated based on provincial standards and compared to the existing storage capacity.

A chart outlining the steps involved in this process is shown below:



For this evaluation, Associated reviewed the following available data and reports:

- 2021 – 2022 Water meter data
- 2020 – 2022 Wellfield and Reservoir system data
- 2020 Official Community Plan (OCP), District of Ucluelet
- 2016 and 2021 Canadian census data
- 2021 Ucluelet First Nation Housing Needs Report (M'akola Development Services, Turner Drake & Partners Ltd.)
- 2017 Water Master Plan (Koers & Associates)
- 2007 Ucluelet Infrastructure Review (Koers & Associates)
- 2012 BC Design Guidelines for Rural Residential Community Water Systems

2 EVALUATION OF EXISTING WATER SYSTEM

2.1 System Inflow from Reservoir

2.1.1 Annual Measured Water Production

In order to determine the total amount of water entering the Ucluelet distribution system, Associated analyzed well pump flows and reservoir levels. Reservoir levels and total pump flows were recorded every 5 days and then totalled to illustrate the monthly water usage, shown in Figure 2-1.

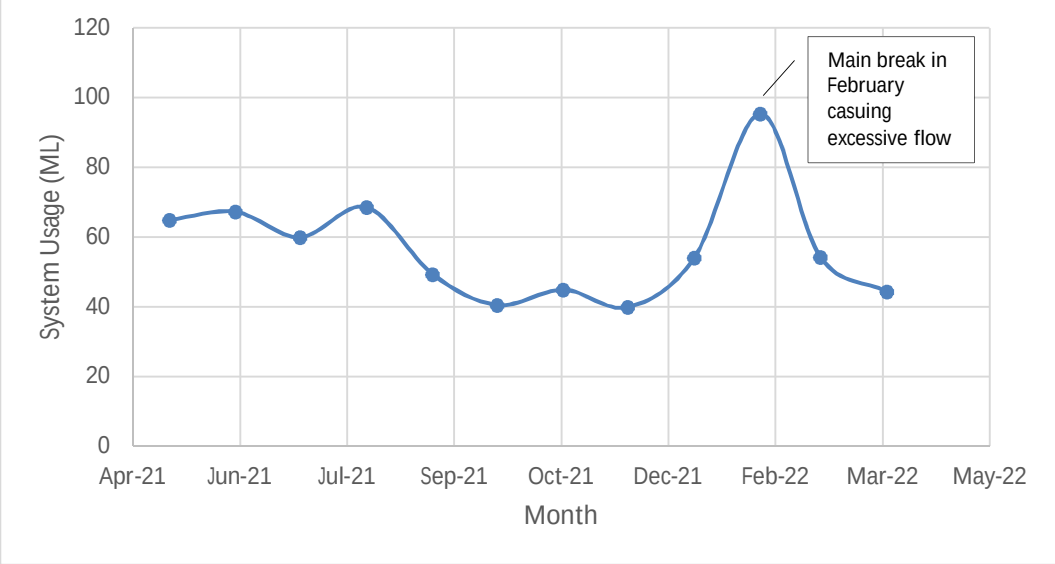


Figure 2-1
Estimated Monthly Water Usage May 2021-April 2022 (calculated from pumping data and reservoir level data)

The results show peaks during the summer months with an average monthly water usage of 53.5 ML, calculated using the pumped groundwater volumes minus net stored volume in the reservoirs. This average was calculated excluding data from February 2022; due to a significant water main break in February, flow values were artificially elevated due to spillage. However, this data point has been shown on the graph for completeness.

The annual water usage over the last year was calculated to be approximately 642.1 ML. This value was calculated by excluding February usage data and replacing it with an average of January and March.

2.1.2 Peak Daily Water Demand

The maximum daily demand was determined by taking the same 5-day water usage (pumping and storage data) referenced in Section 2.1.1, and then averaged to produce single day values. The maximum recorded value was selected from the last year's worth of data, not including peaks in February, as shown in Table 2-1.

Table 2-1
Peak Daily Demand Value for District of Ucluelet (calculated from data)

Parameter	Value	Date Recorded
Peak Daily Demand (ML/day)	2.2	June 27, 2022 – July 2, 2022

Section 4.4 discusses the implications of these values on the capacity design of the system.

2.2 Water Meter Data

The municipality provided 12 months of select water meter data, ranging from June of 2021 to May of 2022. Based on names and locations of the meters, the data was sorted into 7 water consumer categories:

1. Residential
2. Ucluelet First Nation
3. Education
4. Industrial
5. Commercial - Resorts
6. Commercial – Business
7. Recreation

Water metering data was evaluated based on the total annual consumption and on the consumption specific to the 7 consumer categories.

2.2.1 Water Meter Preliminary Assumptions

In order to extrapolate future water demands from the available water consumption data, Associated made assumptions for each of the 7 consumer categories; these assumptions are reported in Table 2-2.

Table 2-2
Assumptions for Water Mater Data for Consumer Categories

Metered Sector	Assumption
Residential	• Residential includes vacation and rental properties, permanent family residences, strata's, and retirement homes. • Not all residential buildings have a meter or were included in the data provided; the ones provided are considered to be representative. • Single family homes have an average population per household of 2.4 people. This was based on data from the 2021 Canadian census comparing the total population of Ucluelet to the number of occupied residential dwellings. • Based on Ucluelet's OCP, 29% of houses in 2016 were being used as vacation rentals. This was substantiated by tourism rental sites, such as Airbnb, which showed approximately 300 of the 1000 houses within Ucluelet being available for short term rent in 2022. However, without information clarifying which meters were associated with vacation rental homes, the overall usage per vacation user was assumed to be the same as a permanent resident. This was a conservative assumption based on the data provided. • The population of apartment buildings, strata's, and retirement homes was estimated based on number of units within each dwelling, where the information was publicly available.
Ucluelet First Nation	• The single meter reading listed for Ucluelet First Nation represented the total amount of municipal water use by the Nation. This is reasonable if there is one supply main to the Nation.
Industrial	• The water meter data provided did not represent all industrial use within Ucluelet.
Commercial – Resorts	• Resorts include hotels, hostels, and rental cabins. • The water meter data provided did not represent all resort use within Ucluelet.
Commercial – Business	• Business includes office buildings, restaurants, stores, and government facilities. • The water meter data provided did not represent all business use within Ucluelet.
Recreation	• Only water meters listed for Pacific Rim National Park were included as recreational use. • The water meter data provided did not represent all recreational use within the service area of Ucluelet.
Education	• The water meter data provided represented all educational sector use within Ucluelet.

2.2.2 Peak Summer Demand

The water meter data provided by the District was also used to determine trends in the demand. When graphed by month, the sectors Commercial – Resorts, Recreation, and Residential Housing all exhibit spikes in water demand during summer months. The results of this investigation are shown in Table 2-3.

Table 2-3
Monthly Peaking Factors by Affected Sector (calculated from water meter data)

Sector	Peaking Factor	Months Observed
Commercial – Resorts	1.6	July, August, September
Recreation	1.5	June. July, August, September
Residential Housing	1.5	July, August

Section 4.4 discusses the implications of these values on the capacity design of the system. Peaking factors were not selected for other categories, such as Education, which only shows a sharp drop in the summer. Lastly, business and industrial usage does not appear to have a clear trend throughout the year.

2.2.3 Water Meter Outliers

Some of the water meters had irregular values of several orders of magnitude higher than typical values, suggesting a need for calibration, or appeared to not be in use. These were excluded from final calculations because they were determined to be erroneous data that could impact the accuracy of water consumption calculations.

3 GROWTH PROJECTIONS

3.1 Population Projections

The total population exerting a water demand within the District of Ucluelet was calculated by taking the average population per household and multiplying it by the total number of private dwellings within the municipality. This accounted for the number of houses being occupied by non-permanent residents, mainly vacation users. Using this method, the total effective population of Ucluelet rises to an average of 2,395 individuals in 2021 from 2,066 people accounted for in the Canadian Census of the same year. Census data in 2016 provides an estimate of 265 individuals within the Ucluelet First Nation.

Population growth data for the municipality and Ucluelet First Nation was pulled from various sources (as noted below) and used to create a range of predictions, as shown in Table 3-1.

Table 3-1
Annual Growth Rate for the District of Ucluelet and the Ucluelet First Nation

Sector	Source	Source Year	Annual Growth Rate
District of Ucluelet Residential Population	Ucluelet Official Community Plan (OCP)	2020	1.36%
	Canadian Census	2021	4.06%
Ucluelet First Nation Population	Ucluelet First Nation Housing Needs Report	2021	1.7%
	Canadian Census	2016	3.60%

Both the District's and UFN's growth rates show significant changes between different reports. The Ucluelet OCP in 2020 actually uses 2016 Canadian Census data for the annual growth rate, which almost triples by the release of the 2021 Census. External factors, such as the Coronavirus pandemic, have been attributed to rapid growth in smaller towns across the province. It is difficult to determine if the movement of people to locations like Ucluelet will continue at current levels or return to numbers previously seen in 2016. Associated has therefore averaged the 2016 and 2021 growth rates for the District to account for this uncertainty. The same process was taken for the Ucluelet First Nation's growth rates. With a rapid drop between 2016 and 2021, Associated cannot currently determine if this trend within UFN will continue or if it is simply an anomaly due to events of the last few years.

The lower, upper, and average growth rates in Table 3-1 were combined with the total effective population of 2,395 individuals in the District in 2021 and 265 individuals in the Ucluelet First Nation in 2016. The final 30-year projected population values are included in Table 3-2.

Table 3-2
30-Year Projected Population Growth for the District of Ucluelet and Ucluelet First Nation

Growth	Sector	Year			
		2022	2032	2042	2052
Minimum	District of Ucluelet Total Population	2,428	2,782	3,187	3,651
	Ucluelet First Nation Population	293	348	412	489
Average	District of Ucluelet Total Population	2461	3227	4231	5549
	Ucluelet First Nation Population	311	405	528	688
Maximum	Total Population of Ucluelet	2,494	3,744	5,618	8,432
	Ucluelet First Nation Population	329	471	676	968

A graph of the final range of population growth including minimum, average, and maximum is shown in Figure 3-1. Associated expects the average population growth rate to best represent the actual population growth trends for the entire Ucluelet area.

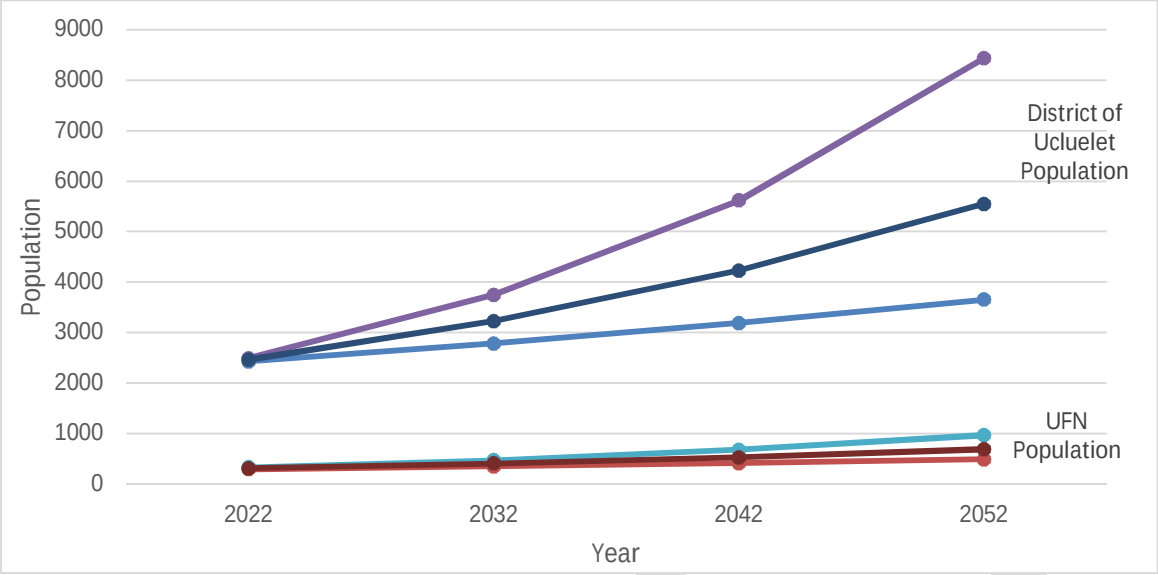


Figure 3-1
30-Year Projected Population Growth for the District of Ucluelet and Ucluelet First Nation

The final average 2052 population for the District of Ucluelet is 5549 and for the Ucluelet First Nation is 688.

3.1.1 Population Growth in Previous Reports

The 2017 Water Master Plan (Koers & Associates) and 2007 Infrastructure Review (Koers & Associates) completed for the District also contain population projections for the District of Ucluelet. Table 3-3 shows the range of growth rates used previously when completing water demand calculations.

Table 3-3
Previously Used Population Growth Rates for the District of Ucluelet

Source	Minimum	Average	Maximum
2017 Water Master Plan (Koers)	0.44% to 0.23%	0.6%	1.32%
2007 Infrastructure Review (Koers)	1.65%	1.74%	3.0%

The 2017 Water Master Plan (Koers & Associates) presents a much smaller growth rate due to its consideration of population trends between 2001 and 2015. This period experienced several drops in the population within the District. Since then the population of the District of Ucluelet has increased significantly. This is shown in the 2016 and 2021 Canadian Census data, exceeding the original predictions made in the 2017 Water Master Plan. The 2007 Infrastructure Review (Koers) report contains similar growth rates to Associated's estimations as it utilized data from multiple decades worth of population trends, rather than just early 2000s.

The 2017 Water Master Plan (Koers) also contains estimations for population growth within Ucluelet First Nation, specifically within Ittatsoo 1, shown below in Table 3-4.

Table 3-4
Previously Used Population Growth Rates for Ucluelet First Nation

Source	Minimum	Average	Maximum
2017 Water Master Plan	0.5%	1.52%	2.0%

In comparison, the range of Associated's estimations for population growth within Ucluelet First Nation are larger and contain a greater spread. This is also due to the rapid growth between 2015 and what was recorded in the 2016 Canadian Census. The 2021 Ucluelet First Nation Housing Needs Report submitted to the District of Ucluelet was used as a more recent source, shown in Table 2-1, but the growth rate is still greater than the average used in the 2017 Water Master Plan (Koers), showing a recent trend of sustained increased growth that should be considered.

3.2 Non-Residential Growth Rate

The growth of the Industrial, Commercial, Recreational, and Education sectors is not necessarily proportional to the population of Ucluelet. Therefore, these sectors have been classified as "non-residential". There is no District information available on expected growth rates for these sectors, so a range of values was selected. A minimum, average, and maximum percentage for annual growth and the justification for each sector are included in Table 3-5. Moving forward in the report, the average growth rate is used for all calculations, with the range only referenced to outline best and worst cast scenarios.

Table 3-5
Predicted Non-Residential Growth Rate for District of Ucluelet

Sector	Minimum Growth	Average Growth	Maximum Growth	Sources
Industrial	-1.00%	-0.53%	0.00%	Based on Canadian Census data showing a decrease in industry workers from 2006 to 2016
Commercial – Resort	1.00%	1.00%	1.00%	Assuming 6 resort development projects over a 30-year horizon with 5% growth per project.
Commercial – Business	-0.41%	0.11%	0.63%	Based on the employment growth provided by the Town Profile for Ucluelet (2019)
Recreation	1.36%	2.71%	4.06%	Based on population growth rates for Ucluelet (Table 3.1)
Education	1.00%	1.00%	1.00%	Based on OCP plans for expansions to existing facilities, assuming 3 major projects over a 30-year horizon with 10% growth per project.

4 WATER DEMAND

4.1 Daily Population Water Usage

The monthly metered water usage for the District of Ucluelet and Ucluelet First Nation were determined by taking the total metered flow for each month and dividing by the population using those meters. These values then divided by the number of days in each month, providing an average daily demand for each month in the last year. Assumptions on the number of people per metered household are explained in Section 2.2.1. The population using metered water for the Ucluelet First Nation was assumed to be the total population of the Nation.

Finally, the 12 values were averaged together to provide the average daily demand per capita from June of 2021 to May of 2022 shown in Table 4-1.

Table 4-1
Daily Per Capita Water Demand by Population Group

Usage Source	Water Demand (L/cap/day)
Average Ucluelet Residential Usage	253
Average Ucluelet First Nation Usage	467

4.1.1 Daily Population Water Usage in Previous Reports

The daily per capita demands, measured in litres per capita per day (lpcd), are a standard calculation when measuring residential water demand. In 2018, the City of Nanaimo Water Audit (Kerr Wood Leidel) determined water usage to be 222 lpcd. A BC municipal water survey performed by the University of British Columbia in 2016 found residential water use have dropped in recent years to 312 lpcd. These can be compared closely to the calculated average demand for the District of Ucluelet at 253 lpcd. Other reports have been known to reference higher values, though this is often attributed to the daily per capita water demands of an entire region, often including agricultural and other uses, rather than just residential use measured here.

4.2 Daily Non-Residential Water Usage

In order to determine the water usage within the industrial, commercial, recreational, and educational sectors, an estimate for the percentage of metered facilities was calculated. It was assumed that the daily population and non-residential usage estimates should sum together over the course of a year to match the total annual system inflow data. A series of percent meter estimations was selected and checked using the following equation:

$$SD = PD + \sum MC \times NRD$$

Where:

SD = System Demand (sum of system inflow data)
PD = Population Demand (determined in Section 3-1)
MC = Multiplication Coefficient
NPD = Non-Residential Demand (from metered data)

The results are shown below in Table 4-2.

Table 4-2
Estimations for Percentage of Metered Facilities in Ucluelet

Sector	Percent Metered (Assumed)	Multiplication Coefficient
Industrial	90%	1.1
Commercial – Resort	50%	2.0
Commercial – Business	50%	2.0
Recreation	50%	2.0
Education	100%	1.0

Using these values, the combined 12-month water meter data for all the sectors matched the measured usage determined in Section 2.1.1. It was also assumed that losses within the distribution network are negligible, since accurate numbers couldn't be calculated without actual percent metered information.

The final daily water demand, both metered and non-metered, by sector is shown in Table 4-3.

Table 4-3
Daily Water Demand by Sector

Usage Source	Water Demand (ML/day)
Industrial Usage	0.39
Commercial – Resorts Usage	0.31
Commercial – Business Usage	0.33
Recreational Usage	0.01
Educational Usage	0.01

Figure 4-1 illustrates the estimated distribution of water consumption by each sector or category.

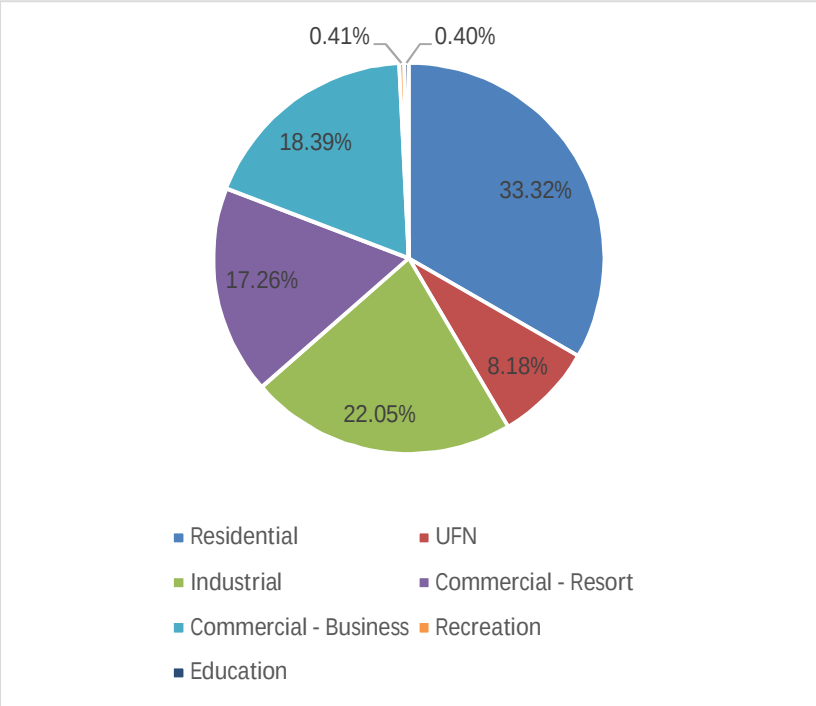


Figure 4-1
2022 Estimated Distribution of Water Usage for each Consumer Category

4.3 Water Demand Projections

Figure 4-2 shows the range of Average Daily Demand (ADD) for all seven sectors projected over a 30-year horizon and totalled to determine a final demand for the entire system based on a minimum, average, and maximum population and non-residential growth rate. This range represents the range in projected demand calculations when planning over a 30-year horizon.

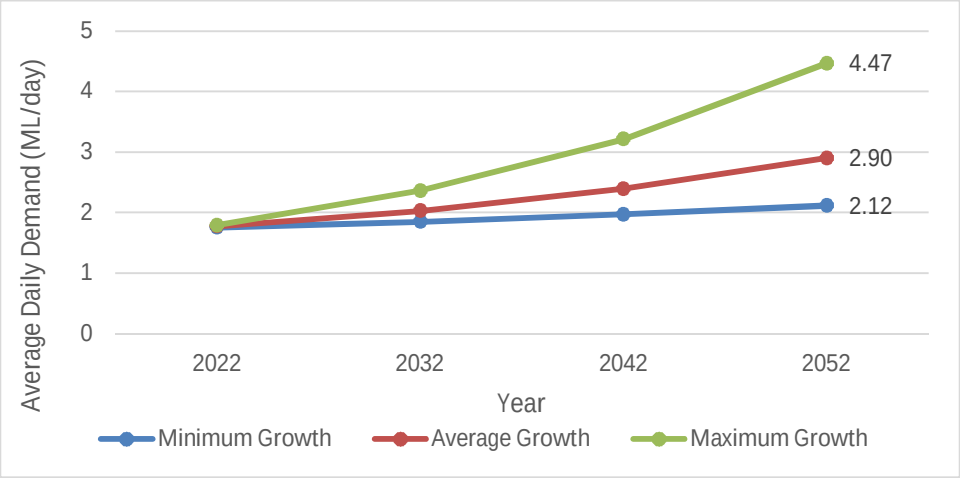


Figure 4-2
Total Projected Average Daily Demand (ADD) for the District of Ucluelet

The most likely 2052 ADD value is 2.90 ML/d but the District should consider implications of experiencing demands as low as 2.12 ML/d or as high as 4.47 ML/d over this horizon as well. The range of annual demand projections, shown in Figure 4-3, was calculated by multiplying the daily demand projections by the number of days in a year.

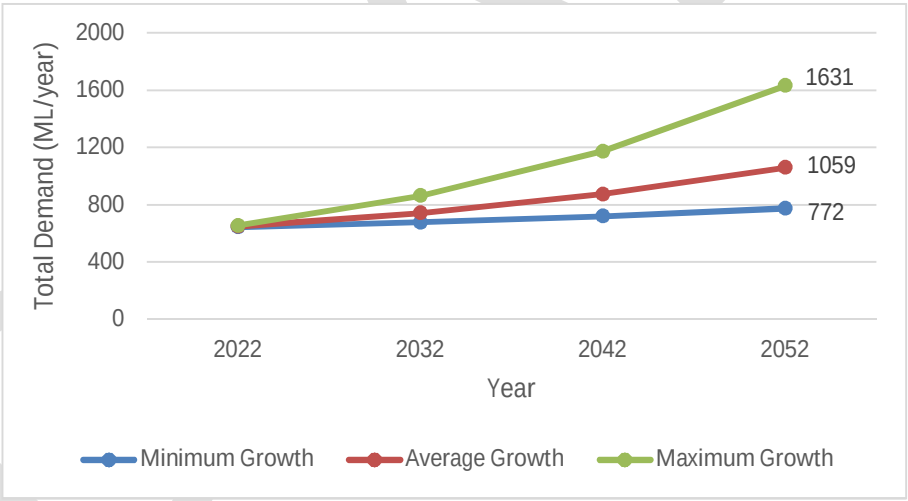


Figure 4-3
Total Projected Yearly Demand for the District of Ucluelet

By 2052 the average growth projections show an annual demand of 1059 ML over the entire system.

4.4 Peak Flow Design

There are various ways to estimate the highest flows a system must be designed to handle. Included within this report are the following:

1. Maximum Daily Demand (MDD)
2. Peak Daily Demand (PDD)
3. Peak Seasonal Demand

The MDD is calculated by taking the average daily demand (ADD) and multiplying by a selected coefficient. For the purposes of this report, a value of 2.5 was selected, which is in keeping with industry practice and considered to be conservative based on the size and population of the District. The Peak Daily Demand (PDD) and Peak Seasonal Demand are calculated by analyzing trends in existing water flow data, explained in Section 2.1.2 and Section 2.2.2 respectively. The PDD was calculated to be 2.27 times greater than the ADD and the Peak Season Demand was 1.55 times greater.

Based on these results, Associated selected the estimated future MDD for design purposes to represent the worst-case scenario that the District's water infrastructure must be designed to handle.

Peak hourly demand is another value often used to determine the criteria for distribution system pipe sizing, storage capacity and/or treatment capacity to meet the needs of a community. However, Associated concluded that the peak hourly demand could not be calculated from data provided since flow measurements for system inflow were 5-day totals and water meter data was provided as monthly totals, so any attempt to calculate hourly peaks from these data are likely to be flawed. A review of existing treatment system and distribution system hydraulics are outside the scope of this report.

4.4.1 Maximum Daily Demand Projections

A coefficient of 2.5 was selected based on industry best practices and then multiplied by the range of ADD to determine 30-year MDD projections. These values are compared to well pumping capacities in Section 5 to provide a timeline for when the maximum demand will exceed the maximum source water capacity. The range of MDD values represents the spread of minimum, average, and maximum growth rates selected in Section 3.1.

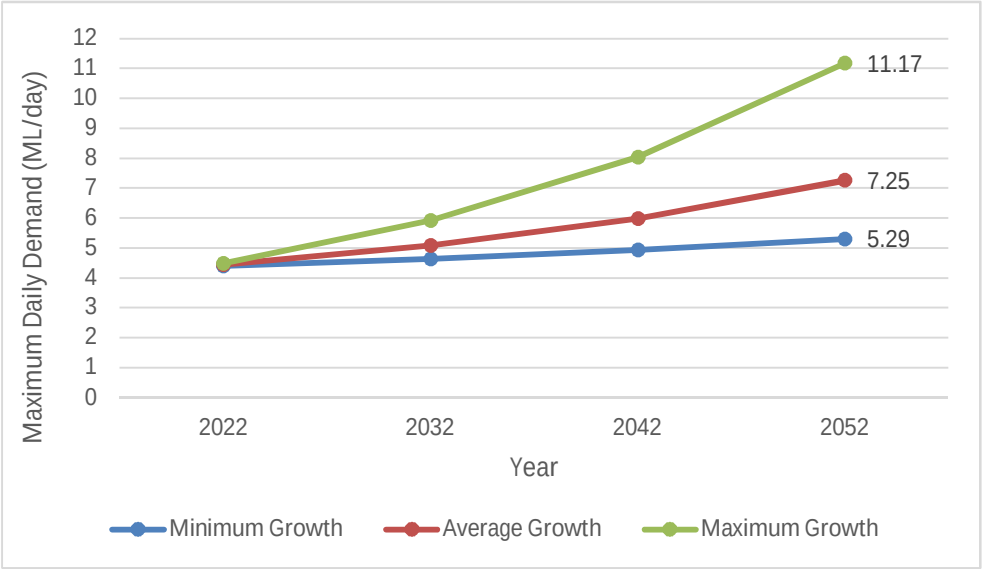


Figure 4-4
Total Projected Maximum Daily Demand (MDD) for the District of Ucluelet

For comparison to infrastructure capacity in Section 5 and Section 6, the exact values by year is included in Table 4-4.

Table 4-4
Total Projected Maximum Daily Demands for the District of Ucluelet

Range	Year			
	2022	2032	2042	2052
Minimum MDD (ML/day)	4.39	4.63	4.93	5.29
Average MDD (ML/day)	4.43	5.08	5.98	7.25
Maximum MDD (ML/day)	4.47	5.91	8.03	11.17

In this study, the Average MDD values will be used for calculations since they represent the increase in demand due to the most likely population and non-residential growth rates. The 2052 MDD is therefore considered to be 7.25 ML/day, or 83.9 L/s.

5 WELL AND AQUIFER CAPACITY

The original calculated maximum well design capacity was 150 L/s total for the four original wells as determined by Pacific Hydrology Consultants Ltd. (PCHL), outlined in the 1999 Lost Shoe Creek Wellfield Report (Fyfe 1999). In the same year, the estimated aquifer recharge rate was 46.6 ML/day (540 L/s). Based on this information, it was determined that the Lost Shoe Creek Aquifer (LSCA) was more than adequate to sustain the maximum proposed withdrawal by the District of Ucluelet.

Since their construction, Well 2 has been taken offline due to elevated manganese levels and Well 3 pump has been replaced with a smaller capacity pump. Additionally, it was assumed the pumps current operational capacity will not realistically be the same as the original design capacity due to reduction over time. In the 2007 Infrastructure Review (Koers 2007) for the District, it was estimated that actual yield of the four wells was only 90% of their original capacity. Therefore, a coefficient of 90% is used in the report to show the actual pumping capacity of aging wells (Table 5-1).

Table 5-1
Well Design and Actual Pumping Capacities for the Lost Shoe Creek Wellfield

Well No.[1]	Original Design Capacity		Actual Pumping Capacity	
	(L/s)	(ML/day)	(L/s)	(ML/day)
1	25.2	2.17	22.7	1.96
3	44.2	3.82	24.3	2.10
4	23.7	2.05	21.3	1.84
Total	93.1	8.04	68.3	5.90

The maximum estimated demand calculated for 2022, based on data provided is 4.43 ML/day (51.3 L/s) which is below the aquifer's max capacity based on estimated aquifer recharge established in 1999, and below the estimated pumping capacity of 5.90 ML/d from Wells 1, 3, and 4 (Table 5-1). Assuming the aquifer capacity has remained unchanged, the District of Ucluelet is not currently limited by the water availability of the aquifer when meeting their water demands. The large difference between the maximum pumping rate of the wells and the recharge of the LSCA also suggests the aquifer capacity is not highly vulnerable to variations in rainfall and weather patterns that may affect aquifer levels in the future, particularly with increased impacts from climate change. However, this is based on information from the 1999 study by Fyfe; the District may wish to have a follow-up hydrogeological assessment of the aquifer completed to confirm current well capacity and to determine whether well redevelopment and/or rehabilitation is required, particularly given previous biofouling issues in the wells. Furthermore, the thickness of the aquifer combined with seasonal low levels could impact available drawdown within the wells with the potential to reduce pumping capacities even further.

[1] *Only Wells 1, 3, and 5 are included since Well 2 is no longer in use.*

Another concern is over pumping within the wells, leading to a water level drawdown that exceeds the depth of the pump, even when the aquifer maintains recharge levels. An analysis was performed on well water level data provided over the last year to determine the validity of these concerns. Well water levels are determined by measuring the height of water from the bottom of the well screen to the water's surface. The well can no longer be pumped when the level reaches 0, as the aquifer elevation has dropped below the base of the well screen or another similar level set-point aimed at maintaining a viable pumping level.

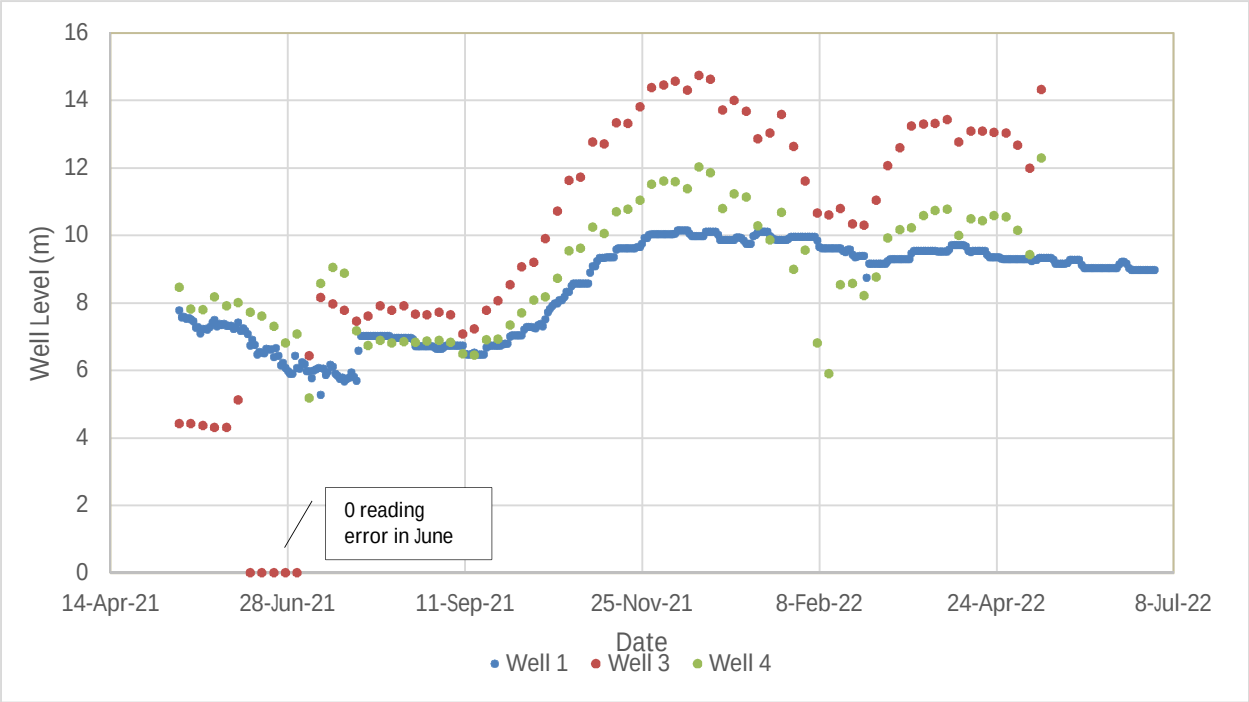


Figure 5-1
Active Well Water Level Data for District of Ucluelet

The results show that even during the driest months of the year, the well levels remain high enough to meet the demands of the District. The only occurrence of a significant drop was in June of 2021 within Well 3. Clarification with the District will be necessary to determine the exact cause, though based on the timeline, the drop was likely caused by work to install a variable frequency drive (VFD) on the well pump, which may have resulted in excessive pumping over a short period or a lack of available data, resulting in a 0 reading.

5.1 Additional Well Capacity

The District is considering the installation of a 5th well with a design capacity of 2.00 ML/day. This would increase the total maximum withdrawal from the LSCA wells to 7.90 ML/day (91.4 L/s), which is within the previously estimated design capacity of the wellfield and well within the estimated recharge capabilities of the aquifer.

With the current maximum pumping rate of 5.90 ML/day compared to the average growth MDD flowrates shown in Table 4-4 the current system would not be able to meet the 2042 demands of 5.98 ML/day, assuming an average growth rate for each of the different sectors. Therefore, the maximum pumping rate will need to be increased before 2042.

With the total pumping rate of 7.90 ML/day from LSCA Wellfield after the Well 5 construction, the 30-year MDD of 7.25 ML/day (assuming average growth rates for every sector) will not exceed the supply.

6 RESERVOIR STORAGE

6.1 Reservoir Design

There are two reservoirs being used by the District of Ucluelet: the Matterson and Highway reservoirs. Each has a designed capacity as well as an operational range of levels that are maintained by the pump system. When the level rises above a certain point the lead pumps turn off, and when the water falls below a certain point the lead pumps turn on. Information about the design parameters of the Reservoirs are provided in Table 6-1.

Table 6-1
Ucluelet Reservoir Design Parameters

	Matterson	Highway
Storage (ML)	1.20	1.40
Maximum Level (%)	90.5	88.1
Minimum Level (%)	70.2	80.1

6.2 Minimum Storage Calculations

While there are several methods used to dictate the minimum amount of storage required for a water system, this report uses the 2012 BC Rural Residential Design Guidelines that were also referenced in the 2017 Ucluelet Water Master Plan (Koers). This storage equation involves meeting requirements for three purposes:

1. Balancing Storage: Used to balance fluctuations in the system and provide enough quantity of water to balance the turning off/on of pumps.

2. Fire Storage: The minimum level of water needed to provide fire flow within the District over a duration of time.

3. Emergency Storage: Water provided in the event of a water restriction, power outage, or non-fire related emergency.

6.2.1 Balancing Storage

The balancing storage is determined by taking 25% of the MDD for the system calculated in Section 4.4.1. The projected results for Ucluelet are shown below (Table 6-2).

Table 6-2
Projected Balancing Storage Values for the District of Ucluelet

Range	Year			
	2022	2032	2042	2052
Minimum (m^3)	1.098	1.157	1.231	1.323
Average (m^3)	1.109	1.269	1.494	1.813
Maximum (m^3)	1.119	1.477	2.007	2.792

6.2.2 Fire Flows

Fire storage is based on recommendations from the Fire Underwriters Survey (FUS) guidelines for "Water Supply for Public Fire Protection". The required fire flow for the District of Ucluelet is 150 L/s for a duration of 2 hours for a total fire storage of 1.080 ML. This value does not contain a range or fluctuate over the 30-year horizon because is not affected by population growth.

6.2.3 Emergency Storage

Emergency storage covers any event which would cut off the supply network from the reservoir. It is calculated using the following equation:

$$ES = 0.25 \times (BL + FS)$$

Where:

ES = Emergency Storage
BL = Balancing Storage
FS = Fire Storage

Table 6-3
Projected Emergency Storage for the District of Ucluelet

Range	Year			
	2022	2032	2042	2052
Minimum (ML)	0.545	0.559	0.578	0.601
Average (ML)	0.547	0.587	0.644	0.723
Maximum (ML)	0.550	0.639	0.772	0.968

6.3 Storage Projections

The total storage projections needed to meet the District of Ucluelet's demand as well as the active deficit are outlined in the table below.

Table 6-4
Projected Storage Demand for the District of Ucluelet

	Year			
	2022	2032	2042	2052
Minimum (ML)	2.723	2.796	2.889	3.003
Average (ML)	2.736	2.937	3.218	3.616
Maximum (ML)	2.748	3.197	3.859	4.841
Average Deficit (ML)	0.136	0.337	0.618	1.016

The projects show an immediate need for 0.136 ML of more water storage, with a 30-year deficit totalling approximately 1.016 ML.

7 CONCLUSIONS AND RECOMMENDATIONS

Key findings of this study are outlined below.

- Population growth expected over a 30-year design horizon as follows:
  - District of Ucluelet average annual growth rate of 2.71%
  - District of Ucluelet total population (including tourism) of 5549
  - Ucluelet First Nation average annual growth rate of 2.65%
  - Ucluelet First Nation average population of 688
- Water demand projections over a 30-year horizon are as follows:
  - Average Day Demand (ADD) of 2.90 MLD or 33.6 L/s
  - Maximum Day Demand (MDD) of 7.25 MLD or 83.9 L/s
- Existing LSCA water source capacity:
  - Existing total well capacity is 5.90 ML/day or 68.3 L/s, assuming a 90% deterioration since original construction.
  - Capacity if a new (fifth) well is established, would be 7.90 ML/day or 91.4 L/s
- The existing well infrastructure is expected to fall short of meeting the future 2042 water demands.
- If an additional new (fifth) well is drilled, the LSCA wells would be expected to meet the 2052 water demand.
- Existing storage (reservoirs) are calculated to have a current deficit of 0.136 ML.
- There is an anticipated storage deficit of approximately 1.1 ML over the 30-year design horizon, without accounting for any planned upgrades.

Based on the data and information provided, the study findings indicate that the LSCA wells will need to be upgraded (a new well added) before 2042 so that the District's future water demands can be met, or the Mercantile Creek source will need to be brought back online to supplement the groundwater source. This anticipated timeline does not account for any water conservation measures that might reduce per capita residential consumption, or any significant changes to industrial or commercial water use.

Associated's assessment also indicates that the existing Highway reservoir presently has a storage deficit; the District might consider prioritizing the addition of more storage when staging of Ucluelet's planned water system upgrades.

Going forward, if the District is to rely substantially or solely on the LSCA, some decline in well yields should be expected, as is typical, especially if bio-fouling and/or mineral encrustation are occurring. As a result, regular well maintenance/rehabilitation will likely be required. Even after physical and chemical well rehabilitation, well yields may not get back to the same level as when the wells were first constructed.

The following actions could be taken by the District to monitor well performance and plan for maintenance requirements:

- Pumping tests could be conducted on the wells to assess current specific capacity and then repeated in the future at the same pumping rates. A comparison of the specific capacities will show if well performance is declining (i.e., an increase in water level drawdown observed in the

well compared to the water level drawdown when pumping at the same rate in previous tests). If a significant decline in specific capacity is observed, it is likely that the well will need some rehabilitation, including removal of biofilms and/or mineral encrustations.

- Continue to monitor aquifer water levels (data could be obtained from the Ministry's nearby observation well) to see if there is a general decline in aquifer water levels. If this happens the available drawdown in the production wells will decrease, which would reduce the long-term sustainable yields. Available data suggests groundwater levels are currently stable, with no declining trend, but there could be value in monitoring over the long term, especially considering potential weather pattern changes resulting from climate change impacts.
- Monitor raw well water for bacteria, including iron related bacteria and sulphate reducing bacteria, which will also provide insight into potential fouling and well rehabilitation needs.

The water demand evaluation presented herein is based on data provided by the District, previous reports and publicly available population data. Monitoring of water production flow rates (i.e. well pumping and reservoir level data) and water demands (e.g. water meter data) should continue. As well, anticipated growth within the District by water user type (e.g. residential, commercial, industrial) should be monitored. These factors will continue to inform both near and long-term water system upgrade requirements for the District.

CLOSURE

This report was prepared for the District of Ucluelet to evaluate the projected water demands for a 30-year design horizon in comparison to the available raw water sources and water storage, with the aim of informing the design criteria and prioritization of planned upgrades to the District's water system.

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Respectfully submitted,

Associated Engineering (B.C.) Ltd.
Engineers & Geoscientists BC Permit Number 1000163

Prepared by:	Reviewed by:
Emma Wardrop Co-op Student	Rachel Trower, P.Eng. Water Process Engineer
Quinn Crosina, M.A.Sc., P.Eng. Manager, Water Group	Garry Drachenberg, P.Eng. Vice President – Water Solutions