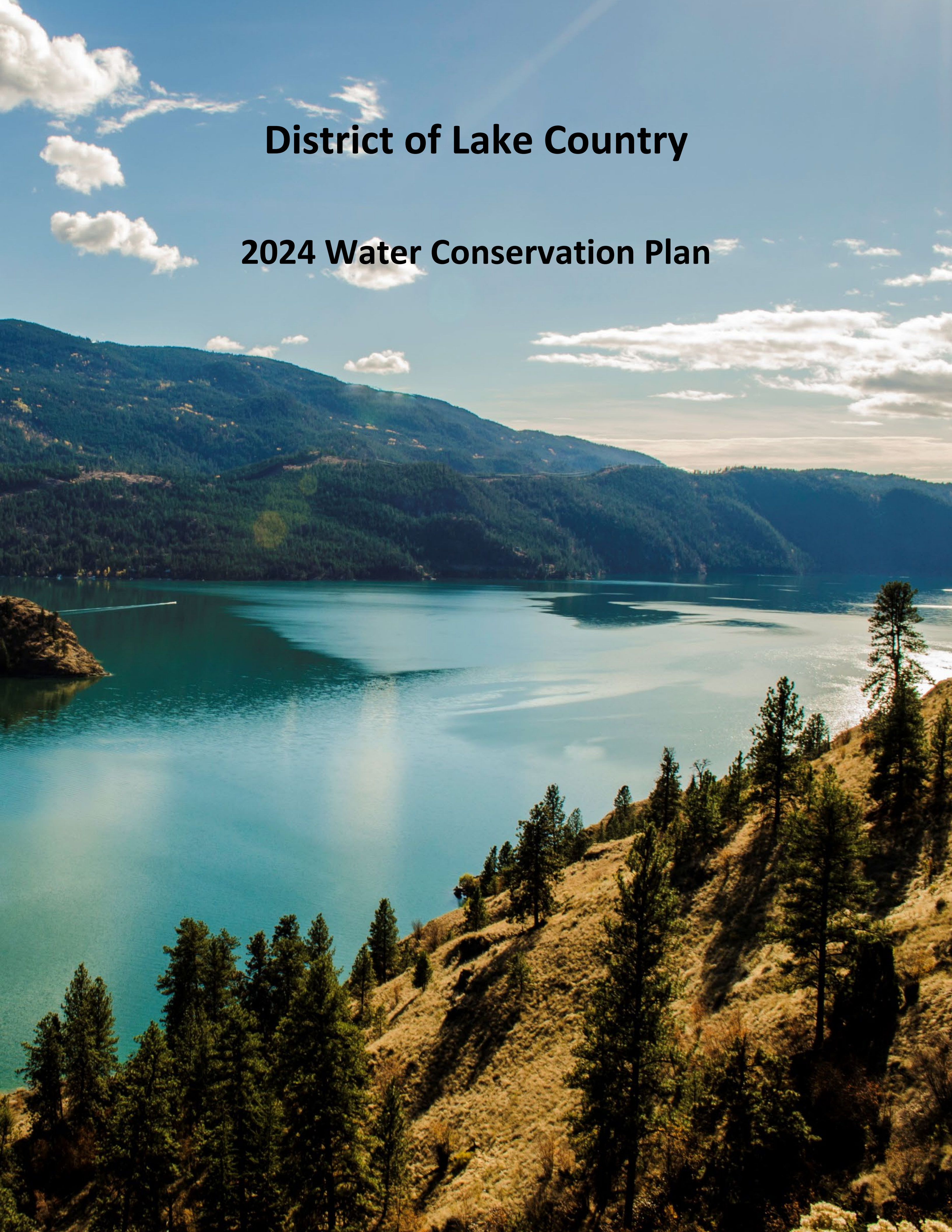
District of Lake Country

2024 Water Conservation Plan



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1.0 Executive Summary

Using less water in communities has many benefits, including reduced operational, maintenance, and infrastructure sizing costs. As climate continues to change it will be important to continuously monitor our own water consumption and actively seek out ways to improve water efficiency. During times of prolonged drought, our agricultural sector will be the most vulnerable and it is prudent to consider initiatives now to protect ourselves in the future. Water conservation plans are effective means for establishing community baseline water consumption behaviours and identifying opportunities to both conserve water demand while ensuring adequate supply.

The 2024 Water Conservation Plan is intended to provide strategic direction for water conservation opportunities while securing long-term, resilient water supplies for our community; it is not intended to be used as a Water Scarcity Plan. The plan examines various supply and demand side management initiatives specific to the District and evaluates their relative effectiveness using multi-criteria analysis. All water savings realized by water conservation efforts should be reserved to help lessen the impacts of climate change and drought. The most effective demand side management strategies are recommended to begin being implemented within the next 3-5 years, which include:

- Agricultural Irrigation Usage Plan to analyze:
  - Efficient Watering Systems (Agricultural)
  - Variable Rate Structure (Agricultural)
  - Tensiometers
- Variable Rate Structure (Non-Agricultural customers)
- Water Meters Fixed Network Leak Detection Program
- Distribution System Leak Detection Programs; and

It is not recommended to explore water conservation initiatives that target the agricultural community until a deeper understanding of their requirements is developed through an **Agricultural Irrigation Usage Plan**. Together, these water conservation strategies project a 355ML reduction in annual water consumption.

Similarly, the top supply side management strategies are recommended to begin implementation within the next 3-5 years, including:

- Removing Beaver Lake Obstruction
- Water Management Plan
- Automated Outlet Valve; and
- Reclaimed Water and Groundwater Extraction

It is estimated that these initiatives would provide an additional 1,766ML of annual water supply and 6,500ML of additional water storage. Alternative supply and demand side are initiatives are recommended to be explored over the next ten years.

2.0 Purpose

The purpose of this document is to analyze water use, availability, and identify water conservation strategies and targets for the District of Lake Country (the District). The primary objectives of this plan are to:

- Improve efficient usage of water to reduce infrastructure service costs;
- Ensure adequate supplies for potable use, agriculture and irrigation, and environmental flows; and
- Help safeguard against drought by proactively reducing usage to avoid water shortages.

It is important to realize that every drop of water comes at a cost and making good decisions prior to urgent drought situations will lessen the impacts and lead to more desirable outcomes. Proactively establishing a framework and understanding alternatives will help us maintain long-term water availability, reduce costs, safeguard against drought, and act with well-informed decisions. Through this process, we are looking to answer the fundamental questions:

Are we using more water than we need, and is there a benefit to using less?

3.0 Introduction

Water is a fundamental part of life in the Okanagan – from the fruit in our orchards, aquatic life in our watershed, and the water coming out of our taps, we rely on safe and reliable water supplies. While the Okanagan boasts one of the most beautiful, sought-after locations to live or visit in Canada, the semi-arid conditions, growing population, and ever-changing climate continue to strain our supply of water.

Developing a water conservation plan helps identify best practices for wise water use. As detailed in latter sections of this report, the District has made significant strides increasing water efficiencies as well as securing our water supplies to safeguard against drought having invested upwards of 18 million dollars over the last two decades. The 2012 Water Master Plan included a water conservation target reducing consumptive use by 25% and we have largely met this ambitious goal decreasing consumption by 22.5% over the last 10 years (refer to section 2.3 Historic Conservation Initiatives)

The long-term objective is to achieve an end state where we have adopted all effective and practical means to be water wise and can unequivocally state we are not using more water than needed.

Although drought mitigation is a part of the Water Conservation Plan, the plan is not intended to be a Water Scarcity Plan. A Water Scarcity Plan is reactive by nature and may partially rely on findings of the Water Conservation Plan to establish contingency plans for multi-year drought scenarios. With respect to safeguarding our community and environment against the impacts of drought, securing our source water supplies are prime considerations of the Water Conservation Plan, as is the potential for groundwater extraction and reclaimed water use for the purposes of irrigation.

Drought conditions are typically caused by a combination of low snowpacks from the previous winter, hot and dry conditions in the summer, or a delay in the onset of annual rains. An increasingly warming climate continues to exacerbate drought-favourable conditions. 2020 exhibited a 1.74°C increase over the 20th century average, which is the highest recorded average annual temperature in 141 years (NCEI, 2022).

Dry periods in 2003, 2009, 2015, and 2021 across British Columbia have stressed the importance of proper drought management and led to Provincial measures for dealing with drought and water scarcity (Deputy Minsters' Committee on Drought, 2021).

Wagon trail beside the Oyama Isthmus in the early 1900's.

Things are changing and we need to adjust and adapt to changes including community growth, climate change, agriculture practices and environmental needs. Changing how we look at water use and water needs is critical in securing long-term water availability.

3.1 Our Water Systems

3.1.1 Okanagan Lake

Okanagan Lake is the largest water body utilized by the District. The lake is used by over 100 known water suppliers and has over 4,000 active water licenses with a total licensed allocation of 443,000ML annually for off-stream use (Guy, 2010). The District's water license allows for 10,997ML to be withdrawn annually, which supplies approximately 6,400 residents. Okanagan Lake represents the District's largest domestic supply of potable water.

3.1.2 Beaver Lake

Beaver Lake is a sub-alpine lake located on the upper plateau area east of the District and is part of the Dee Lake chain. The Beaver Lake watershed has a combined licensed storage of approximately 12,000ML, with currently only 5,500ML accessible on an annual basis. Beaver Lake has an annual water license of 9,100ML, which currently services approximately 3,100 residents and is predominantly relied on for agriculture, serving more than 550 hectares of farmland.

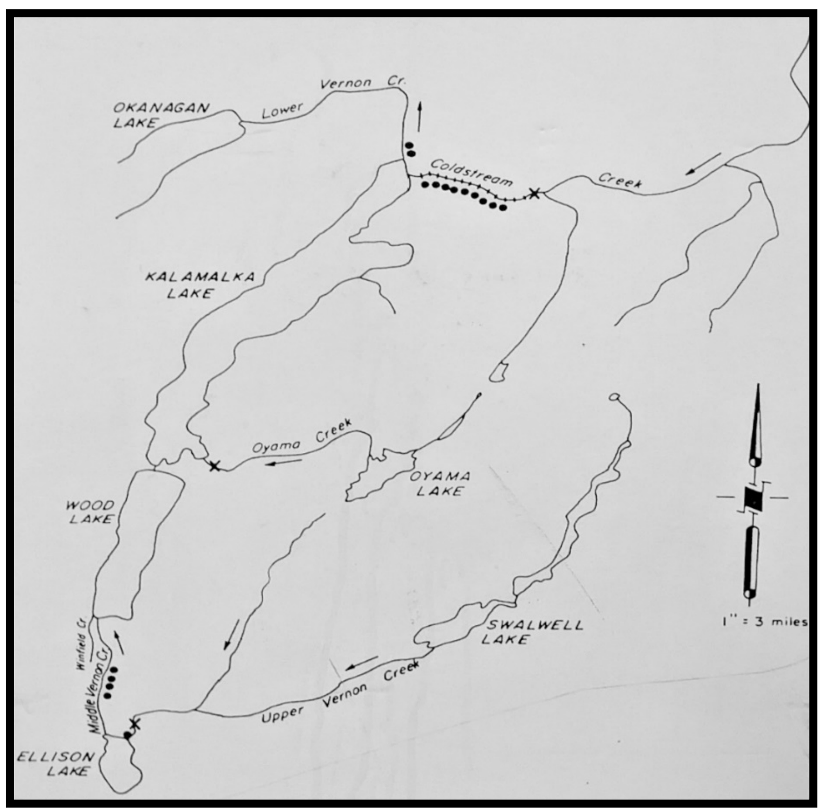
3.1.3 Kalamalka Lake

Kalamalka Lake has an approximate storage of 1.52 million ML (1.52km^3) and multiple water licenses, including the District of Lake Country and the Regional District of North Okanagan. The District has an annual water license of 1,718ML, which provides water to approximately 750 residents and 100 hectares of agricultural land. Water demand on the Kalamalka Lake system is relatively equally split between domestic and agricultural use.

3.1.4 Oyama Lake

Oyama Lake is another one of the Districts upland sources and services the eastern side of Wood Lake. Oyama lake has approximately 5,000ML of storage, and the District holds an annual water licence of 3,891ML. There are approximately 630 residents serviced by the Oyama Lake distribution system, however, the bulk of the usage from Oyama Lake is for agricultural purposes, servicing over 300 hectares of agricultural land.

The Oyama Lake and Kalamalka Lake distribution piping networks are interconnected. When water quality from Oyama Lake is poor the District can supplement the Oyama Lake source with Kalamalka Lake.



3.1.5 Satellite Water Systems

Coral Beach and Lake Pine water systems both supply drinking water to smaller neighbourhoods in, or adjacent to, the Carr's Landing area from Okanagan Lake. Coral Beach and Lake Pine serve approximately 130 and 200 residents, respectively. The combined annual water demand of the satellite systems is less than 2% of the total water supplied by the District. The low demand on these systems is due to both the low population and absence of agricultural use.

3.2 Water Conservation Strategies

When examining water availability and sustainable water supply, both supply side and demand side management strategies should be considered. Supply side water management is usually associated with increasing the amount of available water but can also include initiatives that conserve water in the lakes and streams prior to discharge or use. Potential supply side management strategies include increasing the pumping capacities of water facilities, damming to increase water body reservoir storage, or operational improvements to improve water release management.

Automated valves are used to remotely control releases from our water sources.

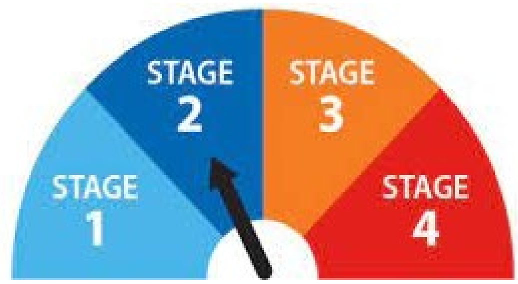
Water meters can be used to track water consumption

Demand side water management typically involves reducing the amount of water that is being used by people for specific purposes, such as household use, farming, municipal, or industrial needs. Demand side water management incorporates conservation strategies within the distribution system and determines if we are using more water than we need. Demand side water management practices include water restrictions, leak detection, universal metering programs, and consumptive rate structures.

By examining both management strategies holistically and comparing them to our current water use habits we will have the information necessary to answer our fundamental questions and in turn establish targets we can strive for as a community.

There are many different tools available to achieve effective and efficient supply and demand side water management strategies specifically tailored to our community. Tools available to us typically fall in one or more of the following categories: regulatory, operations and management, financial, and educational strategies.

3.2.1 Water Conservation Tools



Regulatory management tools utilize policies, standards, bylaws, bylaw fines and enforcement to unilaterally apply water conservation expectations across the District. Examples of regulatory tools include staged watering restrictions, incorporating water efficient fixtures into building and development bylaws, and enforcement to ensure compliance.

Operations and management tools focus on best management practices that minimize losses and supply requirements, while ensuring effective and consistent operation of the distribution system to avoid unnecessary increases in demand. Operational tools include conducting water audits, implementing leak detection programs, and continuously utilizing advances in technology. Operational tools may also include significant changes to water systems such as increasing storage, reclaimed water use, and interconnecting sources.

Financial management tools aim to conserve water by providing residents opportunities to save money through water conscious activities, while incentivising water conservation by discouraging high water consumption. Financial tools include activities such as implementing metered rate structures or providing credits for efficient water use.

Educational tools provide individuals with the knowledge to incorporate water conservation practices into their everyday life. Educational tools focus on teaching users waterwise practices. This sharing of information can be achieved through advertising across a wide array of media, door-to-door canvasing, partnering with local stakeholders, tours of our water facilities, or creating contests for residents or students.

3.3 Historic Conservation Initiatives

Water conservation initiatives carried out by the District over the last 15 years have achieved approximately 4,100ML (approximately 2,000 Olympic sized swimming pools) in annual water savings (refer to Appendix A for a detailed breakdown of these projects).

The District has invested significant time and resources to achieve these water savings, minimize waste, and ensure adequate supply is available for our community and the environment. Financial contributions towards capital projects alone are estimated at $16,000,000 ($18,725,000 adjusting for inflation to 2021 values). Further investments include the creation of bylaws, policies, and internal documents that optimize water conservation, as well as operational maintenance to equipment, reservoirs, dams, and other assets to ensure that systems continue to function as they were originally designed.

Progress towards water conservation targets identified in the 2012 Water Master Plan further underline the commitments the District has made towards water conservation. The 2012 Water Master Plan targeted a 25% reduction from it's 2012 average day demand of 27.4ML by 2030. This results in an average day demand of 20.6ML before adjusting for increases in population, agricultural allotments, and climate change. Actual water consumption in 2021 was found to be 21.21ML for approximately 11,207 water users. Adjusting for the differences in population, agricultural allotments, and climate change, the District's current water consumption can be extrapolated back to an average day demand of 21.23ML in 2012 values. This results in a 22.5% reduction in water consumption.

The construction of the Eldorado reservoir and the implementation of the universal metering program were the two capital projects that contributed the greatest to our water conservation success, each providing over 1,000ML in water savings annually. The results of these actions are easy to see; however, future conservation tactics may no longer yield such drastic reductions in water consumption.

Eldorado Raw Water Balancing Reservoir

As we move through the discussion section, it will be necessary to identify the initiatives that make sense and benefit the community and the options that are worth the investment. At some point it will be important to realize that the effort and resources required for certain initiatives may not result in worthwhile returns on investment, which is called the point of diminishing returns.

3.4 Climate Change

The 2012 Water Master Plan included a 10% safety factor to ensure our systems are resilient with respects to the risks associated with climate change. The requirement to factor in climate change to sustainable water management continues to prove vital, as the magnitude and frequency of extreme weather events increase. Longer dry periods and longer wet periods are becoming more frequent and more defined as time goes on. An analysis of the District's water system predicted an increasing difficulty in maintaining water supply during times of extreme drought.

Figure 1: Predicted Unmet Water Demand at Oyama Lake

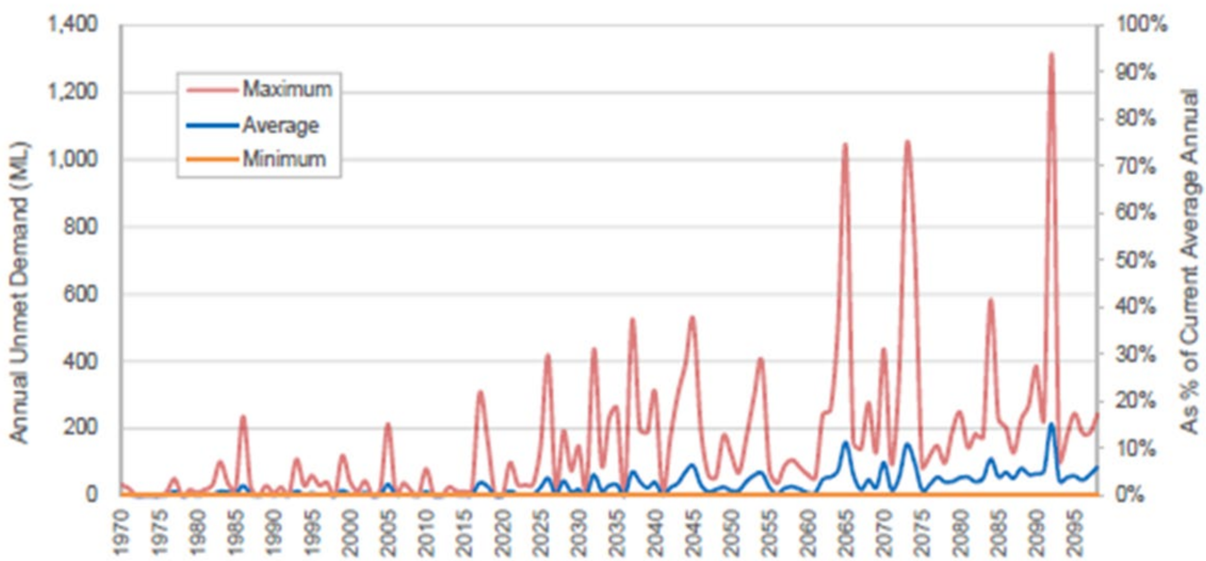


Figure 1 illustrates the predicted volume of water that will not be available to residents connected to the Oyama system as a result of changing climate. The graph is based on statistical modelling (General Circulation Models) of historic and predicted water demands, which returns various unmet water results. The minimum, maximum, and average unmet water demands have been presented.

Although predictions into the far future are less reliable, the overall increasing trend demonstrates the need to establish robust systems with efficient supply and user-conscious demand. The unpredictability of climate change makes it particularly challenging for the agricultural sector. Improvements should be identified and implemented prior to major drought events because **once water scarcity occurs it is typically too late to make significant changes.**

4.0 Discussion

Canadas' residential water use was reported as 215 LPCD in 2019; however, British Columbia has been identified as a province that utilizes water above the national average (Statistics Canada, 2021), with the average District residential customer using 386 LPCD in 2019. Although the District strives to continually increase efficiencies, higher water usage can be attributed to the semi-arid conditions throughout the

Okanagan Valley. This makes it difficult to compare per capita water usage to other, wetter regions of the country, or expect the District to achieve similar water consumption behaviours. From 2012-2016 the Districts' average annual system demand was 8,840ML. From 2017-2022 the average annual system demand was 7,745ML, which is a 12% decrease during a time of unprecedented community growth. Water conservation strategies will need to be based on reasonable changes to our current water use behaviours, as opposed to direct comparisons to other regions of Canada that see considerably larger amounts of annual precipitation and/or cooler temperatures. Focusing strategies specific to our area in conjunction with our historic water consumption will be used to determine if **we are using more water than we need**.

Rapid growth of the area highlights the importance of asset management and planning to ensure the District can meet future water demand requirements as economically as possible. The dominating industries associated with the District include agriculture and tourism, which both significantly increase water demand over warmer months of the year (refer to Appendix A, Figure 14). Agricultural demand accounts for approximately 56% of consumption, while outdoor seasonal irrigation is estimated at 12% of our annual demand. Due to the drastic differences in summer and winter demands across the District, it was determined that the greatest opportunities for water conservation from a supply perspective would come from strategies that target outdoor use. Focusing resources on outdoor use will ensure that we are seeing greater returns on our investments as we seek to determine if **there is a benefit to using less water**.

Strategies should also strive to reduce hydraulic loading of the wastewater treatment plant, reduce peak flows, and should be viable during times of extreme drought. These strategies will consider both the benefits of water conservation to the District, as well as the investments required to implement. Supply and demand management strategies will be explored through regulatory, operational, financial, and educational tools. Further consideration of these strategies will be made to stand up through the unpredictability of stressors that arise due to climate change.

4.1 Demand Side Management Considerations

4.1.1 Outdoor Water Usage (Non-agricultural)

District metering data has shown that significant water reductions were achieved through the implementation of a metered rate structure (Refer to section A.4). While reduced water consumption was an excellent outcome of universal metering, it also provided the District with a means of measuring typical water consumption so that we may better understand the needs of our community. Analysis of metered consumption has shown much of the community is using water appropriately for our climate; however, there are still outliers that are using more water than is considered appropriate.

Contemplated Solutions

4.1.1.1 Regulatory

4.1.1.1.1 New Development Requirements

Census data for 2021 indicated the District has a population of 15,817 and has seen a population growth of 22% over the last 5 years. This growth rate is one of the highest in Canada and highlights the importance of wise water use planning to ensure the District can meet future demand requirements as economically as possible.

It is recommended that any efforts to regulate new development be focused on improvements to outdoor water usage. The following are measures that could be considered as requirements for new development:

i. **Xeriscaping** - Landscaping with low water usage and conservation as a primary objective is considered one of the most effective methods in reducing water consumption for new development. It should be noted that xeriscaping is not landscaping with no vegetation, but rather landscaping using plants (typically native to the area) that can tolerate long periods with little precipitation.

ii. **Rain Sensors** - The District has found that it is typical for many homeowners not to adjust their automated irrigation systems when it is raining. Rain sensors on residential sprinkler systems will automatically turn off irrigation during rainy periods, thus reducing consumption.

iii. **Lawn Requirements** – Requiring the use of native vegetation or the elimination of drought intolerant grasses, such as grass mixtures with more than 30% Kentucky bluegrass by composition, could lead to long-term reductions in outdoor water consumption.

Implementing these measures is estimated to reduce outdoor irrigation usage from new developments by approximately 30%, which equates to 60 LPCD less per new home. The Districts Official Community Plan projects a medium growth rate of 2.4%, which equates to a population growth of approximately 4,700 people by 2032. This translates to a potential annual water savings of **<u>102ML</u>**.

4.1.1.1.2 Residential Allotments

More stringent, year-round regulations could be implemented that aim to reduce outdoor water consumption and seasonal irrigation. Water allotments for the watering of lawns could be changed to a maximum of 0.10 hectares (¼ acre), regardless of lot size. Negative impacts to this solution include reduced property aesthetics and increased fire risk during dry periods. If lawn watering of residential properties followed the recommended 3.2cm application (including rainfall) each week, it is estimated that **<u>56ML</u>** of water savings could be achieved each year.

4.1.1.1.3 Rainwater Harvesting

The District could consider the requirement of rainwater harvesting systems to reduce water users reliance on public water systems to water their lawns and gardens. Rainwater harvesting includes the capture and storage of rainwater into a container for future use. The systems can be large, utilizing underground cisterns to store water, or complex, including the use of pumps to convey stored water. The most common method of rainwater harvesting is through the use of rain barrels, which are connected to residential eaves, thereby capturing precipitation that falls over the entire roof area.

If 30% domestic water user buy-in was achieved by 2032, it is estimated that 2,200 rain barrels would be installed throughout the District. This would allow each property to divert approximately $1m^3$ of water over the dry season when needed. With these assumptions it is estimated that **1ML** in annual water savings could be achieved.

It was assumed that rain barrels would not be adopted by agricultural, institutional, or commercial users due to the time constraints and expected uses of the collected rainwater and distribute throughout the property.

4.1.1.2 Operational

Operational strategies are not recommended for this consideration.

4.1.1.3 Financial

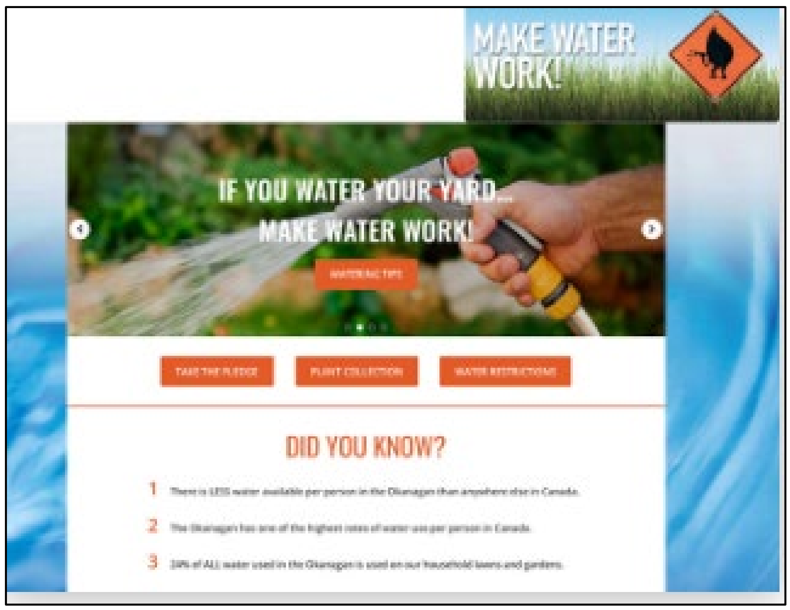
4.1.1.3.1 Variable Rate Structure

Variable rate structures have been proven to be an effective mechanism to both reduce water use and achieve consistent community-wide consumption. The City of Kelowna, Regional District of North Okanagan, and several other neighbouring water districts have all implemented variable rate structures.

Variable rate structures can improve affordability and access by pricing a basic allocation of water at a lower cost. Variable rate structures are effective at incentivising customers to reduce consumption by making higher volumes of water use progressively more expensive. Negative impacts to this solution include reduced property aesthetics and increased fire risk during dry periods. By implementing a variable rate structure, the District would expect to hold the average customers usage at approximately 20LPCD less per year than current average. This equates to a water deduction of nearly **98ML** by 2032.

4.1.1.4 Educational

4.1.1.4.1 Water Ambassadors Outreach



Educational strategies for conserving water within the District would primarily focus on promoting efficient outdoor domestic use. Although long-term residents of the District or Okanagan Valley may be well versed in effective water-saving tactics, the rapidly growing population is likely comprised of many people that are not as familiar with the semi-arid climate and the importance of water conservation. Public information sessions, door-to-door canvasing, informative brochures, and social media platforms are all methods that can help promote water conservation throughout the District.

Possible educational topics of discussion water ambassadors may have with the public include:

i. **Watering** - One of the easiest changes domestic users can make to reduce their outdoor water demand is to adopt more effective and efficient watering methodologies. Primarily, residents should ensure they avoid overwatering and water losses associated with evaporation. The most effective times to water are between 10:00PM and 6:00AM, as up to 50% of water can be lost to evaporation in the heat of the day. Automatic watering systems are recommended to make watering late at night manageable. Sprinkler systems should be inspected regularly for leaks and proper coverage, with upgrades occurring as required.

ii. **Lawn Maintenance** - Small behavioural changes in lawn maintenance can significantly reduce outdoor water demands, while preserving luscious green turfs. Aerating lawns annually and top dressing with organic material helps stimulate good soil composition that promotes proper water adsorption. Sandy soils drain too quickly, while soils with heavy clay composition results in the pooling of water, which is susceptible to evaporation. Leaving grass clippings behind further increases the organic loading of soils, while helping to build healthier and more lush lawns. Grass should be allowed to grow to heights of approximately 6.5cm prior to mowing, as taller grass provides shade and reduces losses due to evaporation. Healthy lawns typically only require around 3.2cm of water each week, including rainfall. Even during extreme heat events, green grass can be achieved primarily through proper fertilization of your lawn. The required watering can generally be achieved through 1.5 hours of sprinkling, one day a week. Minimizing the frequency of waterings promotes drought resilient lawns and helps establish deep, healthy root formation. Finally, drought-tolerant grass seed should be added to existing turf whenever fertilizing, aerating, or top-dressing, to decrease the overall water demand of the lawn.

iii. **Gardening and Landscaping** - Similar to lawns, gardens should frequently be dressed with organic materials to facilitate good soil composition, prevent water losses due to evaporation, and keep roots moist and cool. Organic materials in gardens have the added benefits of discouraging the growth of weeds and providing suitable habitat for decomposers, such as worms, which in turn provide nutrients to stimulate vegetative growth. Drought-resistant plants and plants genetically designed for the semi-arid climate are far less labour-intensive, demand less water, and can still be visually appealing while maintaining the natural beauty of the region. Xeriscaping garden exhibitions could be created through the Parks department to highlight the ease and benefits of the landscaping technique

While the District utilizes educational strategies, such as OBWB's Make Water Work program, there are other opportunities that can be explored. Potential educational strategies that could be promoted by the District target watering (including setting timers and when to water), lawn maintenance, and garden maintenance. Through strong, persistent messaging, the District would target a 5% reduction in domestic outdoor water usage, which equates to **50ML** a year.

4.1.2 Leaking Watermains, Service Lines, Private Fixtures, and Sewer Infrastructure

By analyzing the differences in volume between water entering the system and end-user consumption it was determined that 15-20% of water that enters the distribution system is not registered through a water meter. This is known as unaccounted or non-revenue water. It is estimated that a third of the unaccounted water is attributed to system maintenance procedures such as reservoir cleaning, watermain flushing, or continuously run sampling locations. Another third of non-revenue water is believed to be due to leaks on private service laterals. The remaining third of unaccounted water is believed to be leaking from the Districts' distribution systems (i.e., watermains, leaky valves, worn out gaskets, service lines, etc.).

Leaking sewer infrastructure at maintenance access chambers, pipes, and privately owned fixtures pose problems in both the collection system and at the wastewater treatment plant. Water infiltrating the sewer system can lead to capacity constraints at wastewater pumping stations and the wastewater treatment plant, and as such should be considered in correlation to a water conservation plan.

Contemplated Solutions

4.1.2.1 Regulatory

Regulatory strategies are not recommended for this consideration.

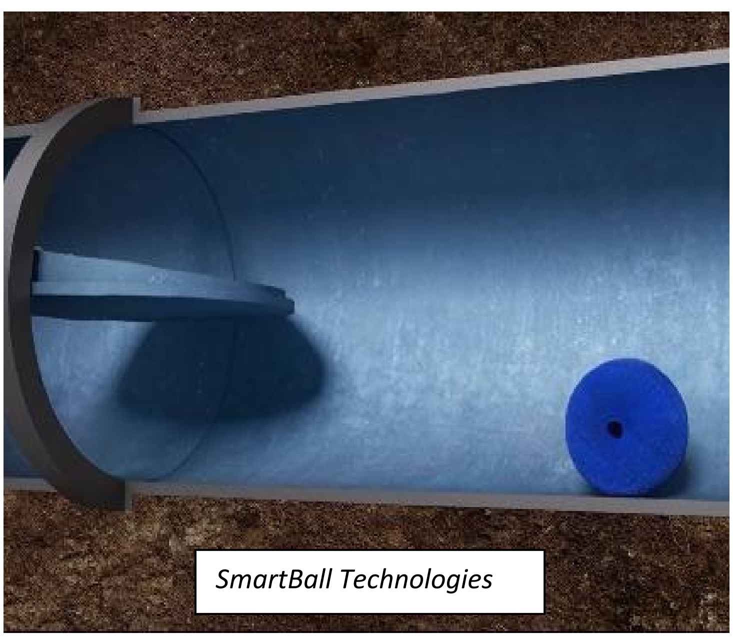
4.1.2.2 Operational

4.1.2.2.1 Distribution System Leak Detection Programs

A leak detection program relies on sensitive sound listening devices that pickup leaks in the subsurface watermain, primarily from metallic water service materials. Implementing this type of leak detection program may not be feasible because the majority of the District watermains are of a material that does not produce a sound that is easily detectable. Many of the District service lines in older neighborhoods are metallic, and there may be opportunity to locate some leaks on these services.

Listening Device

Another potential option for leak detection that could be explored would be the use of SmartBall technologies. SmartBall is specifically designed for use in large diameter metallic watermains and can be used without requiring any service disruptions. SmartBall is inserted into watermains and detects leaks and gas pockets in metallic pipes through acoustic sensors. Additional accelerometer and gyroscopic technologies can be used to simultaneously assess the integrity of watermains, but the additional services are quite expensive.

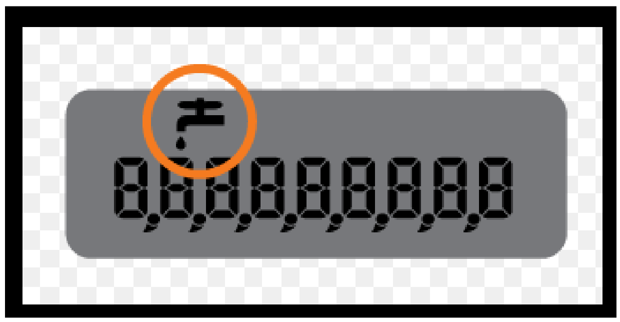


SmartBall Technologies

A leak detection program is labour intensive and can be expensive. If the District were to implement a leak detection program it is recommended to focus on older neighborhoods and large transmission mains. An optimistic estimate in water savings from a leak detection program is 10% of non-revenue water attributed to leaks within the District's distribution system. This equates to an annual water demand reduction of **45ML** per year.

4.1.2.2.2 Water Meters Fixed Network Leak Detection

Since the implementation of the District universal metering program, water meters are read monthly using a radio frequency drive-by system. The drive-by system relies on an operator to collect meter readings and subsequently analyze results and notify customers of potential leaks on their property. Because the District only reads water meters once a month there can be a significant lag from the time the leak begins, to the time a property owner is notified.



The District is currently implementing a reading system known as AMI, which would read the water meters daily and provide real time feedback to the customer. This system should help to reduce the current notification lag, allowing leak repairs to occur in an expedited manner. Fixing leaks inside homes not only has a water demand benefit, but also lowers the flows to the Wastewater Treatment Plant. Implementing an AMI reading system is anticipated to reduce water demand by **12ML** annually. **3ML** of the savings is water that would have otherwise been delivered to the Districts Wastewater Treatment Plant.

4.1.2.2.3 Sewer Inflow and Infiltration

The District has an infiltration and inflow (I&I) program that allows us to find and rectify leaks, breaks, or illegal discharges within the wastewater collection system. One of the tools the District utilizes for our I&I program are SmartCovers, which transmits real-time sewer main flow data to operators using radio frequencies. SmartCovers have proven to be effective at detecting abnormal flows triggered by incidents such as heavy rains, ground water infiltration, or unauthorized resident discharges into the collection system. By incorporating

SmartCovers into the Districts' infiltration and inflow program, it has helped minimize hydraulic loading to the wastewater treatment plant. It is difficult to quantify the volume of water that is diverted from the wastewater collection system; however, the use of SmartCovers has proven to be effective and will continue to be used.

4.1.2.3 Financial

Financial strategies are not recommended for this consideration.

4.1.2.4 Educational

4.1.2.4.1 Community Outreach

Educating the general public on strategies for identifying watermain breaks, broken services, or leaking plumbing fixtures all have the potential to conserve water. Water operators and residents of the District would be more likely to learn of potential leaks early on, which would allow them to respond quickly and reduce water consumption. Community outreach may include updating the District website, holding public information sessions, or door-to-door canvasing to provide residents with tips to detect leaks, who to call if a leak is suspected, and steps to make the necessary reparations. Further information could be provided to encourage residents to regularly check their utility bills and water meters for indications that a leak may be occurring on their property. No reduction volume is estimated for this contemplated solution due to the challenges trying to quantify the unknowns.

4.1.3 Agricultural Irrigation Use

On an average year over 56% of metered water use within the District is for agricultural purposes. Although it is apparent that acquiring additional water supply may be required as the community continues to grow, it is also known that the greatest opportunities for demand side water savings lie with agricultural users, and wise agricultural practices. To date, the District has implemented flow control valves, set allotments, and continues to deliver high consumption notices to reinforce efficient water use. Farmers in our community have also put in a lot of work to conserve water by continually adopting new best management strategies, making use of efficient irrigation systems, and working with District staff to remain within their allotments, especially during threatening times of water scarcity. While staff and many agricultural users strive for efficient management of our water supplies, there is an opportunity to further explore efficient water use for agricultural purposes across the District. This is primarily due to the complex process required to determine what waterwise behaviours are suitable given the diverse crops, irrigation systems, soil compositions, weather, and farming practices. Furthermore, significant changes to agricultural watering practices would not be imposed by the District without significant consultation and input from technical advisors, agrologists, and local farmers who know the area best.

Contemplated Solutions

4.1.3.1 Regulatory

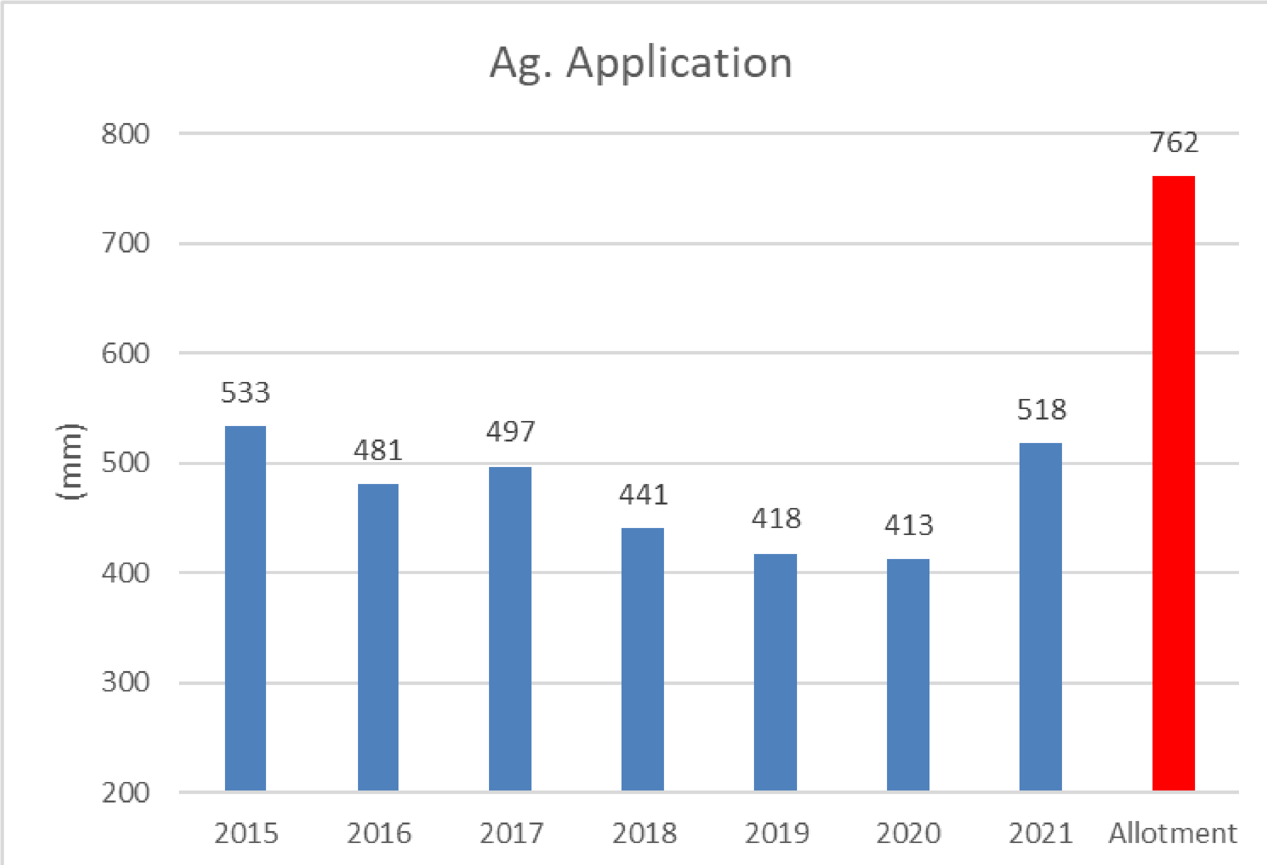
4.1.3.1.1 Agricultural Irrigation Usage Plan

An Agricultural Irrigation Usage Plan could be undertaken by the District alongside local farmers, professional agrologists, and appropriate subject matter experts to establish best management practices that ensure water efficient farming strategies are in place to support a drought resilient community. This collaborative effort between stakeholders is intended to address challenges posed by water scarcity, promote water conservation, and mitigate the impacts of drought on agricultural activities. Elements of the Agricultural Irrigation Usage Plan would include identifying water-efficient farming practices, examining water allocations and scheduling for farming purposes, developing education and outreach programs, and prioritizing crops that would be especially susceptible to drought. This exercise of knowledge sharing between key stakeholders will help identify needs of the farming community, supply capacities of the District, opportunities for efficient water use, and strategies that will mitigate the effects of drought. Although drought mitigation is a part of the Agricultural Irrigation Usage Plan, the plan is not intended to be a Water Scarcity Plan. A Water Scarcity Plan would partially rely on findings of the Agricultural Irrigation Usage Plan to establish contingency plans for multi-year drought scenarios. While the Agricultural Irrigation Usage Plan itself would not offer any direct quantifiable water savings, it is recommended to be completed prior to implementing any changes that would affect current agricultural practices in order to guide informed decisions.

4.1.3.1.2 Agricultural Allotments

Agricultural users are the only remaining customer base that is charged solely on a flat rate basis. On a normal year, agricultural customers are permitted to apply 762mm (30”) of irrigation water over the growing season, which equates to 3,084m^3 per acre. The District has found this volume to be well in excess of what 80% of farms in Lake Country typically uses in an annual growing season. On a normal year the vast majority of farms apply 520mm (20”) to their growing area, which equates to 2,105m^3 per acre. Even though the majority of agriculturalists are found to be using water efficiently, each year approximately 5% of agricultural customers are exceeding allotment, while another 20% of users are over 610mm (24”) application, but still below allotment. Given the majority of farms consistently utilize only two-thirds of their allowable allotment, there may be an opportunity to explore new allotments that promote water conservation while continuing to support a strong farming community. It is important to recognise that water demands for agricultural practices are likely to increase as a result of climate change, and all allocations currently available for agricultural irrigation should remain within the farming community.

Figure 2: Average Agricultural Application



Properties where the application is less than 255mm (10") are not included in the data set.

A collaborative Agricultural Irrigation Usage Plan can be undertaken with input from local farmers, professional agrologists, and appropriate subject matter experts to determine what constitutes waterwise farming practices within the District. Provincial land use databases and water demand modelling systems can be integrated to assess the potential benefits of optimizing allotments to ensure long-term sustainable water availability for future farming requirements.

4.1.3.1.3 Efficient Watering Systems

Agricultural users throughout the District use a variety of irrigation methods to water crops and keep them cool. The types of irrigation systems utilized may not necessarily be the most water-efficient options. The use of overhead irrigation systems to cool orchards raises issues of sustainability, and there should be consideration to move toward efficient watering systems. Enforcing the use of efficient irrigation systems is expected to provide significant cost and water saving opportunities to many agricultural users. Mandating efficient water use systems is something the District should consider, following completion of an Agricultural Irrigation Usage Plan with input from local farmers, professional agrologists, and appropriate subject matter experts. Until the Agriculture Use Plan is finalized an estimated volume of water reduction can not be determined.

4.1.3.2 Operational

4.1.3.2.1 Tensiometers

Tensiometers are tools that can be used to measure moisture content in soils. Tensiometers are strategically installed throughout orchards near the base of crops and allow farmers to determine effective watering schedules based on real-time data. Incorporating tensiometers into general farming practices across the District is expected to reduce overwatering and limit peak hour demands during the hotter, drier months of summer. Modern tensiometers are calibrated depending on soil type; therefore, water demand will vary depending on soil profile, crop type, and growth stage. It is difficult to quantify the expected water savings that would be realized through the use of tensiometers; however, conservation is likely to improve through educational outreach for proper tensiometer use and maintenance. It is recommended that tensiometers be piloted across the District so that we may better understand the potential benefits and begin determining baseline watering requirements.

4.1.3.3 Financial

4.1.3.3.1 Variable Rate Structure

A per cubic meter or variable rate structure for agricultural customers is recommended to help promote efficient watering systems that will reduce water consumption and help prepare agriculturalists for times of drought. By implementing a rate structure, it is estimated that 50% of agricultural users exceeding 610mm (24”) application will no longer do so. Furthermore, it is expected that 90% of agriculturalists exceeding allotment will no longer do so if a higher rate structure is implemented.

Alternatively, water use credits may be further explored whereby agricultural users pay a high rate through the growing season, and those found to use less water receive a credit at the end of the year.

With the projected reductions and heightened awareness of additional savings by using less water, it is estimated that **200ML** of water savings can be achieved annually, although it is not recommended to implement prior to completion of an Agricultural Irrigation Usage Plan.

4.1.3.4 Educational

4.1.3.4.1 Licensed Agrologist Outreach

An educational strategy to promote efficient agricultural water consumption could include employing a licensed professional agrologist. Agrologists are subject matter experts on farming practices and could be helpful in educating both agricultural users and District staff.

i. **Agricultural Users** – Farmers may benefit from new knowledge on best management practices for healthy vegetative growth, maintaining healthy soil conditions, and ensuring efficient and appropriate water use. Various watering techniques could be explored, specific to our semi-arid environment, including the use of tensiometers and efficient irrigation systems. Additionally, a licensed agrologist may have insight on how farmers may expect to mitigate the effects and prepare for climate change and drought.

ii. **District Staff** - Suggestions put forth by an agrologist would help District staff build an understanding of farming requirements, develop FAQ and tips to be added to the District website, or be utilized in public information sessions whereby members of the community would be invited to listen and ask questions as they see fit. Consultation with an agrologist would help inform the District on reasonable requests to ask of the farming community, including setting appropriate water allotments, developing water-efficient farming standards, and contingency planning for the community in the event of extreme or multiyear drought.

The volume of potential water savings would be difficult to quantify without knowing the suggested changes from the agrologist themselves. Were licensed agrologist outreach to be considered, it would be beneficial to have their input incorporated into the Agricultural Irrigation Usage Plan for continuity in messaging.

4.2 Supply Side Management Considerations

4.2.1 Excess Water Releases – Beaver Lake Watershed

Following the construction of the Eldorado Reservoir, the District has been able to conserve a great deal of water by releasing average daily flows from Beaver Lake to meet demand, as opposed to continuously releasing peak flows. Releases are currently set locally, which provides an opportunity to optimize efficiency through implementation of automation. Another opportunity to optimize releases is through the proactive planning of required environmental releases with senior levels of government and key stakeholders.

Contemplated Solutions

4.2.1.1 Regulatory

4.2.1.1.1 Water Management Plan

In 2021 senior levels of government ordered the District to release 1,500ML from Beaver Lake to fill Duck Lake and establish environmental flows for spawning habitat in Middle Vernon Creek. Environmental flows for spawning habitat are important to the District and its residents, but it is believed that a longer term solution that doesn't require the release of such large volumes from Beaver Lake can be achieved. The District is currently in the process of creating a Water Management Plan for Upper Vernon Creek and the Beaver Lake chain. The premise of this plan is to establish water use initiatives that will be undertaken by members who have a vested interest in this watershed to ensure sustainable, long-term water availability. Key stakeholders in the development of this plan include senior levels of government, Okanagan Indian Band, Okanagan Nation Alliance, and the Okanagan Basin Water Board. The Water Management Plan seeks to implement technical solutions that will ensure sustainable environmental flows, while reducing the required water releases of the upper watershed, namely Beaver Lake, especially during times of drought. If a solution can be identified that doesn't require surcharging Duck lake with water from the Beaver Lake watershed to establish flows in Middle Vernon Creek, it is estimated to provide water savings of approximately **700ML** per year.

Figure 3: Overview of District Water Sources

4.2.1.2 Operational

4.2.1.2.1 Automated Outlet Valve

As part of the reconstruction of the Beaver Lake outlet structure, an automated valve will be installed, which will allow operators to make immediate flow adjustments remotely. This will provide the operational flexibility to release the minimum required flows from Beaver Lake; thereby, prolonging the storage of water. It is estimated the valve automation may reduce the volumes required to be released by 2%. Using the average volume released over the last ten year, this equates to approximately **66ML** annually.

Automated Valve Actuator

4.2.1.3 Financial

Financial strategies are not recommended for this consideration.

4.2.1.4 Educational

Educational strategies are not recommended for this consideration.

4.2.2 Insufficient Supply

Overtime, as the District grows, we may be required to consider additional water sources, particularly for agricultural use. Additional sources may also be important for drought mitigation. Identifying economically viable options to increase water supply has become increasingly apparent when analyzing the impacts climate change may have and determining which long-term resilient strategies to adapt. Several options have been considered by the District to ensure our water systems are able to meet demand as the community grows and climate change continues to exacerbate drought conditions.

It should be noted and considered, in relation to additional supply, that there are concerns during years of severe water shortages the Province may regulate or mandate the Districts withdrawal and release rates. This is particularly relevant when considering supply enhancements to the upper watershed during water shortages, as the Province may order the District to release storage to the lower Okanagan basin, thereby negating these improvements.

Contemplated Solutions

4.2.2.1 Regulatory

Regulatory strategies are not recommended for this consideration.

4.2.2.2 Operational

4.2.2.2.1 Increased Pumping Capacity from Okanagan Lake

The District explored the opportunity to either expand the Okanagan Lake pumphouse or construct an additional pumping facility for the Okanagan Lake system. These strategies were considered as alternatives to constructing a water treatment plant on the Beaver Lake source, and as such would require a facility to provide 50ML of water each day in order to meet current and projected growth demands. Although the Okanagan Lake system only utilizes approximately 20% of its available licensing, it currently has no provisions for agricultural use. Given the number of water purveyors that rely on Okanagan Lake water, further questions remain around how resilient this source would be during times of extreme valley-wide drought. The introduction of invasive species, notably quagga and zebra mussels, have become increasingly concerning in large lakes. These invasive mussels have been found to contribute to algal blooms and colonize on water intake structures, which requires costly operational measures to prevent flow restrictions and damages to infrastructure. Additionally, pursuing an expansion on the Okanagan Lake system would both increase the District's reliance on attaining provincial filtration exemptions and reduce redundancy by eliminating the Beaver Lake source. It is estimated that **8,700ML** of additional water could be supplied to the Okanagan/Beaver Lake distribution systems, but at the estimated cost of $45 million (2021 dollars) plus the cost of the required land acquisition.

4.2.2.2.2 Removing Beaver Lake Channel Obstruction

Increasing supply at Beaver Lake could also be achieved by accessing the full volume of available storage currently allotted to the District. The basin shape (geomorphology) of the outlet channel to Upper Vernon Creek is currently shaped in a way that restricts the availability to drawdown water below 6,500ML (see Figure 4). We must undertake environmental assessments and attain approval from the Department of Fisheries and Oceans (DFO) to remove the natural obstruction prior to the outlet of Beaver Lake. This option has the added benefit of additional storage and would not require additional licensing to withdraw. Differing from raising the dams, this option would mean less pushback from stakeholders and costs associated with land acquisition, permitting, or litigation. Removal of this impediment could potentially allow the District access to **6,500ML** of additional storage. It should be noted that partial removal of the obstruction may be considered, as full removal may not be practical.

Figure 4: Channel Prior to Beaver Lake Outlet Structure

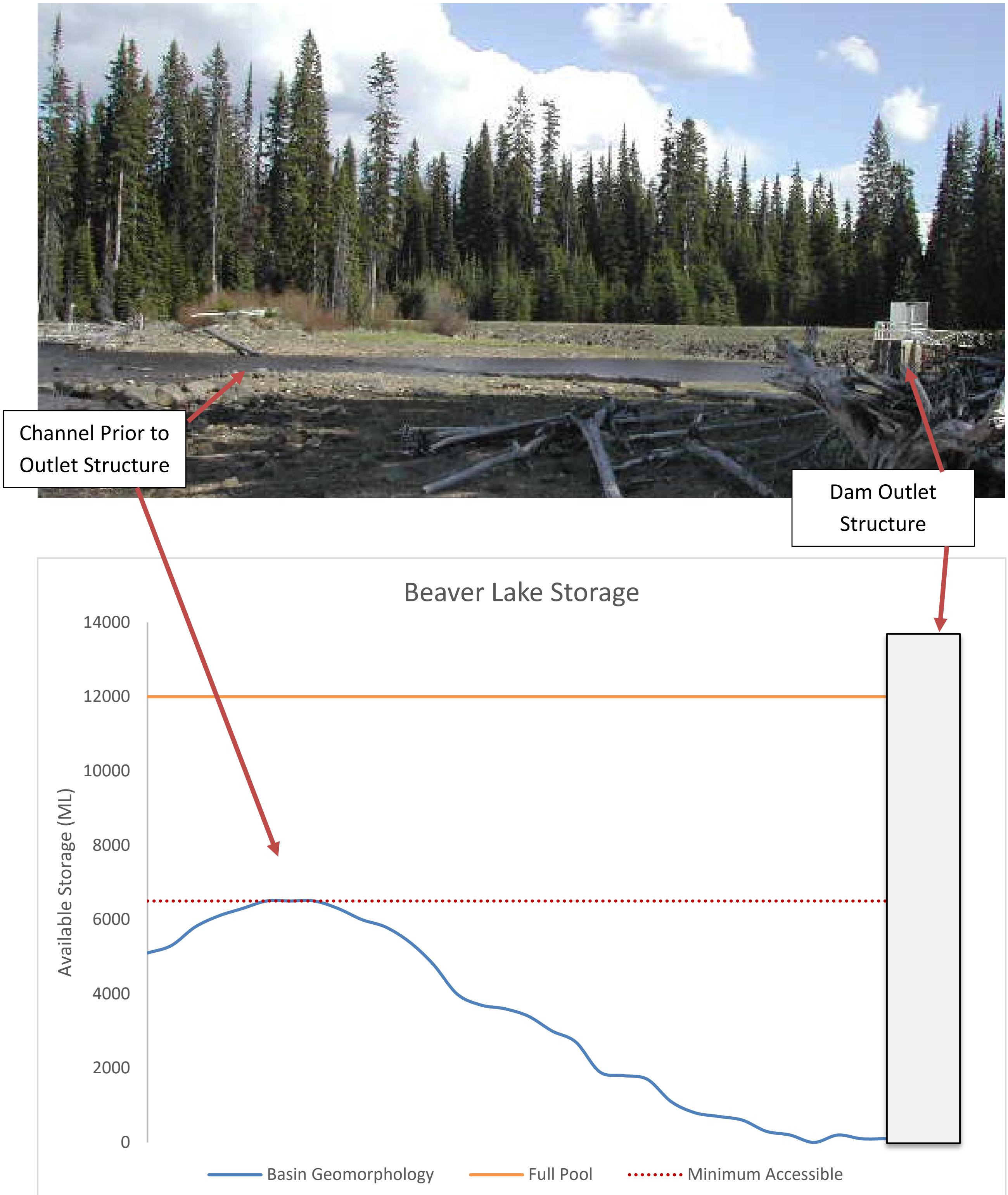


Figure 4 shows the channel prior to the outlet structure on Beaver Lake. The shape of the basin limits the volume of storage accessible by the District. The current inaccessible storage is 6,500ML and the maximum storage of Beaver Lake is approximately 12,000ML.

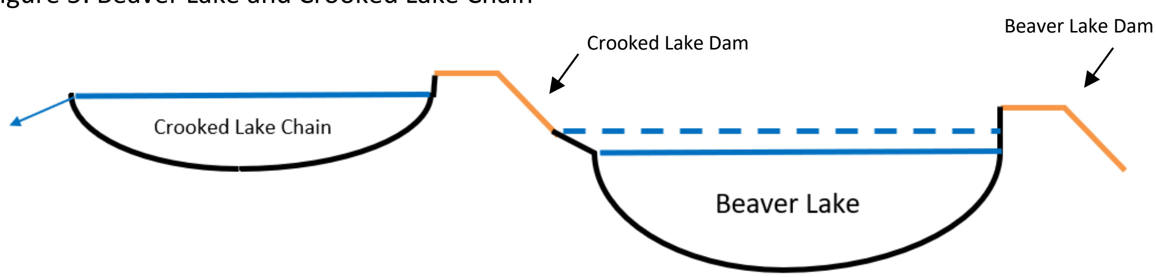
4.2.2.2.3 Raising Beaver Lake Dam

To secure more water storage for the Districts source with the largest water consumption, the Beaver Lake dam level could be raised. This option would provide the District with more operational flexibility and water reserves to combat drought for those that rely on the Beaver Lake watershed. This strategy for water supply management has the added benefit of being relatively affordable; however, it is not guaranteed to receive senior government support. Additionally, Beaver Lake has many stakeholders, including privately owned cabins and the Beaver Lake Lodge resort. These properties are located adjacent to Beaver Lake, so changing the lake level would result in flooding or the loss of land. An environmental impact assessment would need to be conducted to ensure no sensitive ecosystems are affected by the changing lake level. A Summit Environmental Consultants report conducted in 2010 suggested the optimal level to raise Beaver Lake dam would be an additional 1.2 meters, which would provide an additional **4,600ML** of storage each year the reservoir fills. While this option may be cost-effective and favourable, there are many unknown elements that may drastically increase project costs including environmental considerations, regulatory approvals, dam safety concerns, and managing public perception.

4.2.2.2.4 Raising Crooked Lake Dam

This option has essentially the same benefits and risks associated with it as the Beaver Lake dam consideration. Raising the Crooked Lake dam will also provide additional storage and water availability to the Beaver Lake watershed. If the Crooked Lake dam was raised 0.61 meters, it is estimated to provide an additional **1,200ML** of storage. Similar to raising Beaver Lake dam, it is not guaranteed that we will receive senior government support.

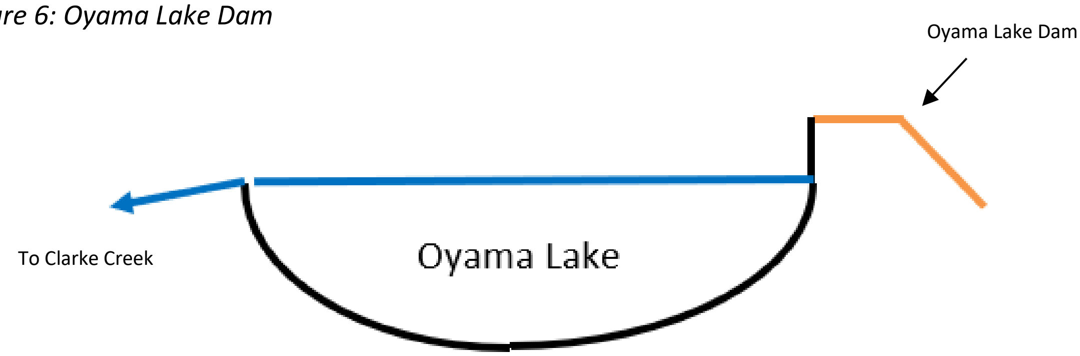
Figure 5: Beaver Lake and Crooked Lake Chain



4.2.2.2.5 Increasing Storage of Oyama Lake

Much like the option to raise the Beaver or Crooked Lake dams, the same strategy could be applied to the Oyama Lake dam. While fewer privately owned properties lie on the shores of Oyama Lake, there still exists several key stakeholders, including the Oyama Lake Eco Lodge, that would be affected by changing water levels. Similar obstacles would need to be overcome, including environmental impact assessments and senior government approvals and licensing. An additional dam would need to be constructed at the south end of Oyama Lake to prevent the increased water level from overflowing into Clarke Creek, adding to the costs and required maintenance. A 2010 report by Summit Environmental Consultants suggested raising this dam level 1.2 meters, which would provide the Oyama watershed with an additional **4,000ML** of water storage.

Figure 6: Oyama Lake Dam



4.2.2.2.6 Reclaimed Water and Groundwater Extraction

The use of reclaimed water for activities other than human consumption is something that is becoming more widely accepted and considered as a viable option. Reclaimed water can come from a variety of sources, including stormwater, grey water, and treated effluent from wastewater treatment plants. The greatest opportunity for the District to increase water supplies and reduce system demand is through the reclamation of treated effluent from the wastewater treatment plant used in combination with groundwater extraction. The City of Vernon has been utilizing reclaimed water from their wastewater treatment plant for over 30 years with much success.

The use of reclaimed water in the District has the added benefit of providing an additional disposal option for treated effluent, which is currently nearing capacity. Reclaimed water in combination with ground water extraction could be used for agricultural purposes, supplying a strategic area of customers currently connected to the Beaver Lake Source (refer to Figure 7), or as a viable option to supplement environmental flows to Middle Vernon Creek during times of water scarcity. Significant capital would be required to construct transmission mains from the wastewater treatment plant. Further investments would be required to install additional disinfection mechanisms necessary to make use of the water supply under provincial legislation. The use of reclaimed water comes with the added layer of difficulty of attaining public buy-in, given the negative connotation historically associated with utilizing treated effluent. However, strict regulations are in place for providing reclaimed water *direct to consumer* and the treated effluent would only be supplied to irrigation connections as allowed under legislation.

Were the District to pursue the use of reclaimed water in combination with ground water extraction, it is estimated that **1,000ML** of additional water could be utilized annually, based on the irrigation area we would look to service (refer to Figure 7). The volume of water supplied has the added benefit of alleviating demand requirements from the Beaver Lake source.

Figure 7: Potential Area for Reclaimed Water Use

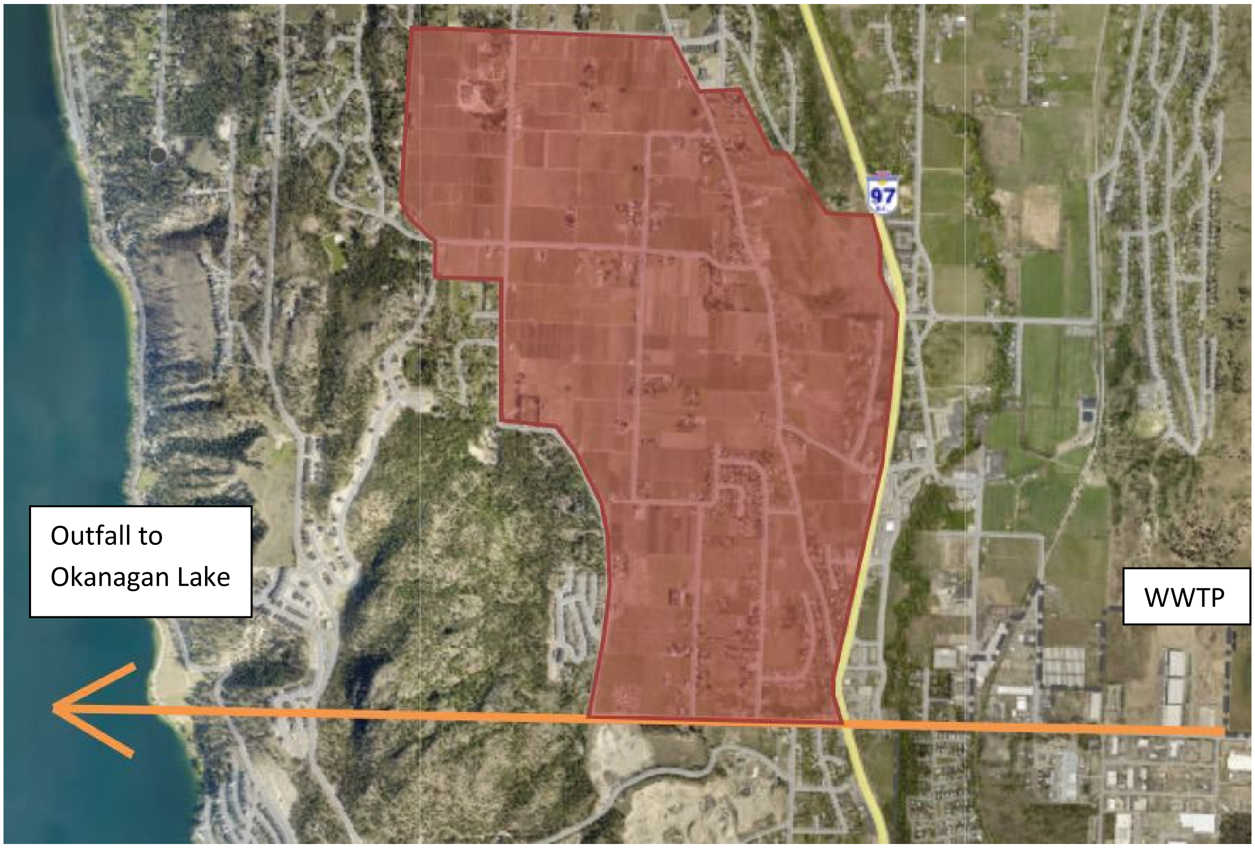


Figure 7 illustrates a proposed treated effluent outfall into Okanagan Lake along with a potential distribution supply area, highlighted in red, for agricultural users.

4.2.2.3 Financial

Financial strategies are not recommended for this consideration.

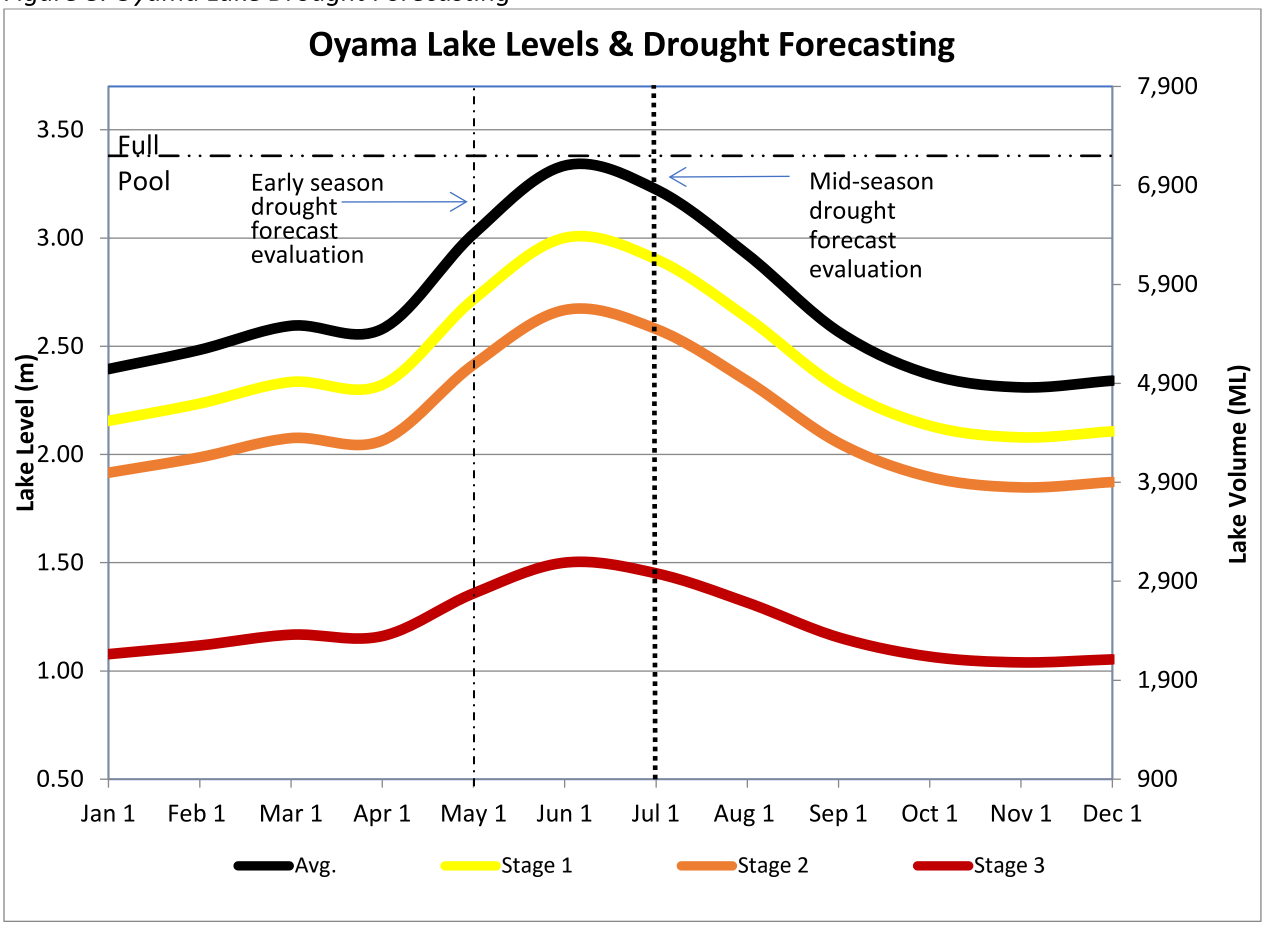
4.2.2.4 Educational

Educational strategies are not recommended for this consideration.

4.3 Watering Restrictions and Drought Management

During times of water scarcity or emergency it is important for the District to have a staged restriction levels for customers to follow. **Appendix C** shows the water restrictions that the District would typically implement at various stages. Drought conditions are evaluated throughout the year, with a key early season drought forecast and a later mid-season drought forecast. It should be noted that these are generally reliable milestones for determining drought like conditions, but there are other regional factors that may contribute to when various stages of restrictions are implemented. For this reason, Council has delegated the Director authority to implement restrictions in excess of those that are displayed in Appendix C.

Figure 8: Oyama Lake Drought Forecasting



Current lake levels of each year are plotted against running average lake levels to determine if water use restrictions are to be implemented. Stage 1, stage 2, and stage 3 restrictions for both upland lakes are implemented at 90%, 80%, and 45% volumes of what is average for that time of year.

During an extreme drought agricultural customers will require the most water and turning off all other outdoor uses would not be enough to meet the agricultural needs. Therefore, some difficult decisions will need to be made regarding which agricultural customers will be permitted to continue watering. It is recommended that this scenario be more thoroughly analyzed through an Agricultural Irrigation Usage Plan.

4.4 Consideration Decision Matrix

Solutions to the various issues discussed throughout the discussion were evaluated using a decision matrix. The various demand and supply side management considerations were evaluated based on their relative cost, estimated water savings (for demand side management) or increased supply (for supply side management), practicality, and effort. Cost scores are inversely proportional to the assumed dollar value required to implement a suggested initiative. Water savings and increased supply scores are directly related to the volume of water that would be conserved or supplied. Practicality was determined from the expected requirement to implement a change, general level of acceptance from the public, and level of enforcement required by the District, with higher scores reflecting easy implementation. Effort was ranked based on time requirements of District staff, regulatory requirements, timelines to achieve approvals, and time required for ongoing maintenance. The results of the matrix were then added to determine the overall effectiveness of each proposed solution. Results of the decision matrix are summarized below.

Table 1: Consideration Decision Matrix

Issue	Management Technique	Tool	Solution	Cost	Water Savings/ Increased Supply	Practicality	Effort	Effectivity
4.1.2 Leaking Watermains, Services Lines, Private Fixtures, and Sewer Infrastructure	Demand	Operational	4.1.2.2.3 Sewer Inflow and Infiltration	4	4	4	3	15
4.1.3 Agricultural Irrigation Use	Demand	Regulatory	4.1.3.1.3 Efficient Watering Systems	5	4	3	3	15
4.2.2 Insufficient Supply	Supply	Operational	4.2.2.2.2 Removing Beaver Lake Channel Obstruction	3	5	4	3	15
4.1.1 Outdoor Water Usage (Non-Agricultural)	Demand	Financial	4.1.1.3.1 Variable Rate Structure	4	3	3	4	14
4.1.3 Agricultural Irrigation Use	Demand	Financial	4.1.3.3.1 Variable Rate Structure	4	5	2	3	14
4.2.1 Excess Water Releases - Beaver Lake Watershed	Supply	Regulatory	4.2.1.1.1 Water Management Plan	3	5	3	3	14

Issue	Management Technique	Tool	Solution	Cost	Water Savings/ Increased Supply	Practicality	Effort	Effectivity
4.2.1 Excess Water Releases – Beaver Lake Watershed	Supply	Operational	4.2.1.2.1 Automated Outlet Valve	4	2	4	4	14
4.1.2 Leaking Watermains, Service Lines, Private Fixtures, and Sewer Infrastructure	Demand	Operational	4.1.2.2.2 Water Meter Fixed Network Leak Detection	4	1	5	4	14
4.1.2 Leaking Watermains, Service Lines, Private Fixtures, and Sewer Infrastructure	Demand	Operational	4.1.2.2.1 Distribution System Leak Detection Programs	4	3	4	3	14
4.1.3 Agricultural Irrigation Use	Demand	Operational	4.1.3.2.1 Tensiometers	3	3	4	4	14
4.1.1 Outdoor Water Usage (Non-Agricultural)	Demand	Regulatory	4.1.1.1.1 New Development Requirements	4	4	2	3	13
4.1.1 Outdoor Water Usage (Non-Agricultural)	Demand	Educational	4.1.1.4.1 Water Ambassadors Outreach	3	3	5	2	13
4.1.2 Leaking Watermains, Service Lines, Private Fixtures, and Sewer Infrastructure	Demand	Educational	4.1.2.4.1 Community Outreach	4	2	4	3	13
4.1.1 Outdoor Water Usage (Non-Agricultural)	Demand	Regulatory	4.1.1.1.2 Residential Allotments	4	3	2	3	12
4.1.3 Agricultural Irrigation Use	Demand	Educational	4.1.3.4.1 Licensed Agrologist Outreach	3	2	4	2	11
4.2.2 Insufficient Supply	Supply	Operational	4.2.2.2.6 Reclaimed Water and Groundwater Extraction	2	4	3	2	11
4.1.1 Outdoor Water Usage (Non-Agricultural)	Demand	Regulatory	4.1.1.1.3 Rainwater Harvesting	5	1	2	2	10

Issue	Management Technique	Tool	Solution	Cost	Water Savings/ Increased Supply	Practicality	Effort	Effectivity
4.1.3 Agricultural Irrigation Use	Demand	Regulatory	4.1.3.1.2 Allotments	4	4	1	1	10
4.2.2 Insufficient Supply	Supply	Operational	4.2.2.2.3 Raising Beaver Lake Dam	2	5	2	1	10
4.2.2 Insufficient Supply	Supply	Operational	4.2.2.2.4 Raising Crooked Lake Dam	2	4	2	1	9
4.2.2 Insufficient Supply	Supply	Operational	4.2.2.2.5 Increasing Storage of Oyama Lake	2	5	1	1	9
4.2.2 Insufficient Supply	Supply	Operational	4.2.2.2.1 Carr's Landing Pumping Facility	1	3	2	1	7

5.0 Recommendations

5.1 Demand Management Considerations

Several demand side water management initiatives have been identified that would prove beneficial to reducing water consumption across the District. From the decision matrix, the top six demand side management strategies have been listed below. It is recommended to work towards implementation of the listed recommendations in the next 3-5 years, while exploring the alternatives over the next 10 years.

1) Agricultural Irrigation Usage Plan to analyze:
   a) Efficient Watering Systems (Agricultural)
   b) Variable Rate Structure (Agricultural)
   c) Tensiometers
2) Variable Rate Structure (Non-Agricultural customers)
3) Water Meters Fixed Network Leak Detection Program
4) Distribution System Leak Detection Programs; and

Agricultural focused demand side management initiatives would not be implemented without consultation amongst the agricultural community through the completion of an Agricultural Irrigation Usage Plan. Implementation of the recommended initiatives projects a **355ML** reduction in current water consumption volumes, annually.

5.2 Supply Management Considerations

Following the same methodology, the top four supply side management strategies were selected from the decision matrix. It is recommended that these strategies begin to be implemented or explored further within the next 3-5 years. Similarly, it is recommended that alternative solutions be re-evaluated within the next 10 years.

1. Removing Beaver Lake Obstruction
2. Water Management Plan
3. Automated Outlet Valve; and
4. Reclaimed Water and Groundwater Extraction

It is estimated that implementing the suggested supply side conservation strategies could result in an additional **1,766ML** of annual water supply and **6,500ML** of additional annual water storage.

6.0 Conclusion

The conservation strategies underlined in this report have been determined based on discussions with District staff, committees, and Council. Through analysis of the District's flow records, universal metering data (2015-present), and general knowledge of the proposed solutions, the numbers presented are estimates. These estimates are researched and educated, but they should only be used for qualitative assessment, and they should not be understood as factual.

In the 2012 Water Master Plan, the District set a target of reducing overall water consumption by 25% by the year 2032. As of 2022 we have already achieved a 22.5% reduction in water consumption. Conservation efforts positively impact our community in a variety of ways, including:

- Reducing infrastructure service costs
- Ensuring adequate supplies for potable use, agriculture and irrigation, and environmental flows
- Helping safeguard against drought by proactively reducing usage to avoid water shortages; and
- Reducing hydraulic loading on our wastewater treatment plant

Furthermore, a Water Conservation Plan with Council endorsement is increasingly becoming a requirement for senior government financial support. The Water Conservation plan is intended to focus on long-term sustainable water use practices and behaviour change; it is not meant to be a Water Scarcity Plan.

The demand side conservation strategies presented in the recommendation section will lead to the conservation of approximately **355ML** annually, which is approximately a **4.5%** reduction in current water consumption. This new reduction target is lower than the previous 2012 target of 25% because as we find ourselves transitioning into an increasingly waterwise community we are experiencing diminishing returns on our conservation efforts.

Agriculture consumes the largest portion of our water use across the District, and while it makes sense that targeting their water consumption behaviours will have the greatest impact on water conservation, eventually they will reach a point where they can no longer conserve anymore water. Crops require a certain amount of water to survive, thrive, and remain economically feasible, and the volume of water required will only increase during hot, dry stretches when water availability is of greatest concern. The use of reclaimed water and groundwater extraction for a condensed area of agricultural use will provide the greatest resiliency during times of drought.

For supply management improvements, it is estimated that implementing the suggested conservation strategies presented in the recommendation section could result in an additional **1,766ML** of annual water supply and potentially **6,500ML** of additional annual water storage. Alternative supply related strategies are beneficial in providing water availability; however, they scored comparatively low on the decision matrix due to their associated high costs, effort, and low practicality.

There is an important distinction between conservation strategies that provide additional water supply and strategies that provide additional water storage. Increasing water storage *may* result in additional water availability each year, but the water is only available if the reserves replenish each season. Increasing water storage does not guarantee reserve volumes will fill and be available during times of need. There are also recent examples where the Province has mandated the release of storage for downstream needs, even though a community may require this water for their own purposes.

At the beginning of the report, we asked ourselves two fundamental questions:

Are we using more water than we need, and is there a benefit to using less?

To both these questions, the answer is currently **YES**. Many of the above demand side strategies may be implemented with little economic impact, while providing modest water savings. Through these strategies, we are establishing a new water conservation target to achieve a **4.5% reduction** in current water consumption within the next 10 years.

Eventually, the District will reach a point where we are using exactly as much water as we need, and we can consider ourselves a “Waterwise” community. This does not mean that a community’s water conservation methods are complete, but rather we shift to a mindset of continued focus to maintain our water conservation standard.

Appendix A – Recent Initiatives

Over the past 20 years, the District has completed numerous water conservation initiatives from both supply and demand management perspectives. The following list of projects and initiatives outline these achievements with approximate water saving volumes and associated costs.

A.1 Oyama Lake Outlet Valve Automation

Project Cost $250,000 (325,000 in 2021 dollars)

In 2006 the District installed an automated valve at the outlet of the Oyama Lake Dam. At the time, access to Oyama Lake was challenging and time consuming. It was not uncommon for the District to release excess water in order to ensure adequate volumes for the systems peak hour demands were available. Once the automated valve was installed, the District was able to adjust releases daily using the Supervisory Control and Data Acquisition (SCADA) system, and this provided significant water savings to be retained in Oyama Lake. Figure 9 shows the impact of annual storage levels in Oyama Lake before and after the installation of the automated valve. With the installation of the valve, it is now common for the reservoir to fill and overflow annually, providing greater reservoir reserves. By the end of the growing season on an average year there is typically 865ML more storage remaining in Oyama Lake, which is currently around 50% of the annual demand required for the Oyama Lake source.

Figure 9: Oyama Lake Levels Pre and Post Valve Automation

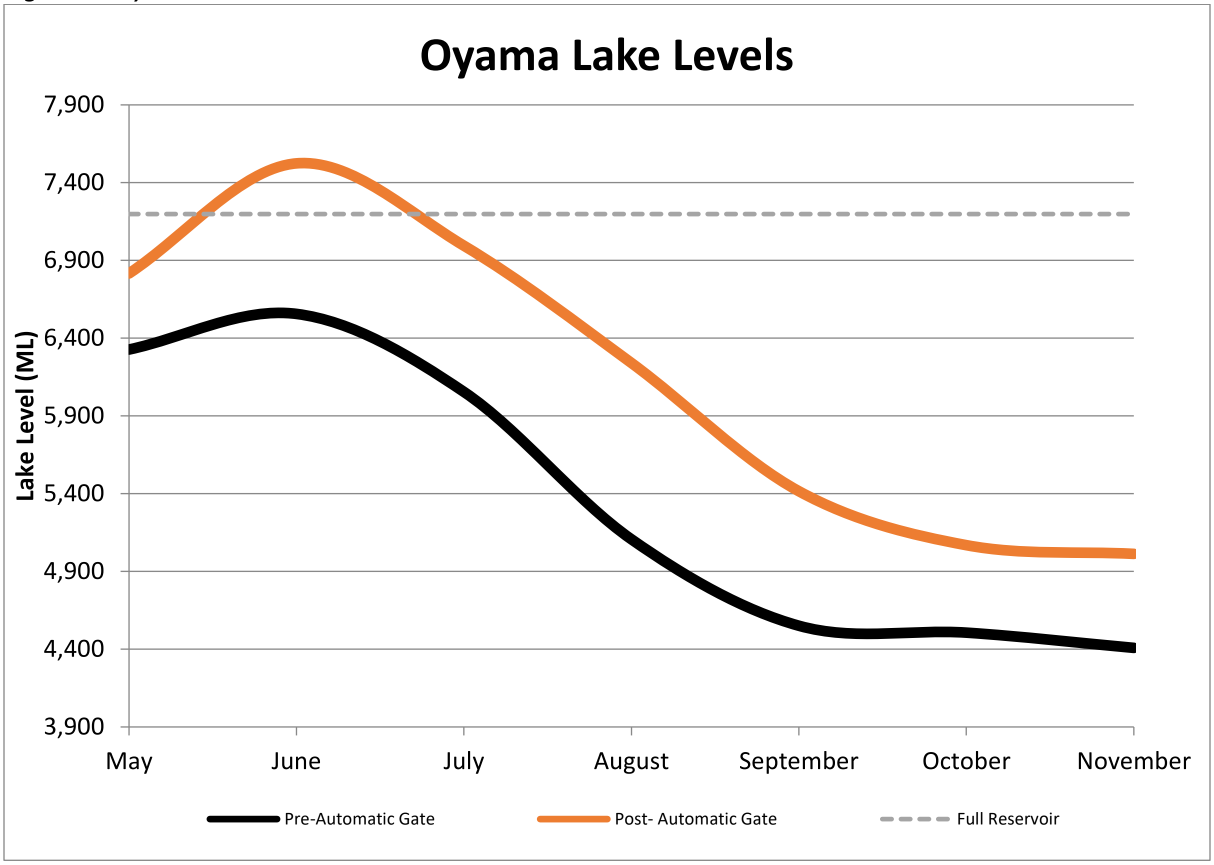


Figure 9 illustrates the increased storage level following the automation of the outlet valve at Oyama Lake Dam. Data points are taken on the 1st of each month. Average storage levels are typically 8-14% higher throughout the year compared to average pre-valve automation lake levels, which translates to approximately 850ML in available source water by the end of the growing season.

A.2 Eldorado Reservoir

Project Cost $4,200,000 ($5,350,000 in 2021 dollars)

In 2007 the District constructed a 30ML reservoir on the Beaver Lake water source. Along with operational benefits such as hydraulic stability, water quality improvements, and increased fire storage, the reservoir greatly improved the District's ability to conserve water. Prior to the construction of the reservoir the District continuously released peak hour demands from Beaver Lake in order to ensure system demands were being met. During non-peak hour, excess water was wasted. Once the 30ML reservoir was constructed, the District was able to release average day demands from Beaver Lake, with the balancing reservoir providing peak flows over and above average day demands. Figure 10 shows the impact and annual water savings due to the construction of the Eldorado Reservoir. During the 2021 drought, the District was able to conserve an additional 1,800ML in Beaver Lake in comparison to the 2003 drought. 1,800ML equates to approximately 65% of the annual demands required for the Beaver

Lake source. The success of this initiative is reinforced by the reduced flows required to supply the Beaver Lake distribution.

Figure 10: Beaver Lake Levels during times of drought

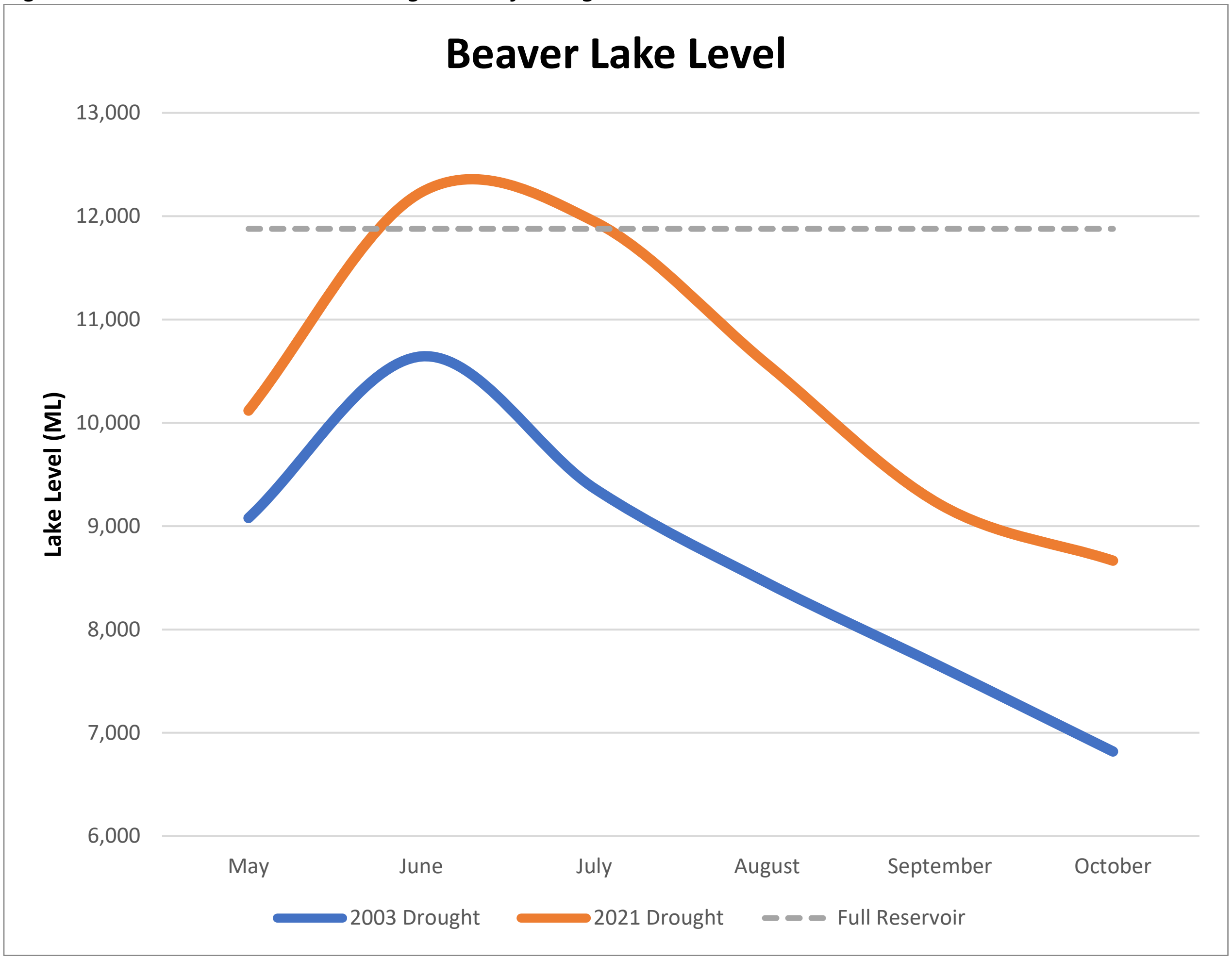


Figure 10 demonstrates the District ability to conserve water in Beaver Lake during times of drought before and after the construction of the Eldorado reservoir.

A.3 Oyama Reservoir & Kalamalka Lake Interconnect

Project Cost $5,500,000 ($6,450,000 in 2021 dollars)

In 2012 the District constructed the Oyama Creek Reservoir and a pumping facility (Sawmill Booster) that interconnected the Kalamalka Lake and Oyama Lake sources. Prior to construction, the Oyama Lake system relied solely on its upland watershed (primarily Oyama Lake). With the construction of the Sawmill Booster station, the District was able to supply the Oyama Lake system with Kalamalka Lake water during the non-peak irrigation season; thereby, conserving additional storage in Oyama Lake that would have otherwise been released. The construction of the Oyama Creek Reservoir and the interconnect also allowed the District to rely on Oyama reservoir's storage and the pumping capacity of the booster station to absorb some of the peak flow demands. Figure 11 below shows the times when the Sawmill Booster is used to supply the Oyama Creek source. Excluding demand during freshet, it estimated to save approximately 175ML of water that would have otherwise been released from Oyama Lake during the winter. The District also has the ability to supplement the Oyama Lake source up to 65ML per month from the Sawmill Booster in peak irrigation season, which could be required during times of drought.

Figure 11: Seasonal Supply of the Oyama Lake System

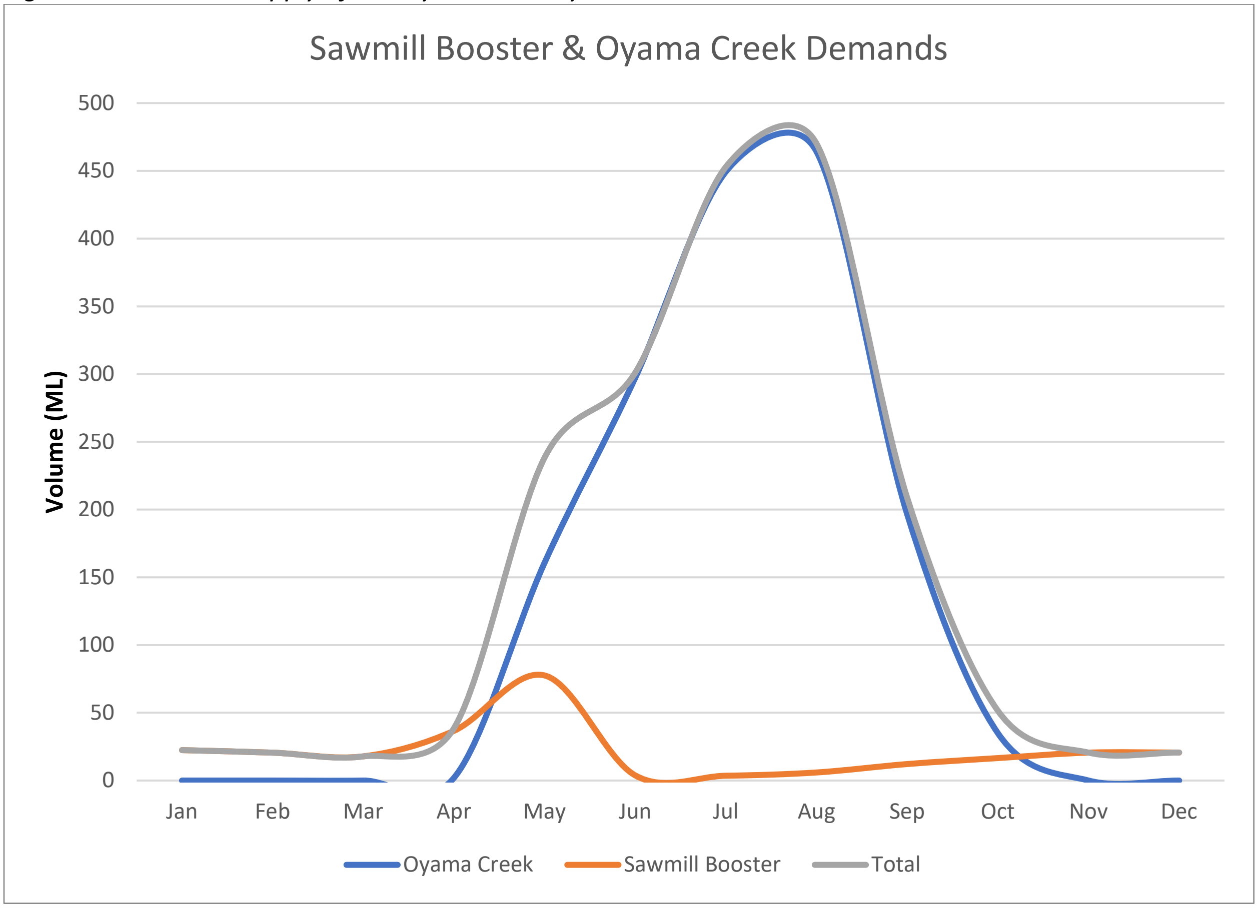


Figure 11 illustrates the seasonal variation where the Oyama Creek source uses Kalamalka Lake water through the Sawmill Booster station, thereby reducing the usage from the upland source.

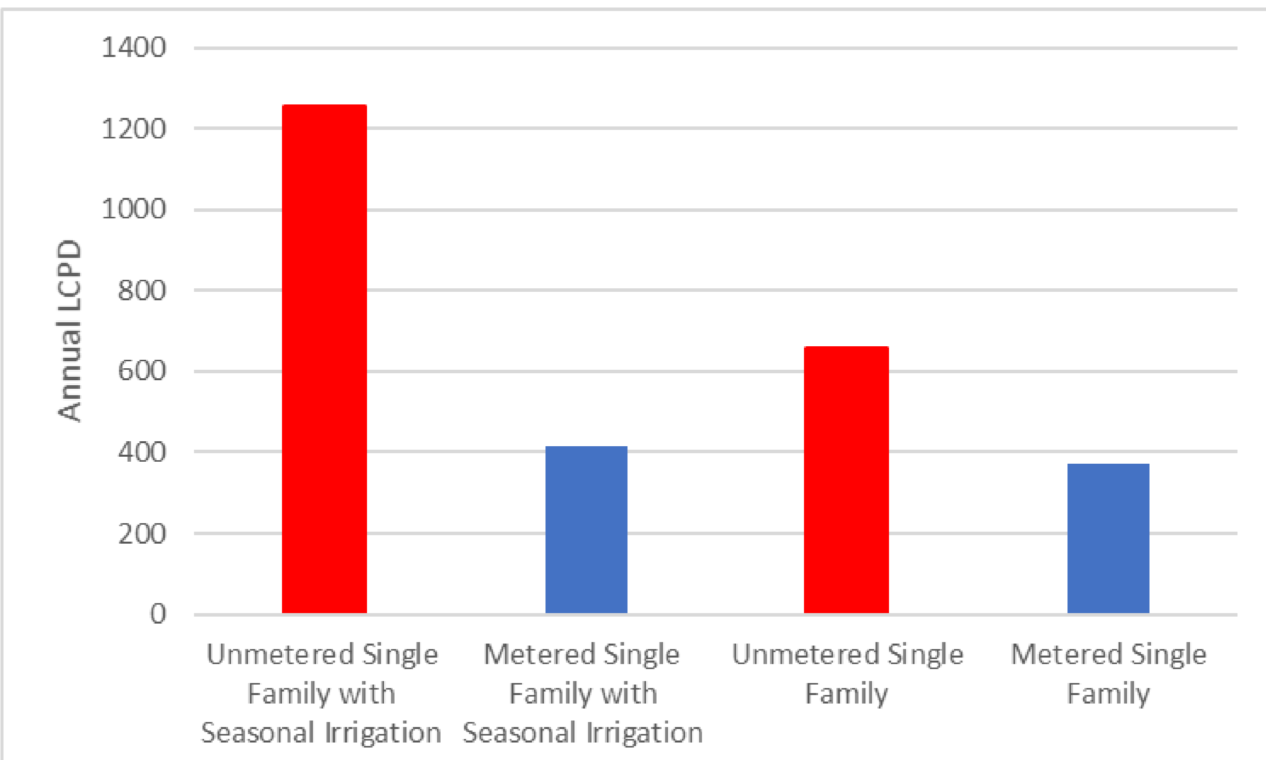
A.4 Universal Metering

Project Cost $3,800,000 ($4,200,000 in 2021 dollars)

From 2014-2016 the District undertook the extensive task of installing water meters on connections for all customer types. At the time only new developments constructed from the early 2000's onward were equipped with water meters (approximately 700 of 4000 total connections), and the metered rate structure was such that properties were only charged on consumption above a predetermined excessive usage volume. In 2017 all connections were metered, and a metered rate structure was implemented based on consumption for all customer types, other than agriculture. Traditional agricultural properties that were not designated with "Farm Status" were reclassified as seasonal irrigation and water consumption began being charged at residential rates.

Figures 12 is an example of the impact of the universal metering project. Since the universal metering project, the District's annual average consumption has dropped by 15%, which equates to approximately 1,240ML.

Figure 12: Water Consumption Pre and Post Universal Metering



Data from Figure 12 is based on observed 2019 metered water consumption.

Figure 13: Metered Annual Single Family Residential Water Consumption

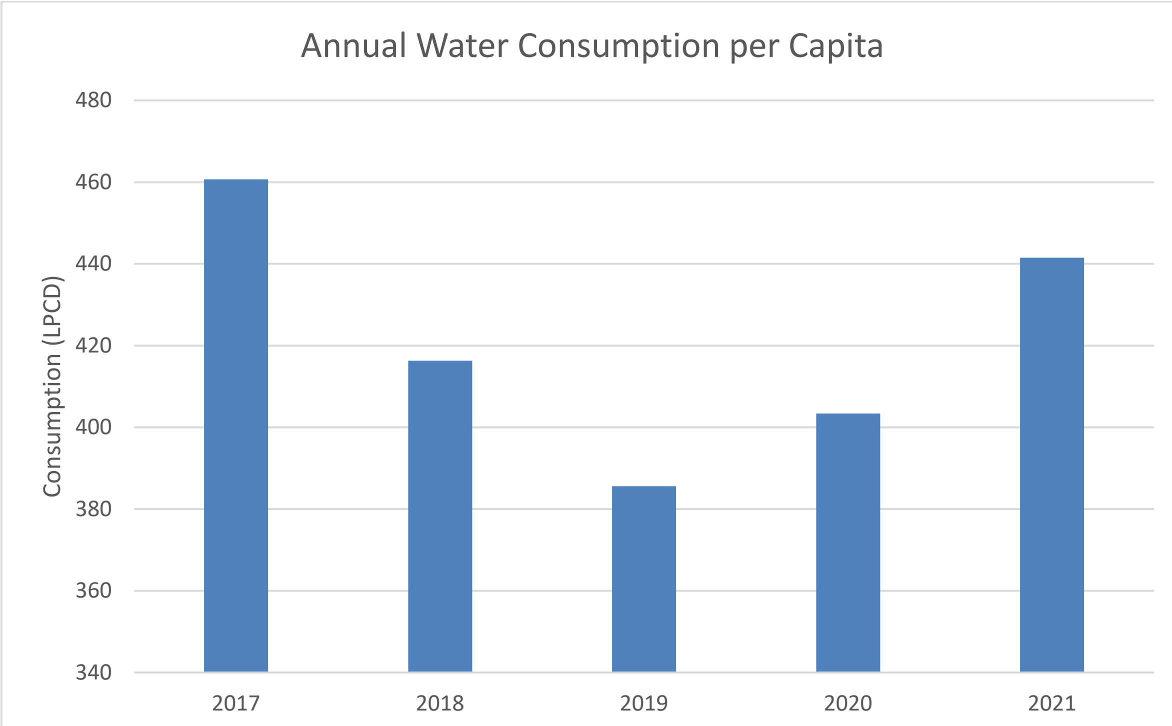


Figure 13 illustrates LPCD consumption following the implementation of the universal metering program. Consumption was determined solely on residential and multi family demand. It should be noted that 2019 was a particularly wet year. The average residential and multifamily consumption since universal metering was implemented is approximately 420 LPCD.

Another key aspect of the universal metering project was the installation of “smart” meters. All connections were equipped with a meter that sends an alarm to the Districts reading system if continuous flow was detected (typically triggered by a leaking toilet or irrigation system). The District in turn would notify the homeowner of the issue, thus typically expediting the repair. By providing this information it is estimated to have saved approximately 25ML per year. 6.25ML of the leak reduction is suspected to be coming from leaking indoor fixtures, that is now no longer going to the Districts Wastewater treatment plant.

A.5 Okanagan and Beaver Lake Interconnect

Project Cost $2,300,000 ($2,400,000 in 2021 dollars)

In 2018 the District constructed a pumping facility (Glenmore Booster) that interconnected the Districts Okanagan Lake and Beaver Lake sources. Prior to the construction of this facility the District relied on a low-capacity pumping facility to supplement the Beaver Lake distribution system with Okanagan Lake water during various times of the year. Although the primary purpose of this pump station is to improve water quality of the Beaver Lake source during spring freshet, it can also serve to supplement demands on the upland Beaver Lake source in times of drought. It is estimated that the District could supplement the Beaver Lake source during times of drought with Okanagan Lake water up to 260ML per month.

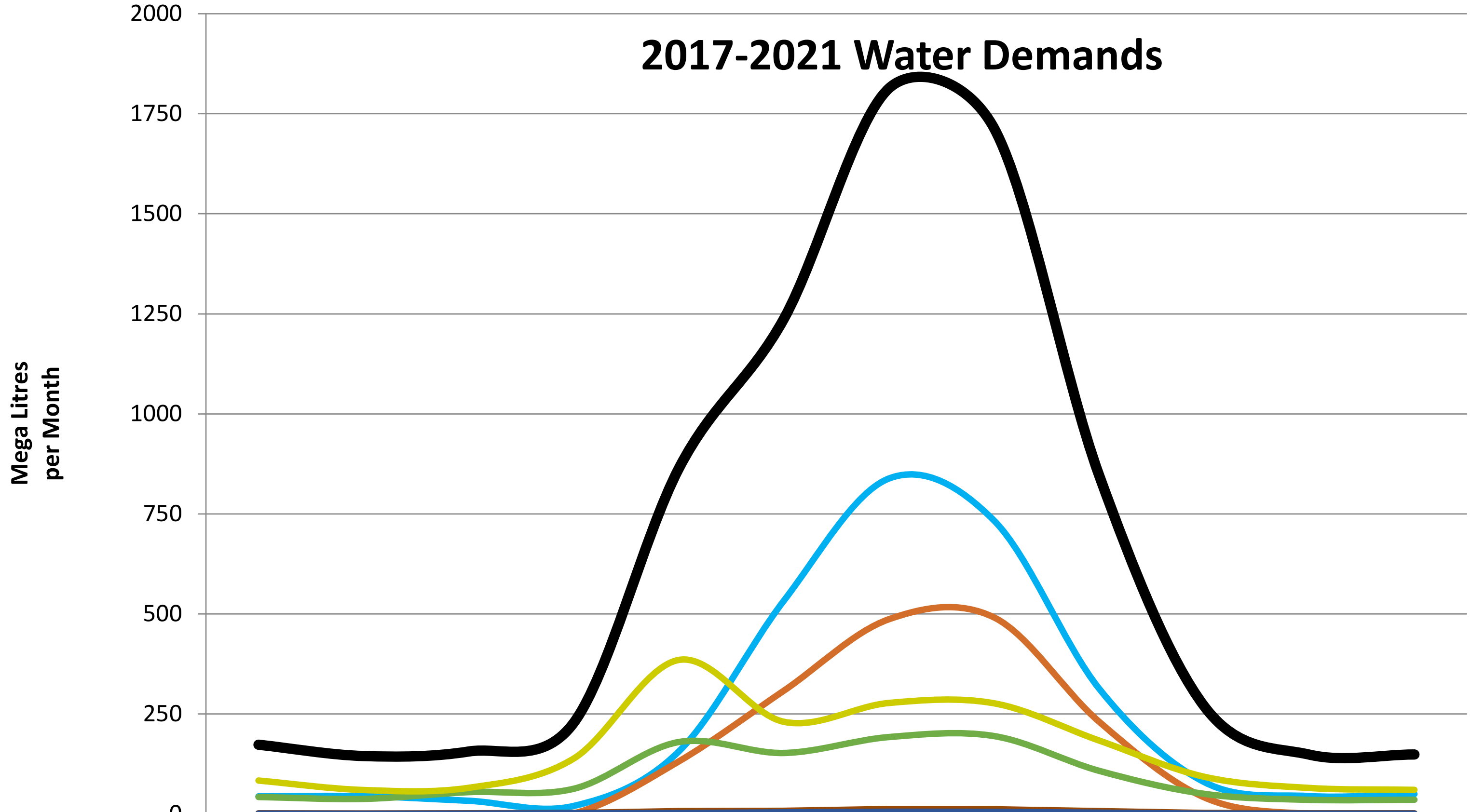
A.6 Effects of Recent Initiatives

The quantitative effects of previous water saving and supply initiatives have been summarised in Table 2. Demand side management initiatives often offer more cost-effective means of attaining sustainable water consumption and help us determine if we are using more water than we need. Supply management initiatives typically offer us significant increases to water storage and availability and are critical in addressing whether there is a benefit to using less water. The synergy between ensuring adequate supply for the community and proactively managing community demand can be seen by the variety of tactics utilized over the years.

Table 2: Historic Water Savings Summary

Supply Side Management	Estimated Supply (ML)	Demand Side Management	Estimated Savings (ML)
Oyama Lake Valve Automation	850	Universal Metering	1,240
Eldorado Balancing Reservoir	1,800	Leak Alarms	25
Sawmill Booster Station	175		
Glenmore Booster Station	n/a		
Total Annual Supply	2,825 ML	**Total Annual Savings**	1,265 ML

Figure 14: Average Monthly Water Demand from 2017-2021



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total	173.29	145.03	156.32	228.11	863.74	1237.70	1813.78	1713.90	846.14	269.34	148.55	148.88
Beaver Lake	44.21	44.68	33.20	20.29	156.50	533.39	838.61	733.33	313.27	79.88	44.89	49.97
Oyama Creek	0.00	0.00	0.00	1.58	131.64	308.42	486.93	491.35	230.65	41.65	0.01	0.00
Kalamalka Lake	42.65	37.91	54.84	63.21	180.03	152.65	192.48	194.90	108.01	50.50	35.56	35.87
Okanagan Lake	83.74	60.10	65.57	138.79	385.16	230.55	277.66	276.78	183.71	93.19	65.20	60.52
Lake Pine	1.79	1.53	1.68	2.62	7.38	8.31	12.57	11.92	7.12	2.59	1.75	1.65
Coral Beach	0.89	0.82	1.03	1.63	3.03	4.39	5.53	5.60	3.38	1.53	1.14	0.87

Appendix B – Current Demand Analysis

The following water demand assessment was completed using metered data from 2017-2021 in an effort to identify water demand characteristics specific to each of the District's primary sources and identify tailored opportunities for water conservation.

Table 3: Water Demand Assessment

	Average Winter Day Demand		Average Day Demand		Maximum Day Demand		Peak Hour Demand[1]	
	L/s	ML/day	L/s	ML/day	L/s	ML/day	L/s	ML/day
Okanagan Lake	27.60	2.38	60.91	5.26	225.29	19.46	337.93	29.20
Beaver Lake	18.80	1.62	91.67	7.92	542.54	46.88	813.81	70.31
Kalamalka Lake	16.27	1.41	36.40	3.15	120.51	10.41	180.76	15.62
Oyama Lake	5.22	0.45	53.64	4.63	249.05	21.52	373.57	32.28

[1]PHD calculated using a multiplier of 1.5 of the MDD

Values are based on total demand of each system, which includes non-revenue water (NRW). Following the implementation of the universal metering program, NRW has been found to account for 15-20% of the annual water demand.

B.1 Average Winter Day Demand (AWDD)

Average winter day demands provide baseline estimates of indoor residential, industrial, and commercial consumption, which are typically assumed to be consistent over the course of a year (refer to Figure 15). This is useful for determining the greatest stressors on water systems by addressing domestic and agricultural consumption separately. Totalizer data from 2017 to 2021 was used to estimate the average winter day demand from each water source. Okanagan Lake, Beaver Lake, and Kalamalka Lake sources had average winter day demands of 2.38ML, 1.62ML, and 1.41ML, respectively. The Oyama distribution system is typically supplied with Kalamalka Lake water during the summer months of high irrigation flow; therefore, winter day demands are typically only observed if growing seasons continue later into October.

Figure 15: Average Winter Day Demand

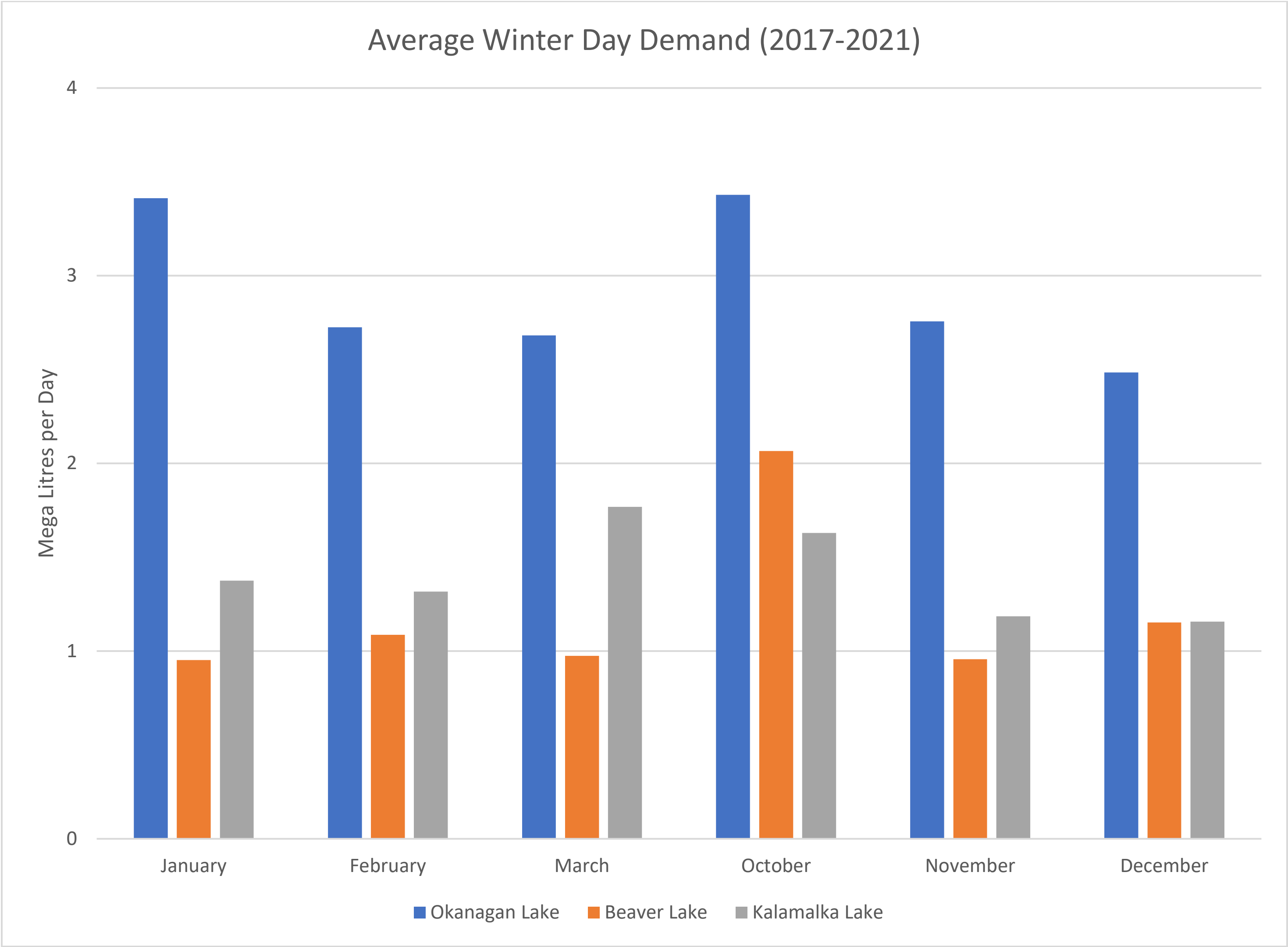


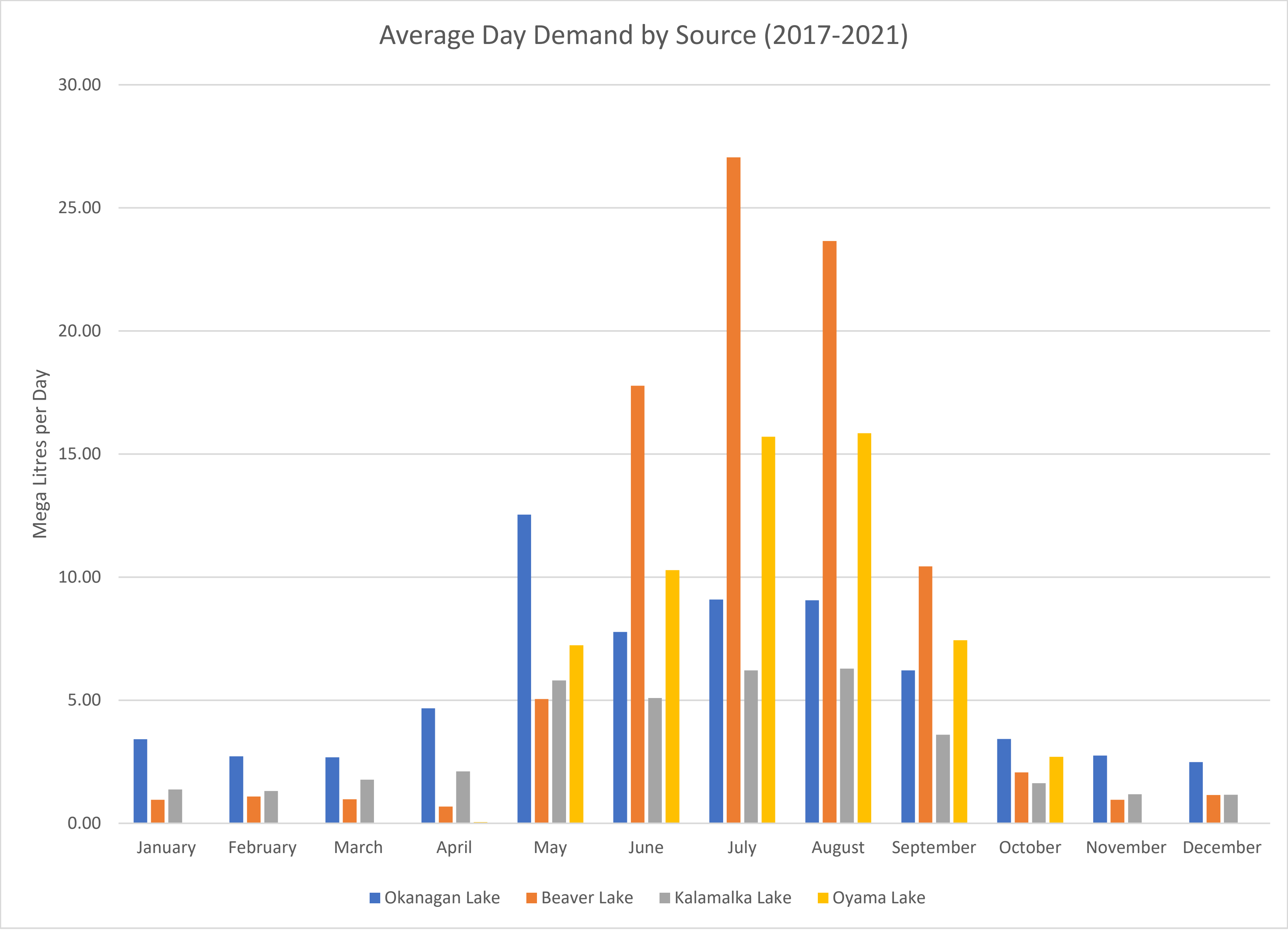
Figure 15 illustrates the average day demand from all active winter sources from 2017 to 2021. Okanagan Lake was out of commission from the end of 2020 to early 2021 and supplied with Beaver Lake water; therefore, values for these years were estimated from previous year averages.

B.2 Average Day Demand (ADD)

The ADD across all user types throughout BC was reported to be 411 LPCD in 2019, while ADD for residential water use was 215 LPCD (Statistics Canada, 2021). Although the District exhibited greater ADD's, 420 LPCD, it is important to note the relatively waterwise usage throughout the community, given the hot, dry, semi-arid conditions of the Okanagan Valley. In comparison, the City of Kelowna reported a system wide ADD of 498 LPCD.

Average day demand was determined over the span of 2017-2021. Okanagan Lake, Beaver Lake, Kalamalka Lake, and Oyama Lake sources had ADDs of 5.26ML, 7.92ML, 3.15ML, and 4.63ML per day, respectively (refer to Figure 16). Beaver Lake and Oyama Lake sources observed 388% and 927% increases in consumption, respectively, when compared to AWDD. These significant increases in water consumption over the summer months indicate the heavy agricultural water demand requirements of these systems. Okanagan Lake and Kalamalka Lake observed 121% and 124% increases in consumption, respectively, when compared to AWDD. The modest increases in water consumption of the Okanagan Lake system can be primarily attributed to seasonal irrigation over warmer months. It should also be noted that Okanagan and Kalamalka Lake consumption is abnormally high from April-June because these sources are used to supplement Beaver and Oyama lake during spring freshet.

Figure 16: Average Day Demand



B.3 Maximum Day Demand (MDD)

Maximum day demand values are outlined in Table 3. The ratio between average ADD and MDD values from 2017-2021 for Okanagan, Beaver, Kalamalka, and Oyama Lake sources were 3.70, 5.92, 3.32, and 4.64, respectively. The disparity between the MDD and ADD is due to the District's heavy agricultural focus, which is especially pronounced in the Beaver and Oyama Lake sources. The base ADD values for Kalamalka Lake are artificially high because the system provides domestic water to the Oyama Lake system outside of the irrigation season; therefore, the ratio between ADD and MDD is greater than calculated. The magnitude of maximum day demand is directly proportional to infrastructure planning and capital costs, as it is used in the determination of volume required to adequately size infrastructure.

B.4 Peak Hour Demand (PHD)

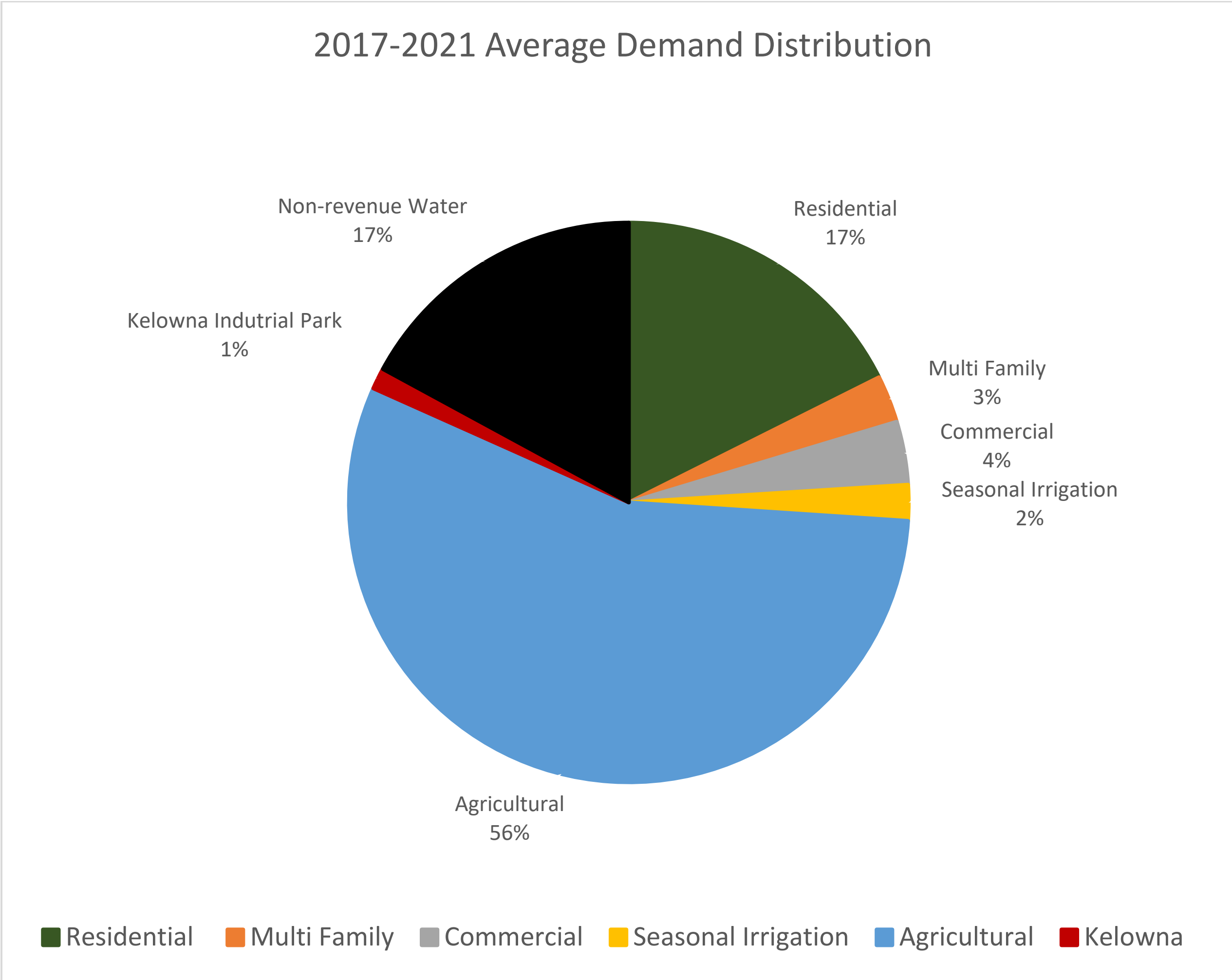
Peak hour demand for each system was determined using a modifier of 1.5 times the maximum day demand. Peak hour demands for each system can be found in Table 3. Peak hour demands are theoretical and relatively high for each system, which is to be expected given the Districts large agricultural use and hot dry nature of the Okanagan climate during the summer.

B.5 Distribution by Customer Type

Using the Districts water metering information, water consumption was differentiated based on customer type. Residential customers are comprised of standard single family dwellings. Multifamily users are connections where multiple dewllings are located on the propoerty; such as row housing, trailer parks, condominiums, and apartment buildings. Commercial customers include industrial, institutional, and commercial connections. Seasonal irrigation users are properties with a dedicated irrigation connection, but are not recognized by BC Assessment as having farm status. Agriculture is supplied from dedicated service connections and are recognized by BC Assessment as having farm status. The District supplies bulk water to the City of Kelowna's north industrial park; however, the City of Kelowna tracks and analyzes all metering information from these customers. Non-revenue water (NRW) is water that is known to have entered the water system, but does not register on a system meter.

Figure 17 shows the Districts water consumption by customer type. The largest water consumer in the District is agriculture, which accounts for 56% of all water supplied. The subsequent largest demands include residental and NRW, both accounting for 17% of the water supplied.

Figure 17: Distribution of Average Water Demand from 2017-2021



Bulk water usage was omitted as it accounted for less than 0.2% of total water demand.

Appendix C – Watering Restrictions

Table 4: Water Use Restrictions at Various Stages of Drought

Drought Condition	Customer Type	Irrigation	Times	Hot Tubs & Pools
Average or Normal	Residential & Commercial	No Restrictions. **Wise water use practice*	Irrigation with automated timing: 12am-6am	No restriction
	Agricultural	Maximum of 762mm application (3,083 m^3 per acre of water rights)	120 days	
Stage 1 90-80% of Average	Residential & Commercial	Three waterings per week Properties are permitted to water a maximum of three days per week. Daily auto watering gardens permitted	Irrigation with automated timing: 12am-6am Manual watering- evenings and mornings	No restriction
	Agricultural	Maximum of 762mm application (3,083 m^3 per acre of water rights)	108 days	
Stage 2 80-45% of Average	Residential & Commercial	Once or Twice a Week Watering or as determined by the Director (see below) Hand watering gardens permitted	Irrigation with automated timing: 12am-6am Manual watering- evenings and or mornings	Not permitted to fill
	Agricultural	Maximum of 600mm application (2,428 m^3 per acre of water rights)	96 days	
Stage 3 <45% of Average	Residential & Commercial	Not permitted	Not permitted	Not permitted to fill
	Agricultural	Maximum to be determined by the Director	90 days	

**Wise water use practice includes but is not limited to: Not irrigating in the heat of the day, when it is windy, or on non-vegetative surfaces. The Director reserves the right to modify water use restrictions to any or all users as required.*

Twice per week watering schedule	
Addresses ending in 0	Saturday & Wednesday
Addresses ending in 1	Sunday & Wednesday
Addresses ending in 2	Monday & Saturday
Addresses ending in 3 & 4	Tuesday & Saturday
Addresses ending in 5	Wednesday & Saturday
Addresses ending in 6 & 7	Thursday & Sunday
Addresses ending in 8 & 9	Friday & Sunday

Once per week watering schedule	
Addresses ending in 0	Saturday
Addresses ending in 1	Sunday
Addresses ending in 2	Monday
Addresses ending in 3 & 4	Tuesday
Addresses ending in 5	Wednesday
Addresses ending in 6 & 7	Thursday
Addresses ending in 8 & 9	Friday

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References

Deputy Ministers' Committee on Drought (2021). *Dealing with Drought: A Handbook for Water Suppliers in British Columbia.* British Columbia Ministry of the Environment. Retrieved online: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/drought-info/dealing_with_drought_handbook.pdf

Guy, B. (2010). *Okanagan Water Supply and Demand Project: Phase 2 Summary Report*. Summit Environmental Consultants Ltd. Retrieved online: https://www.obwb.ca/wsd/wp-content/uploads/2011/02/summary_part5.pdf

Statistics Canada (2021). *Survey of Drinking Water Plants, 2019.* Components of Statistics Canada catalogue no. 11-001-X. Retrieved online: https://www150.statcan.gc.ca/n1/daily-quotidien/210817/dq210817c-eng.pdf