BEAVER LAKE DUAL DISTRIBUTION DISCUSSION PAPER

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A paper aimed to facilitate the discussion of dual distribution and water treatment on the Beaver Lake water source.

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Utilities Manager

Contents

Purpose

Council received a DRAFT 2023 Water Master Plan from staff, and feedback from Council indicated the need for a discussion regarding the long-term servicing plans of the Winfield Okanagan Centre Water System (WOCWS). This discussion paper aims to provide Council with information on the historical decisions made regarding the water system, why maintaining both sources was preferred, and the challenges related to having a dual distribution network. Additionally, the paper will inform Council about the financial impacts to rate payers of building a water treatment facility, and impacts of delaying the adoption of the Water Master Plan. The document will conclude by presenting options for Council to consider moving forward.

Water Sources Background

Since the early 1900s, the residents of the area have depended on the Beaver and Crooked Lake watershed. Initially, the flume systems were built solely to support agriculture. However, as the pressurized piping was installed, many homes connected to the water supply for domestic use. When in use, the Beaver Lake water source serves approximately 1,500 homes, but its largest use is still for agricultural purposes. During the high flow irrigation season, many older and more rural agricultural areas of Winfield and Okanagan Center receive Beaver Lake water. However, the Beaver Lake water source has numerous challenges related to water quality, resulting in many water quality complaints from residents. Additionally, if the District intends to continue using this source for domestic water use, the Interior Health Authority (IHA) requires the source to be treated and filtered.

In 1994 the Hiram Walker pumphouse and distribution network was purchased, which draws water from Okanagan Lake. Since the purchase, the Hiram Walker pumphouse, now known as the District's Okanagan Lake pumphouse, has been the primary source for all new development in the area. Additionally, wherever possible, existing residential neighborhoods were connected to the Okanagan Lake source. The Okanagan Lake source currently services around 3,000 homes and is considered to have higher water quality compared to the Beaver Lake source.

The Beaver Lake and Okanagan Lake sources are interconnected and are considered a single water system known as the Winfield Okanagan Centre Water System (WOCWS). At present, the Okanagan Lake source supplies water to the entire WOCWS for the majority of the year, but the Okanagan Lake source does not have the capacity to supply the entire WOCWS year-round due to seasonal irrigation demand. During the irrigation season from May to October, many properties receive Beaver Lake water because of this limitation of the Okanagan Lake source.

IHA Water Quality Requirements and Challenges

In the mid 2000’s the Interior Health Authority (IHA) implemented the 4-3-2-1-0 water quality drinking water objectives to ensure safe potable drinking water. 4-3-2-1-0 indicates the following:

4: 4-log inactivation of viruses: Typically through the use of chlorine disinfection, water purveyors must ensure 99.99% of all viruses are inactivated.

3: 3-log inactivation of giardia lamblia and cryptosporidium protozoa. Typically achieved through a combination of chlorine disinfection, water treatment, or UV treatment. Water purveyors must ensure 99.9% of all protozoa parasites are inactivated.

2: 2 treatment barriers for all surface water sources. Typically achieved through a combination of chlorine disinfection, filtration, or UV treatment. Filtration is required unless a water purveyor can demonstrate filtration can be deferred and a combination of disinfection processes are implemented.

1: <1 NTU of Turbidity. For sources that experience >1 NTU’s consistently or occasionally, water treatment is required to ensure NTU’s are maintained below 1.

0: 0 Fecal coliform or E. coli bacteria. Through testing water purveyors must demonstrate zero bacteriological activity in their distribution system.

The District's Okanagan Lake source is currently compliant with the Interior Health Authority's (IHA) 4-3-2-1-0 standards and is eligible for filtration deferral. On the other hand, the Beaver Lake source does not have a disinfection process that inactivates cryptosporidium, lacks dual treatment barriers, and is susceptible to turbidity spikes greater than 1NTU. Additionally, the Beaver Lake source experiences tannins from forest runoff that, when combined with chlorine, result in elevated disinfection by-products that are potential carcinogens. Due to these issues with the Beaver Lake source, the IHA has imposed the following restrictions on the water system operating permit:

The District must “**Provide treatment for the Beaver Lake source that meets the Drinking Water Treatment Objectives for Surface Water Supplies in British Columbia by December 31, 2025. Given the challenges with the source water quality, pre-treatment, filtration, and disinfection will be required to meet the Drinking Water Treatment Objectives.**”

Dual Distribution and Prior Analysis

Dual distribution is a concept where the irrigation water system is separate from the domestic water system. This means that in areas with larger irrigation demands and domestic water customers, a

duplicated water system is required. The advantage of dual distribution is that the water quality requirements for irrigation water are lower than those for potable domestic water, resulting in reduced water treatment plant sizing and operational costs. However, dual distribution can be costly due to the installation costs. Operation, and maintenance costs of operating two water systems at the same time are also a factor.

The Beaver Lake source would require approximately 33 kilometers of piping to be duplicated from Beaver Lake Road, in the Eldorado Ranch area, to the lower Okanagan Centre area and Carr's Landing Road to McCreight Road. Because of the elevation changes in the community, many pressure control facilities also require duplication. For these reasons, dual distribution on the Beaver Lake source was not selected as an option for the community. Dual distribution would require digging up and replacing a large number of roads within the community and causing major disruption, which was also a factor in the decision not to implement.

In the 2002 Water Master Plan, several options were analyzed and an engineering peer review concluded that treatment of the Beaver Lake source required further analysis. This issue was further analyzed discussed in the 2012 Water Master Plan, which recommended that a water treatment facility be constructed on the Beaver Lake source. This was endorsed by Council prior to adoption.

In 2022, completely abandoning the Beaver Lake source was considered, but the cost to upgrade the system's capacity was similar to the cost of building a water treatment facility. Furthermore, the District would lose the valued redundancy that maintaining both sources provide.

Projects Related to Past Decisions

With the decision to construct a Beaver Lake water treatment facility made and reviewed multiple times, over the years staff have proceeded to make improvements that aligned with this decision.

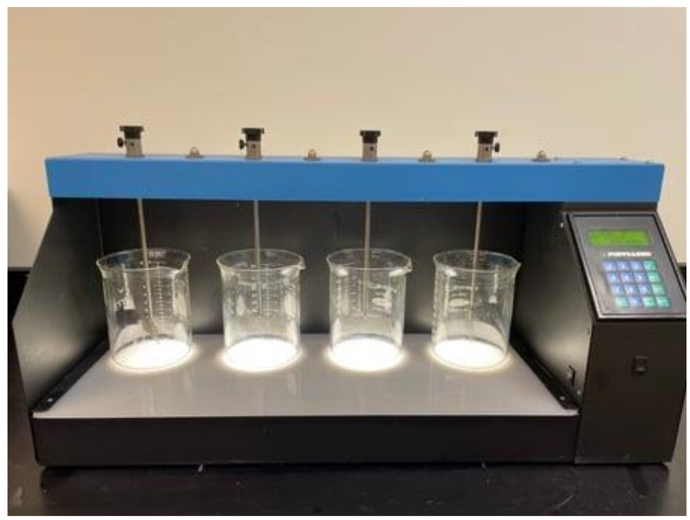
In 2007, the Eldorado balancing reservoir was constructed on the Beaver Lake source to provide additional storage and hydraulic stability. The land acquired for the site was sized to accommodate a future water treatment facility. The reservoir also provides water storage that can be used during short periods of poor water quality. The cost of the project in 2007 was $4.2 million dollars, and would likely not have been constructed in this manner if there was no intention to build a Beaver Lake water treatment facility.

In 2017 & 2018 the Eldorado Treated Water Reservoir, Eldorado Low Lift Booster station, and Glenmore Booster station were constructed on the Beaver Lake source. The treated water reservoir is intended to be a “clear water” reservoir for finished water from the future water treatment facility. The low lift booster facility will pump water from the Eldorado Balancing Reservoir to the future water treatment facility. The Glenmore booster station improved the interconnect between the Beaver and Okanagan Lake sources so that the Beaver Lake source can be augmented with Okanagan Lake water during times of poor water quality. The cost of the project in 2018 was $8.3 million dollars and similarly aspects of this project would likely not have been constructed if there was no intention to construct a Beaver Lake water treatment facility.

In 2020-2021 the Okanagan Lake UV Treatment facility was constructed along with improvements to the Okanagan Lake pumping facility. This project was completed with capacity increases included; however, the increases did not meet the requirements to support dual distribution from the Okanagan Lake source. The additional capacity requirements would likely have been considered if the intent was to abandon the Beaver Lake source or use Okanagan Lake to supply for dual distribution.

Beaver Lake Water Treatment Plant Progress

In 2021, a feasibility study was conducted to construct a Beaver Lake Water Treatment Plant, which was completed in 2022. The purpose of the study was to analyze different treatment options and choose the one that best suits the needs of the community. The study included an $80 million cost estimate and provided options that the District may consider to initially ease the financial burden on the community. However, the implementation of these options would require the support of the local health authority. Staff members are planning to discuss these options with Council if the continued use of the Beaver Lake source is the direction taken.



In addition, a bench scale pilot for the future water treatment plant has been initiated and staff members are looking to proceed with more design works to refine the scope of the water treatment plant as part of the 2023 budget deliberations.

Treatment and Impacts on Water Rates

The Water Master Plan includes the construction of two water treatment facilities: one on the Beaver Lake water source and the other on the Kalamalka Lake water source. These projects are significant, representing $110 million of the total $166 million planned for capital projects.

The financial strategy to pay for these water treatment plants includes a combination of grant funding, development cost charges (DCCs), and user rates. The Water Master Plan relies on only $6.875 million in funding from water rates for the water treatment facilities, with the rest of the funds obtained through a combination of grant funding and DCCs.

The $6.875 million from water rates amounts to approximately $350,000 per year, which is less than 10% of the annual revenue requirements. The District may not be able to use DCC's for dual distribution, which will have impacts on the water rates.

Impacts to Delaying Adoption

The 2023 Water Master Plan update began in 2020 and has had significant impacts on the staff's capacity. The approved budget for this update was $160,000, and the budget has now been fully depleted. Delaying the adoption of the Water Master Plan will have the following impacts:

- **Staff capacity:** Staff capacity is limited, and staff can not move on to other Council initiatives and some projects.
- **Financial:** Budget for the plan is spent. More funding would be required if further work is needed.
- **Water Rates and Capital Projects:** Delaying implementation of the financial strategy impacts staff's ability to keep capital projects on schedule.
- **IHA and Community Expectations:** The Beaver Lake water source is now one of the largest untreated sources in the Okanagan valley. Both the Interior Health Authority and the community have indicated expectations that the water quality issues be addressed. Delaying adoption of the Master Plan delays the strategic direction to staff, which in turn delays work to address the water quality issues.

Options for Council Consideration

1. Direct staff to conduct further analysis, which will require additional budget and staff time. This may impact the delivery of strategic initiatives and projects and could result in displeasure from the community and the Interior Health Authority (IHA). Council will need to decide whether to

complete the analysis in consultation with the Water Master Plan steering committee (which may require new members to be appointed), the Water Service Advisory Committee, or both.

2. Conceptually adopt the Water Master Plan and provide staff with feedback on any minor improvements or changes Council would like to see incorporated into the plan. Staff will then seek to incorporate Council's comments and seek final adoption.
3. Take no action and continue to follow the 2012 Water Master Plan but put on hold any items that Council has indicated they do not support (such as water quality improvements). This option may impact the delivery of strategic initiatives and projects and could result in backlash from the community and potential regulatory action from IHA.

Concluding statement

The District has made significant progress in upgrading our water systems and improving water quality over the past 20 years. In 2002, dual distribution was evaluated as a potential strategic direction for future water servicing in the community. After several peer reviews, it was determined that the best course of action for the community was to plan for a water treatment facility on the Beaver Lake water source. This recommendation was reiterated in the 2012 Water Master Plan.

Throughout the past 20 years, capital improvements have been made with this strategy in mind. While it is still possible to consider implementing a different strategy if Council believes it would be in the community's best interest, our analysis to date suggests that this may not the best course of action. We are eager to discuss this with Council and receive their direction.

Attachment A - IHA 43210 Drinking Water Objectives

4-3-2-1-0 Drinking Water Objective

Water suppliers are required to provide potable water to all users on their systems. The 4-3-2-1-0 drinking water objective provides a performance target for water suppliers to ensure the provision of microbiological safe drinking water. Interior Health supports water suppliers to meet this objective. All water suppliers serving populations greater than 500 people should have an implementation plan to meet this as a standard.
This objective will be applied as a performance standard for all new water systems. Many existing water systems already meet most of the standard. Risk to human health is substantially reduced when water suppliers meet this objective.

Water suppliers will be required to provide long term plans to reach the goals of:

- 4 log inactivation of viruses
- 3 log removal or inactivation of Giardia Lamblia and Cryptosporidium
- 2 refers to two treatment processes for all surface drinking water systems
- 1 for less than 1 NTU of turbidity with a target of 0.1 NTU
- 0 total and fecal coliforms and E. Coli

Definitions:

4 log inactivation of viruses:

Viruses are easily inactivated by the use of chlorine. The common practice of maintaining 0.5 mg/L of free chlorine for 20 minutes is adequate in most cases.

3 log removal or inactivation of giardia lamblia and cryptosporidium protozoa

The 3 log removal or inactivation of these protozoa is the minimum level required of water systems that have a source that is considered "low risk" by Interior Health and have not had an outbreak of either disease. **Giardia** may be inactivated by large doses of free chlorine, ultraviolet light, ozone and chlorine dioxide, or removed by filtration. The US EPA has developed design guidelines to determine that the proposed treatment will provide the inactivation desired. For example, chemically assisted rapid sand filtration with sedimentation is given a credit of 3.0 log inactivation. Log inactivation credits of 3.0 for slow sand filtration and 2.5 for direct filtration are given The remaining credit must be accomplished by another means such as ultraviolet disinfection or free chlorine with a long contact time. The Guidelines for Canadian Drinking Water Quality for **Cryptosporidium** have developed design guidelines to determine that the proposed treatment will provide the inactivation desired. Systems with optimized conventional rapid sand filtration are given a credit of 3.0 logs. Membrane filtration may be required to demonstrate removal efficiency through challenge testing and verified by direct integrity testing. Ultraviolet disinfection is given a credit of 3.0 logs if the dose is a minimum of 40mj/sq. cm.

2 treatment barriers are a minimum for all surface water sources. A multiple barrier approach to water treatment is associated with providing potable water:

The main risk to water quality is from microbiological agents. Some of these microbial risks are more resistant to some forms of treatment than others. It is recognized that effective treatment for all microbial risks by a single treatment barrier is not effective. A minimum dual barrier of treatment is required for all surface water to reduce the risk of microbial or health threats to drinking water**.** Water filtration and disinfection will become the norm for surface water supplies in order to meet the 4-3-2-1-0 performance objectives. For other sources where the turbidity standard can be met without filtration (for example, a well beside a lake), dual treatment may mean chlorination and UV light disinfection. Ground water sources that are not under the influence of surface water will be given credit for filtration.

≤1 NTU of turbidity (less than)

The Guidelines for Canadian Drinking Water Quality currently specify that the filtered treated water turbidity should have a target of less than 0.1 NTU at all times. Specific filtration technologies may have target turbidity ranges from 0.1 to 1.0 NTU. Exemptions for filtration may be considered for those systems that use two disinfectants plus maintain chlorine residual in the distribution system and can demonstrate compliance with the GCDWQ for exemption for filtration..

0 Fecal coliform or E. coli bacteria

The Drinking Water Protection Act requires water suppliers to provide water with 0 E.Coli sample results. Coliform bacteria are easily controlled with chlorine, UV light and can be reduced by filtration.

Attachment B – Winfield Okanagan Centre Water System Permit to Operate

July 8, 2021

District of Lake Country
Infrastructure Services
10150 Bottom Wood Lake Road
Lake Country, BC V4V 2M1

Attention: Kiel Wilkie

RE: Winfield Okanagan Centre Water Supply System Operating Permit #13-122-00009
Water Supplier - District of Lake Country

The purpose of this letter is to provide an update on the Conditions on Permit for the Winfield Okanagan Centre Water Supply System, owned and operated by the District of Lake Country. The information presented outlines the status of the water supplier's compliance with the Drinking Water Protection Act (DWPA) and Regulation (DWPR), the Drinking Water Treatment Objectives for Surface Water Supplies (DWTO) in British Columbia and previous conditions placed on the operating permit.

Currently the District of Lake Country has an operating permit #13-122-00009 for Winfield Okanagan Centre Water System. The Winfield Okanagan Centre Water System name does not match the EOCP classification names. It does not reflect the separate sources, the variation in treatment facilities and the areas where the treated water is distributed. The District utilizes two sources, Beaver Lake (via Vernon Creek) and Okanagan Lake. Although the potential exists to supply water from either source throughout the entire distribution system, it is not the normal operating condition for this water distribution system.

EOCP Facility Name	EOCP #	Classification
Beaver Lake Source Water Treatment Facility	2280	Water Treatment I
Okanagan Lake Source Water Treatment Facility	2281	Water Treatment I
Okanagan Lake Water Distribution System	593	Water Distribution IV

Treated drinking water from the newly constructed Okanagan Lake Source Water Treatment Plant is supplied to approximately 3,000 residential units. Completion of the improvements to Okanagan Lake Water Treatment Facility are a significant step towards providing drinking water that meets the Provincial Drinking Water Treatment Objectives. The UV Reactors will provide an additional disinfection process capable of inactivating protozoa.

In contrast, those customers supplied by the Beaver Lake Water Treatment Facility receive drinking water that does not meet the Provincial Drinking Water Treatment Objectives, as there is no removal Cryptosporidium or organic precursors that are contributing to significant exceedances of the Health Canada Maximum Acceptable Concentration for disinfection by-products.

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Despite efforts of District staff to inform customers about their drinking water source, there is ongoing confusion regarding which source supplies water to their tap.

As we move forward, to avoid further misunderstanding about the different water sources, level of treatment and distribution area, separate operating permits will be issued for each system and Interior Health will refer to the:

1. Beaver Lake Source Water Treatment Facility and the Beaver Lake Water Distribution System.
2. Okanagan Lake Source Water Treatment Facility and the Okanagan Lake Water Distribution System.

This can be re-evaluated in the future when both treatment facilities meet the Provincial Drinking Water Treatment Objectives and Health Canada Drinking Water Quality Guidelines.

The following terms and conditions are for the District of Lake Country operating permits pursuant to Section 8 of the Drinking Water Protection Act. These terms and conditions replace any previous terms and conditions included in the operating permit.

Beaver Lake Source Water Treatment Facility and Beaver Lake Water Distribution System

Beaver Lake Water Treatment Process – Section 6 Drinking Water Protection Act

Status*: Not Compliant*

The Beaver Lake water treatment process does not comply with Section 6 of the *Drinking Water Protection Act* as there is inadequate treatment of the surface water source.

The sole form of treatment for water from the Beaver Lake is chlorine disinfection. As operated, this treatment process:

- Does not provide a 3-log reduction or inactivation of *Cryptosporidium.*
- Does not reduce turbidity below 1 NTU.
- Does not provide a second form of treatment, and
- Does not reduce risks associated with the source water quality.

A review of chemical analysis reports show that the levels of disinfection by-products in the water supplied from the Beaver Lake source and treatment facility exceeds the maximum acceptable concentrations (MAC) listed in the Guidelines for Canadian Drinking Water Quality.

- The concentration of Trihalomethanes (THMs) has exceeded the MAC since 2004, increasing to three times the acceptable concentration since 2011.
- Monitoring of haloacetic acid (HAAs) in 2019 and 2020 indicate that the level of this group of disinfection by-products exceeds the MAC.

Given the source water quality characteristics, treatment to reduce organic precursors, filtration and disinfection will be required to meet the Provincial Drinking Water Treatment Objectives and Canadian Drinking Water Quality Guidelines.

The District of Lake Country have updated their 2020 Annual Drinking Water Report to advise consumers of protozoa risks associated with the Beaver Lake water treatment process, specifically the lack of treatment to provide the minimum 3-log reduction or inactivation of *Cryptosporidium*. It is the responsibility of the District of Lake Country to provide this information to consumers so that they can make an informed decision about additional actions they may take to protect themselves, their family members and their visitors.

Conditions on Permit: 1. Provide treatment for the Beaver Lake source that meets the Drinking Water Treatment Objectives for Surface Water Supplies in British Columbia by December 31, 2025. Given the challenges with the source water quality, pre-treatment, filtration and disinfection will be required to meet the Drinking Water Treatment Objectives. 2. Provide treatment for the Beaver Lake source that reduces disinfection by-product formation to below the Health Canada Maximum Acceptable Concentration level by December 31, 2025. 3. Advise customers that water supplied from the Beaver Lake Source Water Treatment Facility does not meet Provincial Drinking Water Treatment Objectives for Surface Water Supplies in British Columbia in the annual drinking water report, in the Water Quality Advisory posted on the District's website and in billing statements, until appropriate treatment is in place.

Required Actions:

1. Develop a treatment process that addresses health related risks associated with the Beaver Lake source water quality.
2. Provide a written plan to Interior Health by December 31, 2021 that outlines the implementation plan for treatment improvements for the Beaver Lake source.
3. Update the Public Notification Process for the Beaver Lake source to make water users aware that:
   i. Current treatment does not reduce the risk of protozoan pathogens in the source water, and
   ii. The concentration of disinfection by-products in the water supply exceeds the Health Canada Maximum Acceptable Concentrations.

   This information is important to help consumers make decisions regarding additional steps to take to protect the health of their family and visitors.

Okanagan Lake Source Water Treatment Facility and Distribution System

Okanagan Lake Water Treatment Process

Status: UV Disinfection Treatment Facility was commissioned in March 2021 and an application for Filtration Exemption is in progress for the Okanagan Lake source.

The District of Lake Country installed UV reactors and new chlorine disinfection equipment at the Okanagan Lake Water Treatment Facility. The water supplier will need to ensure that:

- the UV Reactors are operated in accordance with the validated operational parameters to achieve the protozoan log reduction credit,
- chlorine disinfection provides a minimum 4-log reduction or inactivation of viruses,
- maintain turbidity of water entering the distribution system below 1 NTU and
- submit the remaining components of the filtration exemption application once completed.

To operate without filtration, the water supplier must demonstrate that it is possible to consistently meet filtration exemption criteria and address any other health related risks associated with use of this surface water source through the treatment process employed. One of the criteria for filtration exemption is that a watershed control program is in place to minimize the potential for fecal contamination in the source water. (Health Canada, 2012).

Application for an Operating Permit for the Okanagan Lake Source Water Treatment Plant was submitted to Interior Health on March 5, 2021 along with the initial application for Filtration Exemption.

Required Actions:

1. Complete the outstanding items for filtration exemption application and submit to Interior Health by March 31, 2022.
2. Provide water quality monitoring results in monthly report that demonstrate whether minimum operating parameters were met and report the volume of off-specification water released into the distribution system.
3. Update ERCP to reflect new water treatment process and actions that will be taken should an alarm or failure occur.
4. Update the monitoring plan for the Okanagan Lake Source Water Treatment Facility and Distribution System.
5. Develop and implement a source protection plan.
6. Improve the public education/notification process to clearly identify those connections supplied by the Okanagan Lake Water Treatment Plant.

Water treatment is one part of the multi-barrier approach to providing safe drinking water. Understanding the source water quality, implementing a source protection plan, reducing distribution system risks, having trained operators and ongoing monitoring and reporting are essential complementary steps to providing treatment.

Environmental Operators Certification Program (EOCP) - Facility Classification and Operator Training
Status: Compliant

According to section 12(2) of the DWPR, "a person is qualified to operate, maintain or repair a water supply system if the person is certified by the EOCP for that class of system as classified under the EOCP". The District of Lake Country Water Supply System classifications as listed by the EOCP are:

EOCP Facility #	Facility Name	EOCP Classification Level	Classification Expiry Date
2280	Beaver Lake Water Treatment Facility	I	27 Dec 2023
2281	Okanagan Lake Source Water Treatment Facility	I	10 Mar 2026
593	Okanagan Lake Source Water Distribution System	IV	27 Dec 2023

Some of the information provided in the EOCP Classification applications does not match the information provided to Interior Health. It is the responsibility of the water supplier to ensure that both treatment facility and distribution system applications reflect the nature of infrastructure, influences on the source and that classifications are up-to-date.

The District employs eight operators as noted below. Operators must maintain the appropriate level of CEUs and demonstrate to EOCP that they meet the CEU criteria prior to expiration of their certificates.

Operator Name	Certification Number	Certifications
Mike Mitchell	1839	WD4, CH, WT2
Rob Witzke	1841	WD2, CH
Patti Meger	4838	WT1, CH, WD1
Kiel Wilkie	6503	WD3, CH
Tyler Friedrich	7697	WD2, WT1
Mike Kristensen	8344	WD1, WT1
Tessa Luison	1000130	WD1, CH
Evan Kemp	8114	WWT3, WWC1, CH

It is the responsibility of the water supplier to ensure that there are appropriately certified operators to operate, maintain or repair the water supply system. This includes providing enough certified operators to carry out operational activities and to compensate for vacation, employee illness, emergencies, and succession planning.

Emergency Response and Contingency Plan
Status: Requires Updating

The District maintains an Emergency Response and Contingency Plan for the water supply systems. Update the ERCP protocols to include:

1. A response plan for operational issues or abnormal operating circumstances at the Okanagan Lake Water Treatment Plant including a detailed assessment and response for UV lamp breakage, operation of the UV reactors during periods when validated operating parameters are not met, and capacity to provide water beyond the Okanagan Lake Distribution System connections.

2. Improvements to the Public Notification Process
   The number of customer complaints over the past year, demonstrate that it is not clear to customers (i) which of the DLC sources supplies their tap water, and (ii) that there is a lack of treatment to reduce/inactivate Cryptosporidium when chlorination is the sole treatment process.
   - Provide a notification protocol for Beaver Lake Source customers advising them of the lack of treatment for Cryptosporidium and disinfection by-products exceed the Health Canada MAC.
   - Provide a notification protocol to advise Okanagan Lake Source Water Treatment Facility customers of any switch to Beaver Lake source.

   Provide a copy of the up-dated ERCP to Interior Health by December 1, 2021.

Water Quality Monitoring Program and Monthly Reports
Status*:* Requires Improvement

Monthly reports are not submitted in a timely manner, and are missing required data.

The monthly reports submitted to Interior Health prior to the onset of the pandemic were missing data. Monthly report submission did not resume until September and did not include the missing data. A similar delay in report submission occurred in 2017 and 2018. This demonstrates that the District is not able to meet operational requirements and consideration should be given to providing additional staff and/or automating report compilation.

Section 11 of the Drinking Water Protection Act requires a water supplier to monitor the drinking water source, treatment and the water supplied in the distribution system. Timely submission of monthly reports is required as a Condition on the Operating Permit for DLC water systems. Information submitted in the monthly reports helps to demonstrate whether the water supplier is complying with monitoring requirements under the Drinking Water Protection Regulation.

1. Samples are being collected for bacterial analysis in accordance with the frequency set out in Schedule B of the Drinking Water Protection Regulation.

   Distribution system monitoring and reporting is complex due to the two sources and potential mixing of water from these sources in the distribution areas.

   Adjustments are being made to the sampling frequency for the Beaver Lake and the Okanagan Lake distribution systems in 2021. With the significant amount of development in Lake Country, the information on the number of connections and population served by each of these distribution systems has been updated.

   The number of connections to the Okanagan Lake Source has increased over the past five years.

	Estimate of Population Served	Min # of samples required by DWPR
Okanagan Lake Source Water Distribution System Area	6,000	6 samples per month
Beaver Lake Source Water Distribution System Area	3,000	4 samples per month

2. Monitoring results demonstrate that in 2020
   (i) Beaver Lake source water **did not** meet the turbidity objective of less than 1 NTU
   (ii) Okanagan Lake source water did meet the turbidity objective of less than 1 NTU

   set out in the Provincial DWTO for surface water supplies in British Columbia.

3. Turbidity is monitored at the source and in the distribution system.
4. Quarterly analysis of disinfection by-products. ***Incomplete, requires updating.***
   - DLC is reporting annual averages of THMs for the entire distribution system.
   - DBPs are not monitored quarterly.

   Best practice is to report THMs and HAAs as a locational running annual average (LRA) of a minimum of quarterly samples taken at appropriate locations in the distribution system.

   LRA provides information about seasonal variations, areas where the levels are higher or lower, or operational actions could be utilized to decrease THMs. The goal is to have accurate information over time to support treatment process decisions.

Beaver Lake Source

The levels of disinfection by-products in the treated water supplied from the Beaver Lake source exceeds the MACs outlined in the Canadian Drinking Water Quality Guidelines. The table below sets out the annual average THM for the Beaver Lake source, averaged from two locations in the distribution system. In 2019, DLC added the analysis of HAAs.

Beaver Lake Source	System Averaged THMs	System Averaged HAAs
2020	0.345	0.316
2019	0.302	0.247
2018	0.237	
2017	0.231	
2016	0.181	
2015	0.220	
HC MAC	0.100	0.080

Okanagan Lake Source

Prior to 2020, the levels of disinfection by-products from the Okanagan Lake source did not exceed the Canadian Drinking Water Quality Guidelines. In response to the extension of the distribution system and storage reservoirs for the Okanagan Lake source, DLC staff initiated monitoring at the furthest reservoir in 2019. Results indicate that THMs are higher at the ends of the distribution system. Additional monitoring will be done in 2021 to assess the impact of the new water treatment process and the level of disinfection by-product formation.

Provide a copy of any chemical monitoring analysis (including DBP monitoring results) in with monthly reports (or the following month after the lab report is provided to DLC).

Okanagan Lake Source	Glenmore Booster THMs	Upper Lakes Reservoir THMs	Glenmore Booster HAAs	Upper Lakes Reservoir HAAs
2020	0.060	0.1023	0.039	0.058
2019	0.064	0.0997	0.035	0.061
2018	0.078			
2017	0.063			
2016	0.047			
2015	0.054			
HC MAC	0.100	0.100	0.080	0.080

Required Actions: Update water quality monitoring plan to include and report out on:

1. Sampling is representative of the water distribution systems.
2. The number of days that source water turbidity exceeds 1 NTU and 5 NTU for each source.
3. Monitoring of disinfection by-products (THMs and HAAs) quarterly for the Okanagan Lake water distribution system.
4. Monitoring of disinfection by-products (THMs and HAAs) quarterly for each of the two locations towards the ends of the Beaver Lake water distribution system.
5. Weekly monitoring of E. coli and total coliform from the Okanagan Lake intake prior to any addition of chlorine.
6. Cryptosporidium and giardia monitoring of the Okanagan Lake source to establish a baseline for filtration exemption application.
7. Additional sampling is conducted as needed for monitoring of seasonal changes in water quality.
8. There are clear instruction for sample collection procedures and that staff are following these procedures.

Annual Reports
Status*: Compliant, needs Improvement*

The District of Lake Country posted the 2020 Annual Drinking Water Report on their website on April 21, 2021. The legislative intent of requiring water supplier to publish an annual drinking water report is to provide customers with information regarding the quality of their drinking water supply.

- In the past two years, Interior Health received a number of complaints from customers stating that it is challenging for them to find the information specific to their drinking water source.
- The District's Annual Drinking Water Report is complex as it incorporates information from the six water supply systems, and that the information is spread throughout the document requiring the customer to read through the lengthy document to pull out information specific to their drinking water source.

The Annual Drinking Water Report is an important part of the water supplier's responsibility to provide water users with information regarding the quality and the risks associated with the water supply system. It also provides an opportunity for the water supplier to educate the public about ongoing issues and improvements to the water supply system.

Required Action: Review and update the District of Lake Country Annual Drinking Water Report to provide the information in a manner that is concise and specific for each water supply system.

Cross Connection Control Program
Status: Compliant

The District of Lake Country has a Cross Connection Control Program.

- From 2014 to 2016 all seasonal and agricultural irrigation connections were equipped with backflow prevention (BFP) devices (~500).
- The number of residential fire suppression sprinkler systems installed in new construction has increased the number of residential connections with BFP devices.

A company that specializes in Cross Connection Control will be reviewing BFP devices in 2021.

Thank you for your continuing cooperation and effort towards improving the District of Lake Country Water Supply Systems and taking the necessary steps to create a sustainable water supply network.

If you have any questions please call me directly at (250) 469-7070 ext. 12274.

Sincerely,

Judi Ekkert
Specialist Environmental Health Officer

cc by email: *Wayne Radomske, Public Health Engineer*

In summary, the following conditions have been added to the Operating Permit #13-122-00009 for the Beaver Lake Source Water Supply System.

Conditions on Permit:		Timeline
1.	Provide treatment for the Beaver Lake source that meets the Drinking Water Treatment Objectives for Surface Water Supplies in B.C.	December 31, 2025
2.	Provide treatment for the Beaver Lake source that reduces disinfection by-product formation to below the Health Canada MAC levels.	December 31, 2025
3.	Report out on Source Protection Activities in annual drinking water report.	Annually
4.	Provide an updated Water Quality Monitoring Plan.	December 1, 2021
5.	Submit monthly water quality monitoring reports to Interior Health.	By 10th of month
6.	Provide an annual summary of water quality monitoring results.	Annually by April 1st
7.	Advise customers that water supplied from the Beaver Lake Water Treatment Facility does not meet the Drinking Water Treatment Objectives for Surface Water Supplies in B.C., in the annual drinking water report, in the Water Quality Advisory posted on the District's website and in billing statements.	Until appropriate treatment is provided

The following conditions have been added to the Operating Permit for the Okanagan Lake Source Water Supply System.

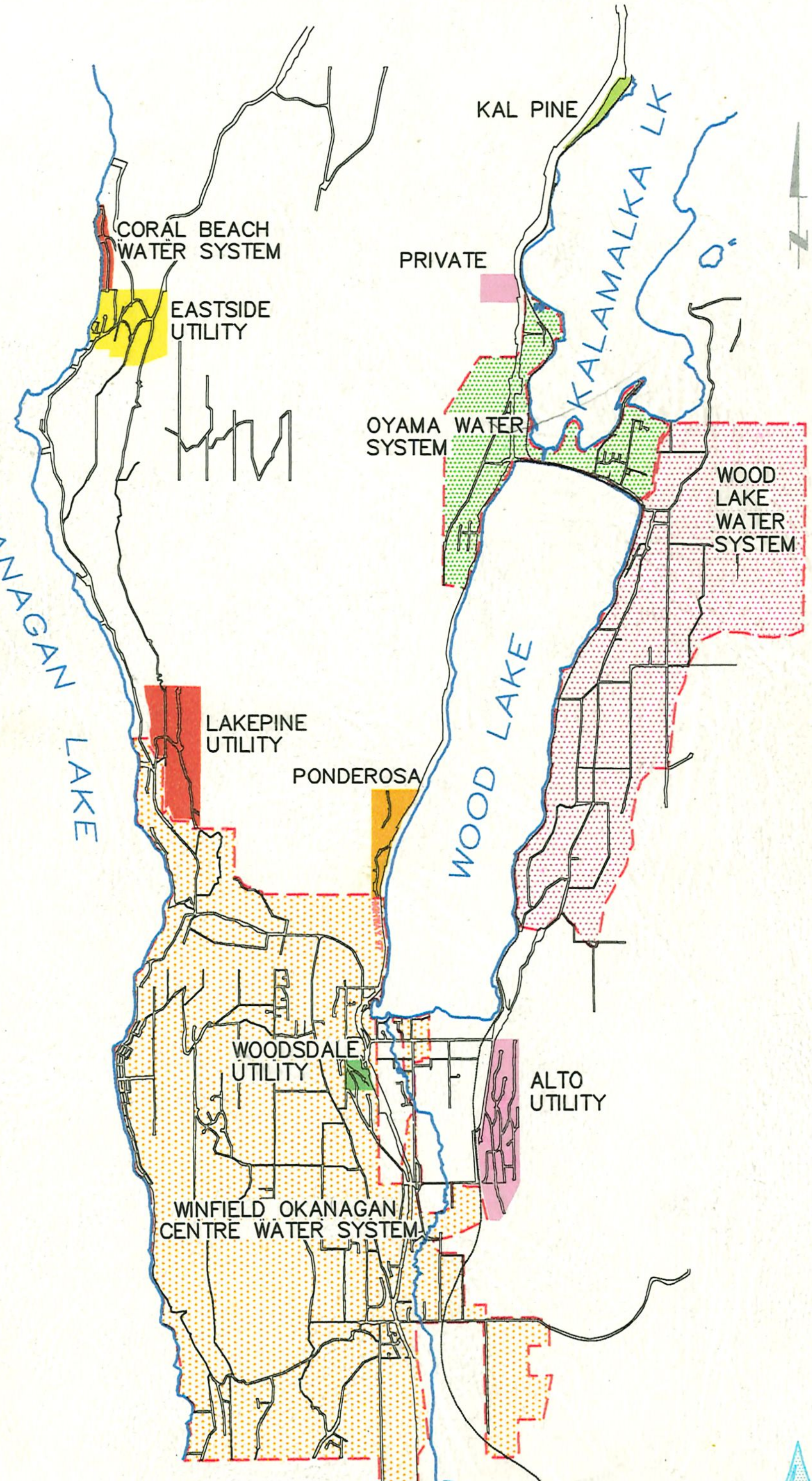
Conditions on Permit:		Timeline
1.	Submit completed application for Filtration Exemption to Interior Health.	March 31, 2022
2.	Complete a Source Protection Plan for Okanagan Lake Intake.	December 1, 2022
3.	Report out on Source Protection Activities in annual report.	Annually
4.	Provide an updated Water Quality Monitoring Plan.	December 1, 2021
5.	Submit monthly water quality monitoring reports to Interior Health.	By 10th of month
6.	Provide an annual summary of water quality monitoring results.	Annually by April 1st
7.	Provide a copy of the updated ERCP.	December 1, 2021

Attachment C – 2002 Master Water Servicing Plan

JACK ALLINGHAM

DISTRICT OF LAKE COUNTRY

MASTER WATER SERVICING PLAN



MOULD ENGINEERING

DISTRICT OF LAKE COUNTRY

MASTER WATER SERVICING PLAN

February 2002

Prepared By:

Mould Engineering
#206- 437 Glenmore Road
Kelowna, BC V1V 1Y5
Ph:(250)868-2072 Fax:(250)868-2078

DISTRICT OF LAKE COUNTRY

MASTER WATER SERVICING PLAN

TABLE OF CONTENTS

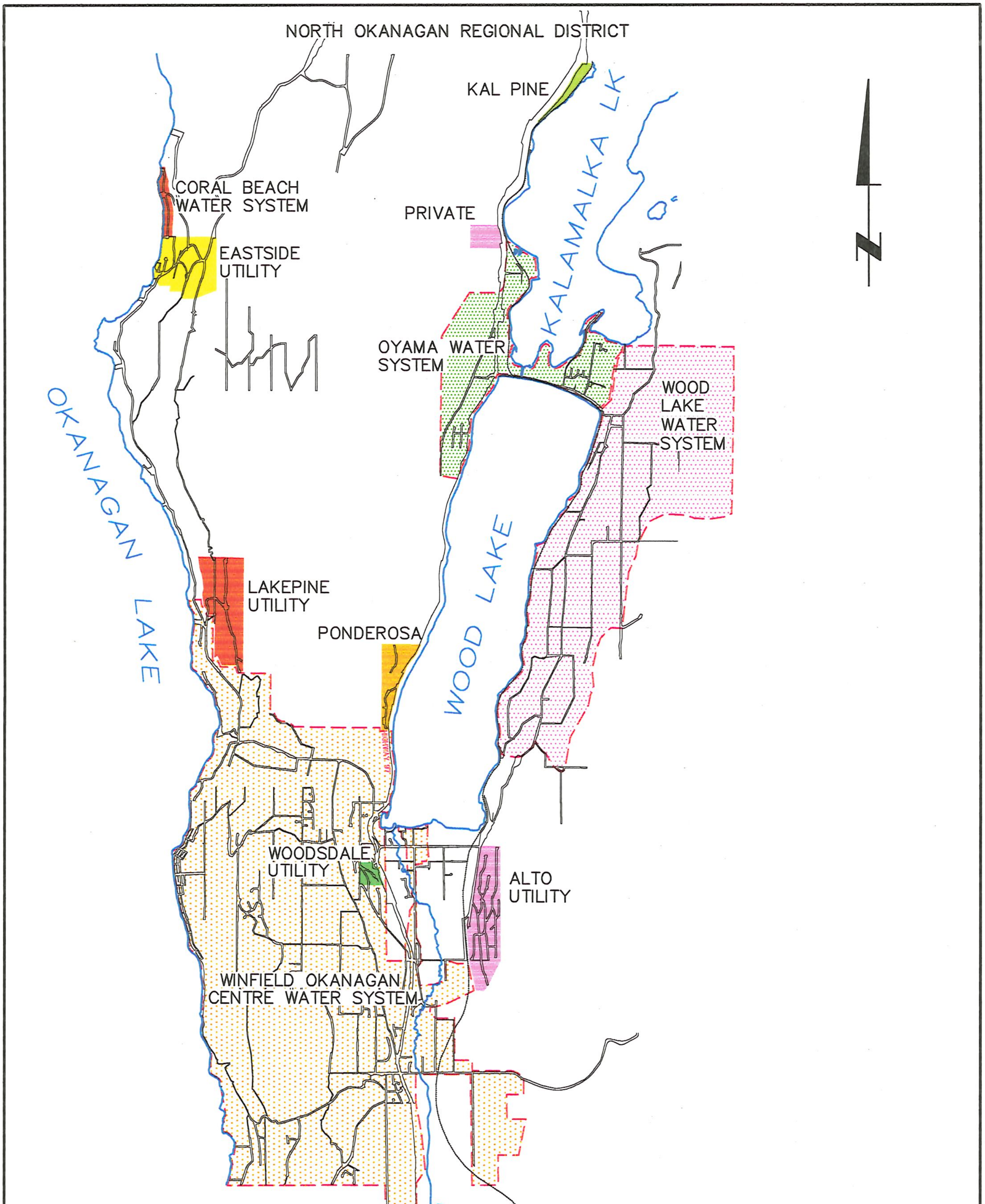
TABLES

FIGURES

ANNEXES

FIGURES

ANNEXES



DISTRICT OF LAKE COUNTRY

KEY MAP

SCALE: 1:75,000

DECEMBER 2001

DISTRICT OF LAKE COUNTRY
MASTER WATER SERVICING PLAN

EXECUTIVE SUMMARY

This Master Water Servicing Plan has been commissioned by the District of Lake Country to establish long term planning for the numerous water systems within the District. Located on the east side of Okanagan Lake, and bounded by the City of Kelowna (the City) and the North Okanagan Regional District, the District of Lake Country (the District) encompasses eleven individual water systems, as shown on the Key Map opposite. The three largest systems are maintained, operated, and funded by Lake Country, as well as two small systems, Coral Beach and Ponderosa. The remaining systems are relatively small and privately owned.

When completed, the Master Plan for the District of Lake Country will provide: System operation guidelines; an outline of capital works required to improve the existing system; recommendations for water quality improvements; concept plans for infrastructure required to service new developments; watershed management plans; water conservation options; and outline possibilities for interconnection of the numerous water systems. Also, financial implications of constructing the recommended works will be provided as well as the charges to be attributed to existing and future users. The plan forms the technical basis for an application to obtain Federal/Provincial funding, and the basis for establishing development cost charge bylaws, as well as annual water rates.

Terms of reference for preparation of the first section of the Master Plan are outlined in a proposal prepared by Mould Engineering dated May 2001. The first section of the Master Plan is a review of the **Winfield Okanagan Centre Water System,** which services the largest area of the District. At this time, the District of Lake Country has commissioned a study of three components of the Winfield System. These components - Existing Water System, Water Quality, and Infrastructure for New Development - form the foundation of the Master Plan.

Following are the sections that will complete the District of Lake Country Master Water Servicing Plan:

Section A: Winfield Okanagan Centre Water System
Section B: Wood Lake Water System
Section C: Oyama Water System
Section D: Private Water Systems
Section E: Water System Interconnection Possibilities

Similar reports have been completed for the Wood Lake and Oyama Water Systems, Section B and C, to address some of the critical components. The reports are not current (1998), but when updated, will be included in the Master Water Servicing Plan. Limited work has been completed on the Private Water Systems and Water System Interconnection Possibilities, Sections D and E.

A summary of the findings to date is as follows:

SECTION A: WINFIELD OKANAGAN CENTRE WATER SYSTEM

Existing Water System

Vernon Creek and Okanagan Lake are the existing water sources. The principal source is Vernon Creek, which supplies irrigation and domestic water through a gravity pressurized distribution system. Many components were installed in the late 1960's and are nearing the end of their expected life. Deficiencies include: Screening works on Vernon Creek which are labour intensive, a mainline which is hydraulically unstable resulting in high pressure fluctuations and considerable repair costs, unnecessary pressure reducing (PR) stations and supply zones, as well as many areas of substandard fire flows.

Recommended improvements to the existing system include:

- New screening works on Vernon Creek to lower operating costs;
- Replacement of PR stations 1 and 2 with a storage/balancing reservoir to resolve mainline pressure instabilities and reduce operating costs;
- Removal of a number of PR stations to simplify the system, improve pressure instabilities, and decrease capital and operating costs;
- Replacement 7 km of small diameter pipe to improve fire flow capacities.

The estimated cost of the improvements required for the existing water system is $4,350,000.

Water Quality

The District has been issued ten Boil Water Advisories from the Health Officer over the past eight years. Vernon Creek water quality does not meet the Guidelines for Canadian Drinking Water Quality. The Okanagan Lake source does meet the guidelines, has surplus capacity, and should be used to enhance the quality of water supplied to the users.

users. Okanagan Lake is a pumped source and cannot meet the demands of the District's agricultural water users. Therefore, the feasibility of constructing a separate distribution system for domestic users has been reviewed. This option involves: capital costs estimated at $10,950,000; increased water service costs; nearly doubling the length of distribution pipe and number of PR stations; and has numerous operating and administration complications. Therefore, a separate domestic system is not recommended.

Recommended works necessary to provide superior water quality year round include:

- Installation of a pipeline along Okanagan Centre Road to increase the gravity supply area from Okanagan Lake reservoir;
- Upgrading the Okanagan Lake pump station to utilize its full capacity;
- A booster pump / pressure reducing station on Glenmore Road to convey additional Okanagan Lake water into the system;
- Constructing of water treatment facility on the Vernon Creek to supply the remaining water demand.

The estimated cost of the recommended water quality improvements is $12,100,000.

Infrastructure for New Development

This component of the Winfield Okanagan Centre Water System has not been completed. Additional components required to complete the Winfield Okanagan Centre Water System study include: **Water Conservation Options**, and **Watershed Management.**

Master Water Servicing Plan

Section A:
Winfield Okanagan Centre Water System

DISTRICT OF LAKE COUNTRY

MASTER WATER SERVICING PLAN

SECTION A: WINFIELD OKANAGAN CENTRE WATER SYSTEM

1. INTRODUCTION

The Winfield Okanagan Centre Water System is located within the southern portion of the District of Lake Country. It is bound by the City of Kelowna to the South, Okanagan Lake to the West, and elevated lands to the East. The service area includes: 1,750 domestics (a population of 4,800); 928 hectares (2,293 ac) of irrigated land; the Winfield Town Centre; as well as an industrial park within the City of Kelowna. This is the largest system within the District supplying approximately three times the volume of the Wood Lake Water System.

The principle source of supply for the Winfield Okanagan Centre Water System is Vernon Creek. Water quality concerns have been expressed by landowners and Town Centre commercial establishments as the Creek often contains high turbidity, colour, coliforms, and suspended solids, particularly during the spring and fall months. The Medical Health Officer has issued boil water advisories to the District for the past eight consecutive years. A significant alternate source is Okanagan Lake via a large pump station purchased from Hiram-Walker Distilleries in 1994. Good water quality is available from Okanagan Lake, and the objective is to utilize this source to its potential.

Many components of the distribution system are over 30 years old and in need of repair or replacement. The system was poorly designed, and funds have bee provided for routing annual maintenance items. However, planning for larger scale capital replacement works has not been addressed. Objectives in reviewing the existing works include stabilizing the pressures in the mainline, simplifying daily operation by removing unnecessary works, and identifying other system deficiencies.

Hydraulic instability in the mainline exists due to high pressures, considerable velocities, and numerous PR stations located downstream. Critical facilities are considered unsafe during peak flow conditions.

Concept plans and cost estimates have been prepared for the proposed works, and expenses to be borne by the existing users have been outlined. The estimated costs for the water quality improvements are outlined separately to facilitate the District of Lake Country in applying for funding assistance from the Federal / Provincial Infrastructure Program.

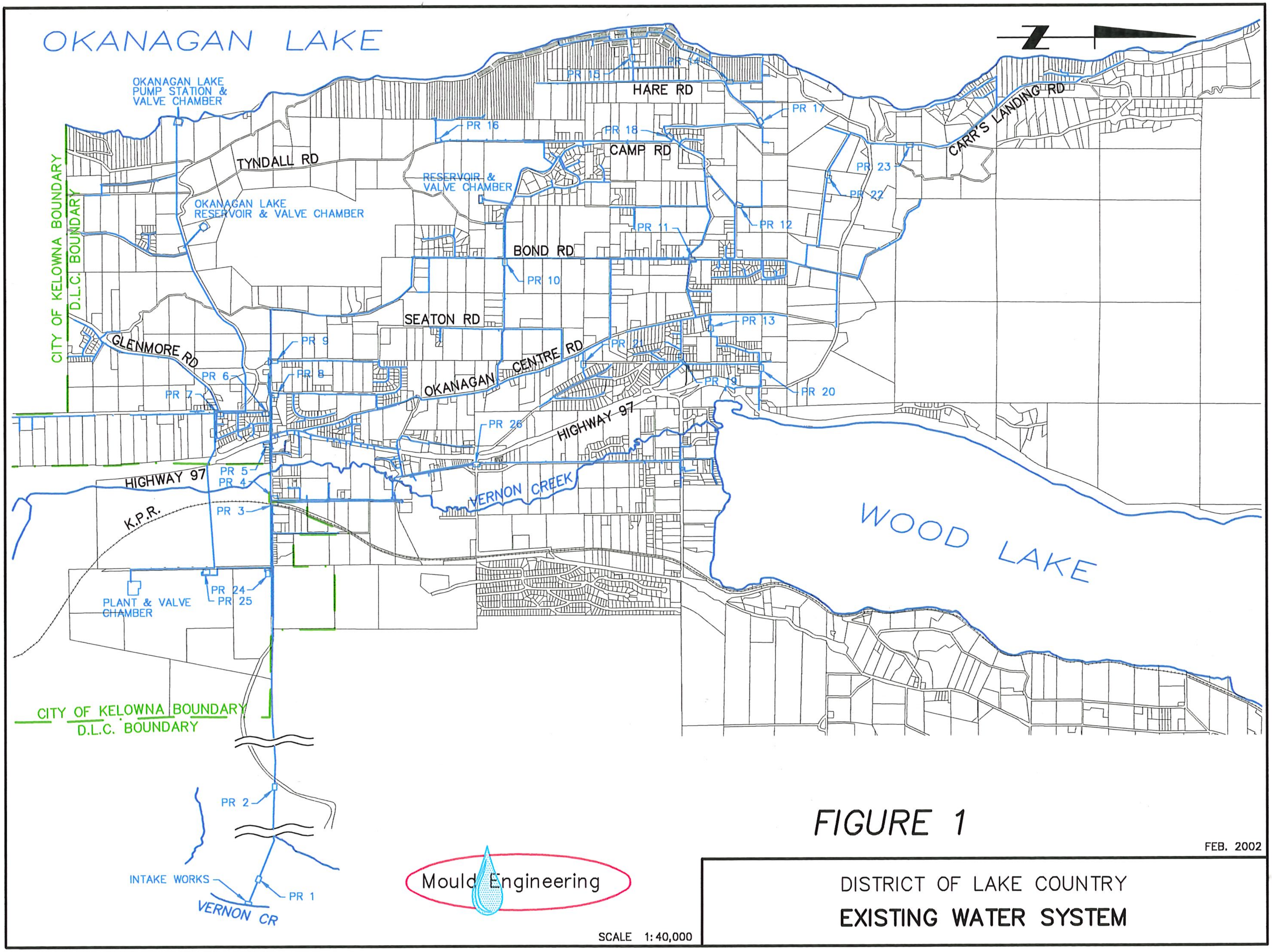


FIGURE 1

FEB. 2002

DISTRICT OF LAKE COUNTRY

EXISTING WATER SYSTEM

2.3 *WATER CONSUMPTION*

.1 Annual Use

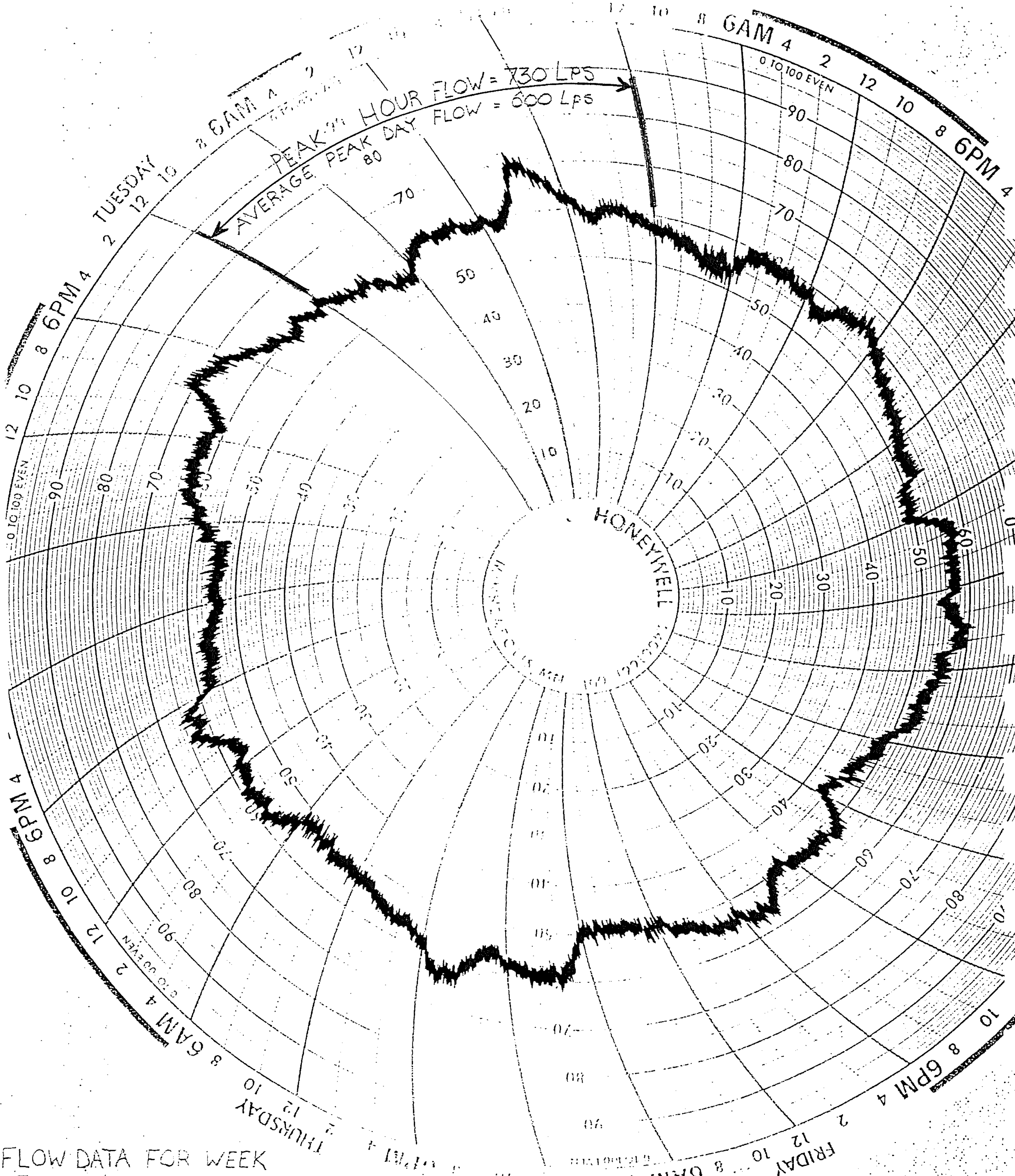
During a drought year, the annual water requirements for the current water supply commitments is estimated at 7,825 da m^3 (6,350 ac-ft). The calculation is shown in the following table.

Table 2
Annual Water Requirements

1.	*Irrigation*	
	.1 Grade 'A' Land Serviced, 928 ha @ *7.3 da m^3/ha	6,775 da m^3
2.	*Domestic*	
	.1 Rural Residential, 1750 conn. @ 0.25 da m^3	438 da m^3
	.2 Multi-family & Stratas, 100 Units @ 0.17 da m^3	17 da m^3
	.3 Commercial, Industrial & Institutional, 60 Conn. @ 0.17 da m^3	10 da m^3
3.	*Total Annual Use from Vernon Creek*	*7,240 da m^3*
4.	*City of Kelowna*	
	.1 Industrial Area, 80 ha @ 7.3 da m^3/ha	585 da m^3
5.	*TOTAL*	*7,825 da m^3*

NOTES: * Estimated annual irrigation requirements are from the *Irrigation Design Manual* prepared by the British Columbia Ministry of Agriculture

The Grade 'A' land serviced area of 928 ha included the irrigated areas within the Rural Residential, Multi-Family & Stratas, and Commercial, Industrial & Institutional developments.



FLOW DATA FOR WEEK
OF JULY 24, 1998

2. Existing Water System

The main components of the Winfield Okanagan Centre Water System are shown in Figure 1, opposite. The principal water source is a fully utilized, gravity supply from Vernon Creek. The secondary source is a pumped supply from Okanagan Lake. Water quality characteristics of the sources and the upgrading required to meet drinking water guidelines are outlined in Section 3, Water Quality.

The majority of the distribution system supplied by Vernon Creek was installed under the Agricultural and Rural Development Act program (ARDA) in the late 60's and early 70's. Many components of the system are in need of repair or replacement. The head works of the system are located at a much higher elevation than the distribution system, therefore PR Stations 1 and 2 provide vital pressure reduction in the mainline. As a result of the topography within Lake Country, the distribution system is very complicated with a large number of pressure zones.

The Okanagan Lake pump station and concrete balancing reservoir were constructed in 1970 by Hiram-Walker Distillery. These works were purchased by Lake Country in 1994, and have not yet been used to their full potential. Presently served are two small residential areas, the Woodsdale area and an industrial park located within the City of Kelowna. The Town Centre area also receives a supply from Okanagan Lake other than during high flow conditions.

In summary, the Winfield Okanagan Centre Water System consists of the following components: Okanagan Lake pump station; Vernon Creek intake works; two balancing reservoirs; 26 pressure reducing stations, approximately 70 km of pipe; and approximately 150 fire hydrants

2.1 DISTRIBUTION SYSTEM COMPONENTS AND ANALYSIS

Several site inspections of the pertinent water system works were completed and following is a brief description of the components and their functions. Also outlined are deficiencies, as well as operating and maintenance problems. Distribution system improvements are discussed in Section 2.5.

.1 *Vernon Creek Intake Works*

An earth fill dam and concrete spillway have been constructed across Vernon creek to create a small settling/head pond. A concrete block building houses the intake works and screens, as well as a solar powered, automated water quality monitoring station, installed by the Provincial Government. The screens are 16 mesh, 4.4 m^2 in area, and lie horizontally on the building floor. With an opening size of approximately 1.2 mm square, the screens remove leaves, twigs, pine needles and larger sands and gravels that may be carried by the water. The screens cannot be inspected to determine if cleaning is required, as they are covered by approximately three metres of water. There have been several screen failures in the past due to sudden increases in creek turbidity. Due to the severe consequences of screen failure (e.g. PR valve damage/blockage and pipe failure), the screens must be manually maintained often throughout the winter months and twice daily from spring to fall. The procedure requires two personnel to lower the water level in the intake building by restricting the flow through a valve. Then while standing four metres below ground level in the rushing water, personnel must sweep debris from the screens into a trough. The procedure is time consuming, costly, and poses risks to the maintenance personnel.

.2 *Vernon Creek Mainline*

An 800 mm diameter steel mainline conveys water from the Vernon Creek intake, down the eastern hillside and along Beaver Lake Road to Highway 97, a distance of 6.4 km. The steel mainline, mostly 700 mm diameter continues another 2.6 km to the intersection of Chase and Camp Roads. Pressures are within the design parameters of the mainline, reaching 250 to 300 psi upstream of PR 2 and across the valley bottom. Water velocities are moderate in the 800mm mainline reaching 1.0 m/s during an average year (500 lps) and peaking at 1.5 m/s in 1998 (730 lps). The combination of these velocities, the mainline length, and PR stations in series (PR 1 and 2) is not recommended and results in serious pressure surges. Pressure relief valves located at Clark and Vernon Creeks may have contributed to the pressure surge problem and were isolated from the mainline. Regardless of the reason, Vernon Creek station must remain isolated, as chlorinated water cannot be discharged into the creek.

Limited corrosion protection exists on the mainline. Some works have been completed which have allowed for a limited inspection of the mainline. At the observed locations, the mainline appears to be in good condition. Protection is important, as pockets of corrosive soil conditions exist and the number of buried utilities that may contribute to corrosion are increasing. Southwest Corrosion Control will be conducting tests to determine if additional corrosion protection is required.

.3 *Pressure Reducing Stations 1 and 2*

Pressure reducing stations 1 and 2 are located in series on the mainline and each is equipped with four PR valves to cover the wide flow range. PR Station 2 houses one tonne chlorine cylinders and the auxiliary works required for disinfecting the water. The elevation drop from Vernon Creek intake to the valley bottom is 412 m, requiring pressure reduction at PR 1 from 165 psi to 60 psi and pressure reduction at PR 2 from 275 psi to 90 psi.

The PR stations are poorly designed and are showing their age. Several major problems are listed below:

- Important thrust restraint measures were missed at some point during the original project so cables are being used to hold the piping together. The cables are corroded, clutter the station, and give the appearance of a safety hazard.

- Hydraulic instability exists due to the large number of PR stations downstream, high velocities, as well as having to reduce pressure across a large range. Pressure surges are common and severe, imposing great stress on the ageing installations.

- The chlorine disinfection facility at PR 2 is located directly above the valve chamber. Should a chlorine leak occur, hazardous gas would fill the cramped PR chamber.

- Chlorine contact time to the first users during peak flow conditions is only about 20 minutes, which is deficient by 40 minutes.

.4 Pressure Reducing Stations

The Winfield Okanagan Centre distribution system supplies water over a wide range of elevations, requiring numerous PR stations. However, many of the 26 PR's currently on the system are not required, are inefficiently placed or not optimally operated. This causes some unnecessary dead-end pipelines, plus the long lengths of pipe and large number of fast acting valves increase the hydraulic instability of the mainline. Water races through PR stations 5, 15, 19, and 23 during some conditions, adding to the instability. Most of the chambers have manhole entries, which creates a confined space. Some are located on the pavement edge of busy roads, thereby adding hazard to entry and servicing of the stations. In general, the stations are dark, and cramped, and some do not meet Workers Compensation Board requirements.

.5 Okanagan Lake Pump Station and Reservoir

These works are located near the southwestern boundary of Lake Country. The Okanagan Lake pump station consists of two 750 hp pumps and motors, with a third 750 hp motor operating as a 350 hp. The original bowl assembly on the third pump was replaced with a smaller unit in 1996. The rebowl was completed following closure of the distillery, to reduce the electrical demand charges and power costs. A new telemetry system has recently been installed, as the old system was faulty and alarming frequently. The pump stations wet well is fed by a

1200 mm diameter pipe with the intake situated 31 m below the Okanagan Lake surface. The design pumping rate is 464 lps (7350 USgpm) with two 750 hp units operating. Additional pump control features are required in order for the third unit to serve as a backup in the event of servicing or problems with the other two pumps. Fish screens, with an area of 11.8 m^2, are located at the head of the wet well. Also present are one tonne chlorine cylinders and the auxiliary works required to disinfect the water.

A 2270 cubic metre (600,000 USgal) reservoir situated near McCoubrey Road, with a high water elevation of 536.4 m, is used for controlling starting and stopping of pumps, and balancing fluctuations in demand. The mainline is an 850 mm diameter steel pipe extending a total of 5 km to the reservoir and beyond to Jim Bailey Road and the decommissioned Hiram-Walker Distillery. This pipeline crosses IR #7 and the agreement for its location is to be renegotiated by Year 2009. A pipeline on Jim Bailey Road is the only interconnection between the Okanagan Lake system and the Vernon Creek system.

The Okanagan Lake pumped system has considerable surplus capacity that could be utilized to improve water quality, however, a few deficiencies and concerns need to be addressed (refer to Section 3, Water Quality).

.6 *Camp Road Reservoir*

Constructed in 1983, the Camp Road Reservoir is located on the hillside behind the works yard. The reservoir is 1500 cubic metres (400,000 USgal) in size with a high water elevation of 588.4 m. The reservoir is supplied by the mainline pressure from PR station 2, however, the hydraulic grade line (HGL) is 29 m higher than the reservoir. This renders the reservoir ineffective, as even under peak hour conditions with a fire flow (60 lps) nearby, the reservoir does not supply water to the system. The installation does not serve any purpose, other than very short-term backup supply in the event of a mainline break or to service the system. The only immediate concern is to ensure that an adequate volume of water is flushed through the piping and reservoir, to ensure the water is fresh if needed. If repair or maintenance of these works is needed in the future, consideration should be given to abandonment of the installation.

.7 *Distribution Piping*

Not including the mainlines, the distribution network consists of approximately 56 km of pipe ranging in size from 600 mm to 50 mm diameter. Approximately 12 km of this length is 100 mm diameter asbestos cement pipe, which has proven to be more susceptible to breakage in comparison to larger pipe diameters. The majority of the distribution piping is asbestos cement (AC), some concrete cylinder (CC), with more recent installations being polyvinyl chloride (PVC) and high density polyethylene (HDPE). There is also some galvanized and series PVC piping in the smaller diameters. In general, there have been few leaks considering the high pressures in the system so the piping seems to be in good condition. There is however, corrosion of service connections occurring in some areas creating leaks, and pressure surges are causing the leaks to appear sooner than would naturally occur.

2.2 *DESIGN PARAMETERS*

The criteria used to analyze the water system includes both standard design values and values obtained from experience with other Irrigation and Improvement Districts. Applicable criteria is shown in the table below, and it should be noted that some values vary, or are not shown in the District of Lake Country Subdivision and Development Servicing Bylaw.

Table 1
Design Parameters

	American Units	Metric Units	DLC Bylaw
1. Peak Day Demand a.) Agricultural b.) Rural Residential c.) Multi-Family Residential d.) Commercial, Ind. & Institutional	 *5.0 – 6.5 USgpm/acre 3.8 USgpm/conn. (0.5-1.0 acre lot) 1.9 USgpm/conn. (<0.5 acre lot) 1.0 USgpm/conn. 10 USgpm/ac	 *47-61 lpm/ha 14.4 lpm/conn (0.2 –0.4 ha lot) 7.2 lpm/conn (<0.2 –0.4 ha lot) 3.8 lpm/conn 15.3 lpm/ha	6.2 lpm/conn.
2. Peak Hour Demand a.) Rural Residential b.) Multi-Family Residential c.) Commercial, Ind., & Institutional	 6.0 USgpm/conn. (0.5-1.0 acre lot) 3.0 USgpm/conn. (<0.5 acre lot) 1.6 USgpm/conn. 16.0 USgpm/ac	 22.7 lpm/conn.(0.2 –0.4 ha lot) 11.4 lpm/conn. (<0.2 ha lot) 6.0 lpm/conn. 24.5 lpm/ha	10.4 lpm/conn.
3. Water Disinfection Time a.) Minimum Contact for Lake Water b.) Minimum Contact for Creek Water	 20 ~~60~~ minutes 60 ~~20~~ minutes	where are these from Health?	
4. Fire Flow a.) Volume determined by b.) Minimum Rural Residential	 Fire Underwriters Survey Guidelines 950 USgpm	 60 lps	
5. Reservoir Storage a.) Fire Flow b.) Balancing c.) Emergency	 Largest Flow x Duration 25% of Residential Peak Day Demand 25% of a.) and b.)		
6. System Pressures a.) Maximum b.) Minimum c.) Minimum at Hydrant during fire	 140 psi 40 psi 20 psi	 965 kPa 275 kPa 140 kPa	 1,000 kPa 275 kPa 140kPa
7. Maximum Pipeline Velocity a.) Peak Hour b.) Peak Day plus Fire Flow	 6.5 ft/s 13 ft/s	 2.0 m/s 4.0 m/s	 2.0 m/s 4.0 m/s
8. Maximum PRV Velocities c.) Peak Hour d.) Peak Day plus Fire Flow	 20 ft/s 25 ft/s	 6.0 m/s 7. 6 m/s	

*The agricultural water demand is based on the soil duty maps prepared by the Ministry of Agriculture.

Water licenses total 8213 da m^3 (6,661 ac-ft) on Vernon Creek and the mountain storage reservoirs on Beaver (Swalwell) and Crooked Lakes. As shown in Table 2, annual water requirements from Vernon Creek are 7,240 da m^3, therefore the licences are sufficient. Prior to increasing the water requirements on Vernon Creek, watershed hydrology information must be reviewed as some creeks have been over licensed. Okanagan Lake is licensed for 879 da m^3, of which 65% is committed to the City of Kelowna. An application for additional licences on Okanagan Lake has been submitted in the amount of 2,200 da m^3. License details are attached in Annex 3.

.2 *Peak Use*

The summer of 1998 was the longest and hottest recorded by Environment Canada during the past 140 years. On July 24, 1998 a flow of 730 lps (11,570 USgpm) was recorded in the mainline, as shown on the chart opposite. The volume supplied from the Okanagan Lake pumped source during this time was only about 20 lps, totalling a system peak demand of 750 lps. The chart, opposite, shows seven days of flow records and it is evident that 750 lps is a peak hour value. A peak day value of 600 lps has been interpolated. The peak day to peak hour ratio is 1.2, which is low. This is a result of the irrigation demand being relatively constant throughout a day. The irrigation portion of the peak flow is about 65% with the domestic component being 35%.

It should be noted that while the above flows are for a peak year, higher flows could occur based on the current water supply commitments. A survey completed during the summer of 2001 indicates there is an additional volume of 52 lps, which is allocated to landowners but not being utilized. This was also likely the case for 1998. As well, water use within the City of Kelowna Industrial Park is well below the current water supply agreements.

.3 *City of Kelowna Bulk Water Agreement*

The supply to the City of Kelowna industrial park is metered and covered by two agreements. The first is for a 20 ha parcel at the corner of Beaver Lake and Jim Bailey Roads, stating the District must supply potable water at a maximum peak day flow rate of 21 lps and a fire flow of 190 lps for a duration of three hours. The second agreement covers parcels on the east side of Jim Bailey Road that have a combined water allocation of 60 ha. A maximum peak day flow rate of 98 lps and a fire flow of 227 lps for a duration of three hours must be provided to this site. The City representatives have not yet signed this agreement. The combined peak day flow committed to the City is 119 lps (1,885 USgpm). The agreement indicates potable water can be supplied from either the District's gravity or pumped source.

The water servicing requirements for the City industrial area can be satisfied by the District, however, it must be noted the Okanagan Lake reservoir is not large enough to meet the fire flow duration requirement

2.4 COMPUTER MODEL ANALYSIS

To analyse the hydraulics of the system, a computer model of the distribution system was developed using Waterworks for AutoCAD R14. The assessment roll showing the land entitled to water, in conjunction with the design values outlined in Table 1, were entered into the computer model to determine the peak hourly flow. A value of 1,200 lps was obtained, which is considerably higher than the 1998 peak of 750 lps (refer to Section 2.3 Water consumption). This was expected as some landowners are not consuming water at all and it is highly unlikely the remaining users would require their peak demand at the same time. A scaling factor of 75% has been used to reduce the computer model demand to a peak hour flow of 900 lps. This is a realistic value that could possibly be seen with the existing water supply commitments. A copy of the computer printout is enclosed in Annex 2. The scaling factor of 75% is in line with other Irrigation Districts in the area.

The model was calibrated against a variety of flow regimes observed during the summer of 2001. The calibration data consisted of field pressures measured at each PR station and other critical areas. The model simulated field conditions accurately (±3% on average), under both high and low flow conditions. The calibration printout for a flow of 428 lps in the Vernon Creek mainline is also included in Annex 2.

A review of the Winfield Okanagan Centre Water System model, in conjunction with the Design Parameters outlined previously, reveals the following:

.1 *Extreme Pressures, Velocities, and Inadequate Fire Flows*

As mentioned, many PR stations are not optimally placed or operated, which causes several high and low pressure areas. Exceeding recommended values, pressures reach 180 psi on Pow, Oceola, Robinson, Lang, and Goldie Roads. The low pressure areas are on McCoubrey, Wilson, Long Roads, and the south ends of Cemetery and Shanks Roads.

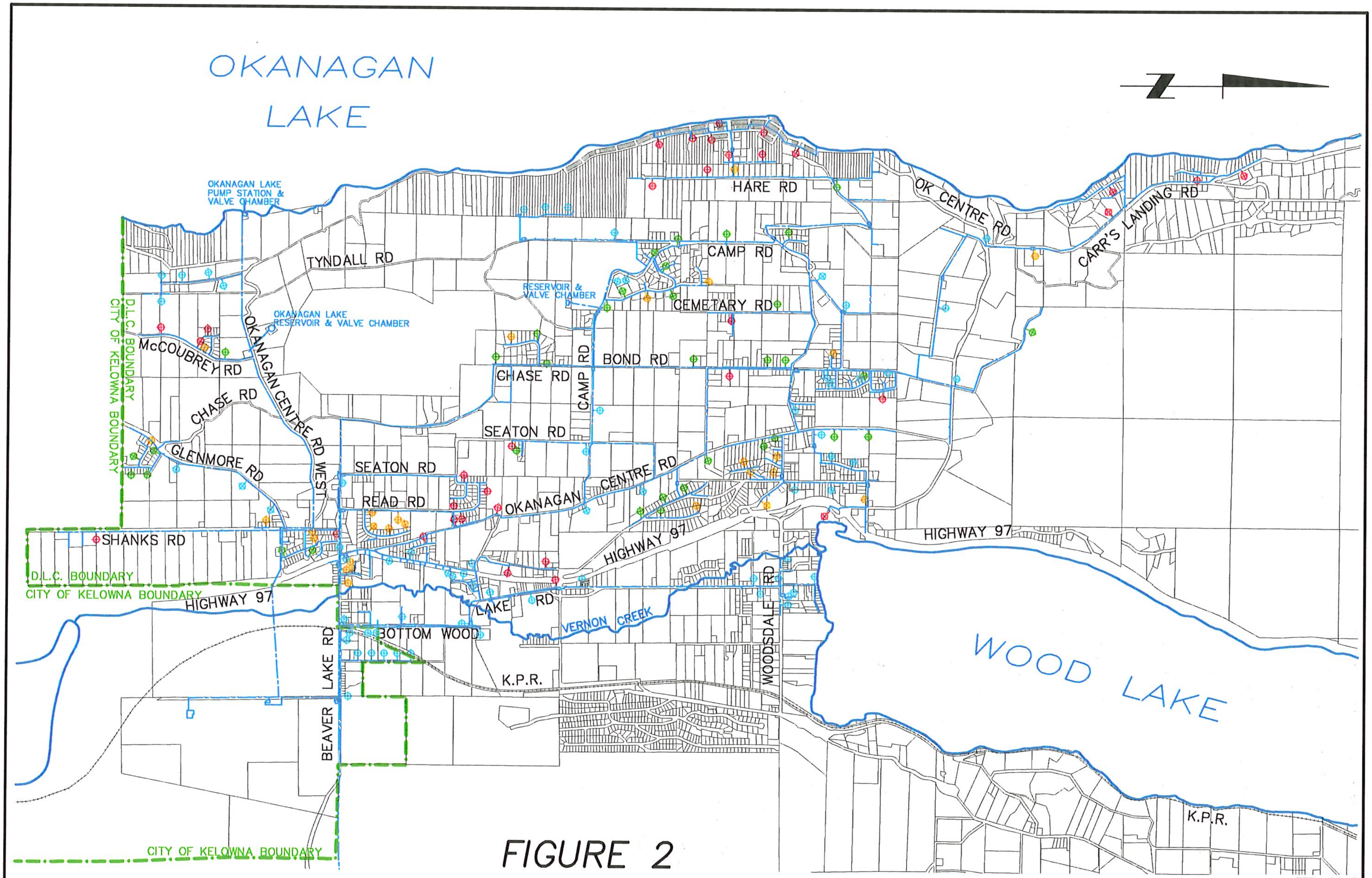


FIGURE 2

FEB. 2002

LEGEND

WATERMAIN

D.L.C. BOUNDARY

- < 32 lps (< 500 US gpm)
- < 60 lps (< 950 US gpm)
- 60 – 95 lps (950 – 1500 US gpm)
- > 95 lps (1500 US gpm)

Mould Engineering

SCALE 1:40,000

DISTRICT OF LAKE COUNTRY

WINFIELD OKANAGAN CENTRE WATER SYSTEM

FIRE HYDRANT FLOW CAPACITIES

The distribution piping is generally well sized to supply the current peak hour demand. The only two pipelines where velocities exceed the design parameters during peak flow are Seaton Road (100 mm AC) and Hare Road (150 mm AC). In addition to, and as a result of exceeding the maximum design velocities, these pipes greatly restrict flow to the downstream users.

Approximately forty percent of the District's 150 hydrants are located on or downstream of small diameter (100 mm) pipe and cannot supply the minimum fire flow of 60 lps. The computer model was used to determine the available flow at every hydrant on the system. Opposite is a hydrant coding map illustrating hydrant capacities, and a larger version, drawing no. DLC-105, is enclosed.

An accurate computer model is a very useful tool and has been used extensively to determine available fire flows, review looping options in order to eliminate dead end pipes, investigate the removal of PR stations, and to integrate some of the pressure zones. Results include the abandonment of fifteen existing PR chambers and the installation of seven new chambers, therefore resulting in the removal of eight chambers. These works as well as looping possibilities are shown in the Distribution System Improvements and Water Quality Improvements Sections.

2.5 DISTRIBUTION SYSTEM IMPROVEMENTS

This section provides solutions for the system deficiencies outlined in Sections 2.1 and 2.4. The subsections are in order of priority, although some recommendations require little work and could be completed immediately.

.1 Vernon Creek Intake

The mainline intake screens on Vernon Creek are maintenance intensive, and pose considerable liability to the District. It is recommended that a new screening system be constructed inside the existing building.

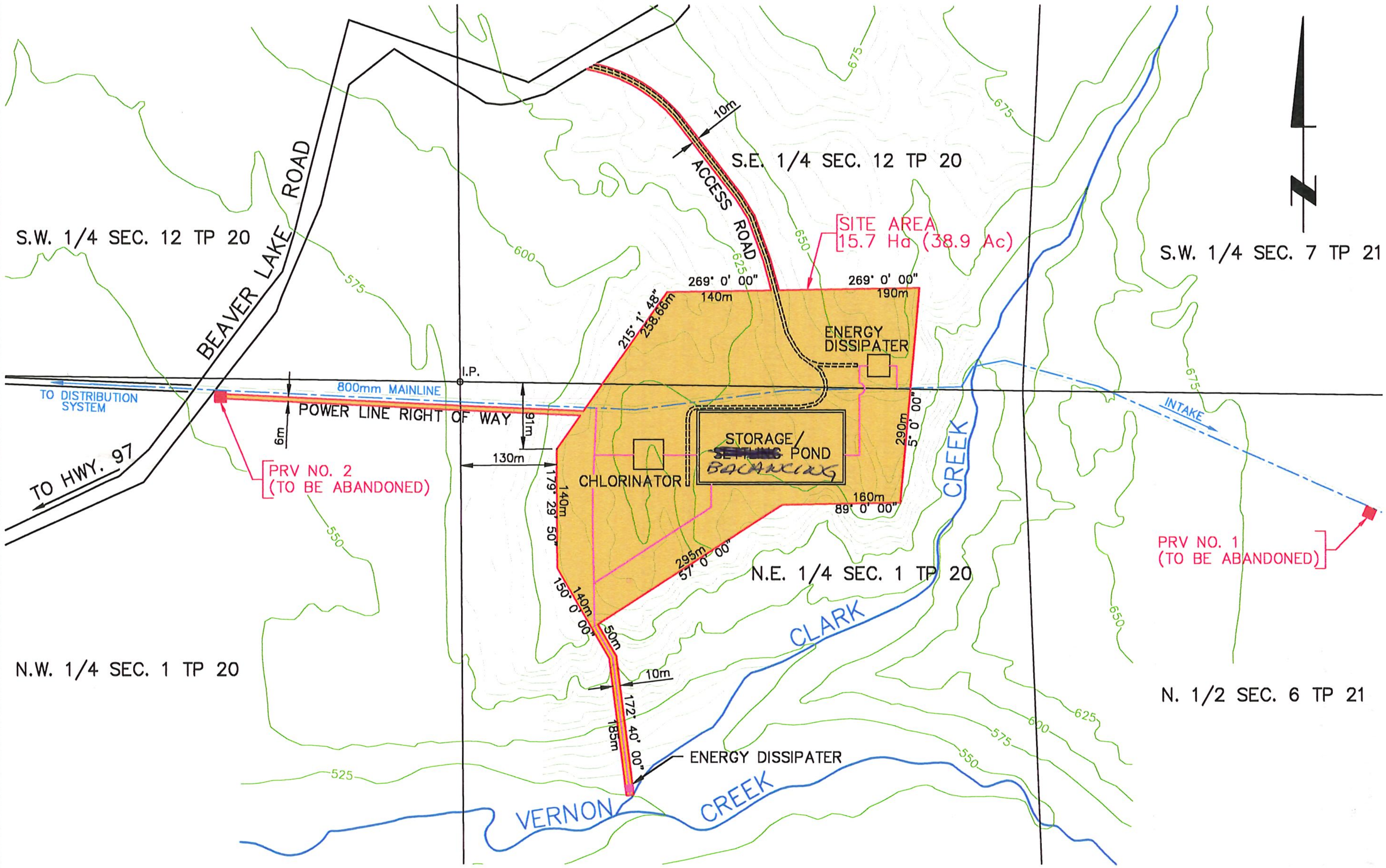
Travelling screens would be ideal for this application, however, they require a power source presently unavailable at the site, and installation would be very costly. The recommended solution is fixed, sloped screens, which will be primarily self-cleaning. Only one staff member should be required to clean and inspect the screens, and the cleaning frequency should be reduced from twice daily to four times per week. The screens will be 40 Mesh and have an area of 12 m^2. The existing intake structure is of sufficient size to house a suitable screening arrangement.

An automated gate via telemetry to the District's office will control flow into the intake building. The existing solar panels and batteries at the intake building can be used to operate the gate and telemetry. Operation costs will be reduced considerably and savings are outlined in Section 2.7, Financial implications

Estimated Cost: $ 125,000

.2 Mainline Corrosion Protection

The steel mainlines within the system are adequately sized and no leaks are obvious so upgrading is not necessary. The only work need is to ensure the mainline is protected against corrosion, as replacement costs will be extremely



FEB. 2002

DISTRICT OF LAKE COUNTRY

PROPOSED RESERVOIR AND DISINFECTION FACILITIES

FIGURE 3

Mould Engineering

SCALE: 1:7,500

high. A study will be undertaken to determine if additional corrosion protection is required and the cost of the works required should be added to this section.

Estimated Cost: $ N/A

.3 *Vernon Creek Reservoir & Disinfection Facility*

The construction of Vernon Creek Reservoir and Disinfection Facility is instrumental in the removal of PR stations 1 and 2, and hence the stabilization of mainline pressures. The site is shown on the plan opposite, and is located on a bench above PR 2 at a hydraulic grade line (HGL) of approximately 627 m. The mainline pressure will increase about 14 psi, as the current HGL is 617 m. The facility is to be an earthfill dam containing 63 000 m^3 (51 ac-ft) of water.

Vernon Creek is the main source of supply and a large reservoir is recommended, as a result of the numerous landslide areas immediately upstream of the intake. Remedial work has been completed, however, large unstable banks remain which could result in further landslides, thereby jeopardizing the water supply. The proposed reservoir will be capable of supplying the Winfield system for one day during peak flow conditions. With proper management, this reservoir will also reduce operating costs by lowering the number of gate changes required to release water from mountain storage. As well, volumes of mountain storage water discharged past the intake should be reduced, as the reservoir can balance the demand fluctuations from the distribution system.

WATER QUALITY SIDE BENEFITS

There will be noticeable water quality side benefits as a result of the construction of this reservoir. The reservoir will allow high turbidity events in Vernon Creek to be circumvented. This can be achieved by installing a turbidity meter at the intake structure, and connecting it to a system that will close the gate to the mainline should turbidity exceed a set threshold. The system will be equipped with low-level sensors at the reservoir to override the mainline closure, during a sustained turbidity event. There will also be a colour reduction, as a result of chlorinating the water as it enters the reservoir. Water quality testing could be conducted to determine the extent of the colour reduction.

TABLE 3

PR Number	PR Station Name / Location	Valve Sizes (in)	Ex. D/S Pressure (psi)	Ex. D/S HGL (m)	New D/S Pressure (psi)	New D/S HGL (m)	Comments
Pressure Reducing Stations Existing System Improvements							
1	Upper Range	12, 10, 8, 4	59	744			To be abandoned
2	Lower Range (Beaver Lake Rd)	12, 10, 8, 4	93	617			To be abandoned
3	Beaver Lake / Bottom Wood Lake Rds (East)	6, 2	CLOSED	500	90	486	To be abandoned
4	Beaver Lake / Bottom Wood Lake Rds (West)	6, 2	70	472			To be abandoned
5	Kobayashi - Beaver Lake Rd	4, 2	91	502	75	491	Larger valve required
6	Glenmore Rd / Beaver Lake Rd	6, 2.5	133	554			
7	Harwood Rd (Glenmore Rd)	6, 2	61	510	80	523	
8	Read Rd / Dyck Rd	3, 2	60	513	80	527	Valve at Read / Kel-Vern Roads to be opened
9	Seaton Rd / Dyck Rd	4, 2	70	527	75	531	
10	Bond Rd / Camp Rd	8, 3	64	578	50	568	
11	Tepper - Bond Rd / Davidson Rd	8, 6, 3	60	577	50	570	
12	Amundsen - McGowan Rd	4, 2	44	559	75	585	To be relocated, larger valve required
13	Brew Rd	4, 2	30	506			
14	Camp Rd / Hare Rd	4, 2	61	434	50	426	
15	6th Street	4, 2	58	421			Larger valve required
16	Tyndall Rd	4, 2	40	553			
17	Dobson - Camp Rd	6, 2	79	484	70	478	
18	Davidson Rd / Camp Rd	6, 2, 1.5	41	527			
19	Robinson Rd / Pretty Rd	3, 2	77	506			Larger valve required
20	Pretty Rd / Middleton Rd	2, 2	57	463			
21	Jardine Rd	4, 2	65	541	60	537	
22	Hikichi - Goldie Rd	6, 2	59	492	40	479	
23	McFarlane - Carrs Landing Rd	4, 1.5	83	450	60	445	To be relocated / larger valve required
24	Jim Bailey Rd / Beaver Lake Rd	10, 8	N/A	N/A	90	496	To be reconfigured
					85	493	Fire flow backup
25	HRI - Jim Bailey Rd	8	88	505	75	496	To be abandoned
26	Taiji Ct	8, 2	78	462	OPEN		To be abandoned
27	Camp Rd / Tyndall Rd	N/A			85	588	NEW
28	Bond Rd / Lacresta Rd	N/A			40	528	NEW
29	Dyck Rd / Chase Rd	N/A			105	576	NEW

NOTE: Red text indicates change dependent upon new works completion

Other works involved with this project include: Construction of an energy dissipater on the mainline prior to the reservoir; replacement of two mainline air valves with surge control devices; removal of the works at PR stations 1 and 2; and construction of a new chlorination facility. The water in the reservoir will be chlorinated thereby exceeding the Ministry of Health requirements for chlorine contact time. It would also make sense for the District maintenance shop to be relocated from Camp Road to this site, however, this expense has not been included. Additional works recommended at this site, to further improve water quality, are outlined in Section 3.4, Water Quality Improvements.

Estimated Cost: $2,000,000

.4 *Pressure Reducing Stations*

The existing PR station locations and settings cause several high and low pressure areas as well as unnecessary dead end watermains. The PR stations are key to the performance and longevity of the distribution system. The following are recommended changes in PR station works, also illustrated on Drawing No. DLC-107 and Table 3 opposite. The distribution system is complicated and several of the recommended adjustments and works must be completed simultaneously.

- In general, it was concluded that PR stations 3, 4, 25, and 26 could be abandoned, PR stations 12 and 23 are best relocated, and three new PR's should be installed. Also, PR valves in stations 5, 15, 19 and 23 need to be upsized in order to slow velocities during peak flows.

- The supply to Read and Seaton Roads, PR stations 8 and 9, should be revised to provide better service. The two supplies are segregated, however, it is possible to loop the two systems by simply opening a valve and adjusting the PR settings as per the Table. Linking the two systems provides the users with increased fire protection, as the fire hydrants will be supplied from both directions.

- The industrial park within the City of Kelowna and the Town Centre / Bottom Wood Lake Road area lies in a topographically simple area and changes should be made to simplify operations. The area is fed by PR stations 3, 4, 5, 24 and 25, with PR 26 creating another pressure zone within the area. PR stations 3, 4, 5 and 24 supply from the Vernon Creek mainline and PR station 25 supplies from the Okanagan Lake system. To abandon the unnecessary PR stations, first adjust the pressure settings of PR stations 3, 5, 24, 25, and 26, as outlined in Table 3. It is recommended these settings be adjusted over a period of time and be tested for a while to ensure the users are comfortable with this operation. Next, PR station 24 can be reconfigured to supply from Okanagan Lake to the Town Centre / Bottom Wood Lake Road areas. When complete, PR stations 3, 25 and 26 may be abandoned.

- PR station 18 experiences excessively high upstream pressures, and is required to reduce the pressure over a large range. To remedy this situation and allow for future looping options (Amundsen Road to Bond Road), PR station 12 should be relocated upstream of the Davidson / Amundsen Roads intersection. The move will also require upgrading of the main PR valve. In conjunction with this move, a new PR station is required at the intersection of Camp / Tyndall Roads, and should be constructed prior to relocating PR 12.

- The remaining PR stations require new access hatches, ladders, miscellaneous equipment, and painting. A program needs to be established for maintenance and replacement of PR valves, isolating valves, corroded piping, strainers, and pressure gauges. The maintenance portion of the program is key in identifying equipment and operational problems, thereby minimizing the risk of large repair projects.

Estimated Cost: $450,000

.5 Distribution System

The District has approximately 12 km of 100 mm diameter AC pipe. Approximately 7 km of length causes inadequate hydrant capacities and funds should be set aside to replace sections annually. In most cases 150 mm diameter pipe is sufficient in size. However, each project should be reviewed, as future growth or other considerations may dictate larger diameter pipe.

As problems occur, galvanized and series PVC pipe may also need to be replaced. However, individual projects should be reviewed, as considerable lengths of pipe could be abandoned. Replacement of this piping has not been included in the cost estimate.

Estimated Cost: $1,430,000

.6 Extreme Pressures, Velocities and Inadequate Fire Flows

High pressure areas and inadequate fire flows are discussed in the preceding sections, Pressure Reducing Stations and Distribution System.

McCoubrey Road elevations are near the HGL of the supplying Okanagan Lake reservoir, and has low pressures and hydrants incapable of supplying adequate flow. The Vernon Creek mainline operates at a significantly higher HGL and is able to supply the area with adequate pressure. A pipeline to McCoubrey Road from the corner of Dyck and Chase Roads, complete with a pressure reducing station, is proposed to resolve the low pressure problem.

Hare Road has an inadequately sized 150 mm AC pipe that exceeds the maximum flow of 2.0 m/s. This pipeline should be upgraded to 200 mm diameter PVC.

Estimated Cost: $345,000

2.6 *COST ESTIMATE SUMMARY*

The estimated cost of the works required to upgrade the Existing System are summarized below. Details of the estimates are contained in Annex 1. It should be noted that these projects are capital works and annual operation and maintenance projects are not included. The cost estimates do not included land acquisition, are based on limited design and fieldwork, and should therefore be considered preliminary. Subsurface materials, such as bedrock or groundwater that may be encountered during construction, have not been included in the estimates.

Existing System Improvements

1.	Vernon Creek Intake Screens	$ 125,000
2.	Mainline Corrosion Protection	$ N/A
3.	Vernon Creek Reservoir & Disinfection Facility	$2,000,000
4.	PR Stations	$ 450,000
5.	Distribution System	$1,775,000
6.	**TOTAL**	**$4,350,000**

2.7 *FINANCIAL IMPLICATIONS*

The estimated costs outlined in the previous section ($4,350,000) are system improvements to be borne by existing users. Details of project financing will be completed by the District, and the following points should be taken into consideration.

.1 Replacement of the Vernon Creek Intake Screens with an improved maintenance design should save $20,000 - $25,000 annually in system operations. At a capital cost of $125,000, this represents a 5 to 6 year return on investment. There will also be fewer staff disruptions for screen cleaning, therefore allowing for increased work force productivity.

.2 A considerable portion of the operating, maintenance and repair expenses can be contributed directly to PR stations 1 and 2, and the pressure surges that occur in the mainline. Construction of the Vernon Creek Reservoir and Disinfection Facility will reduce these expenses and eliminate the need for an immediate capital expenditure of approximately $250,000. This capital would upgrade the critical components at PR stations 1 and 2 but would not resolve the major problems.

.3 Besides the abandonment of PR stations 1 and 2, the system improvements outline four other stations to be removed. Fewer stations will simplify system operations, reduce operating and maintenance costs, and remove old infrastructure, which needs to be replaced.

.4 An important consideration is the annual cost to be borne by the existing users. If the entire estimated cost of $4,350,000 is financed, the annual cost for repayment of debt will be $343,000. This assumes financing through a Municipal Finance Authority debenture, amortized over twenty years at an interest rate of 5%. If you consider the 160 multi-family, commercial, and institutional type units equivalent to 80 rural residential connections, there are 1,830 total connections. Therefore, the annual debt per connection equates to about $188. This would almost double the current annual rate of $203.

2.8 *CONCLUSIONS AND RECOMMENDATIONS*

These conclusions and recommendations are made following an analysis of the existing System.

.1 A study of the Winfield Okanagan Centre Water System reveals a poorly designed system that has resulted in serious pressure surges in the mainline and high annual operating and maintenance expenditures. Also, many critical facilities are over 30 years old and are in need of repair or replacement.

.2 Serious pressure surges in the mainline can cause failure of critical facilities and result in considerable damage to the infrastructure and private property.

.3 Chlorine contact time supplied to the first users is only 20 minutes, which does not meet Ministry of Health requirements.

.4 Approximately one third of the fire hydrants do not meet minimum flow requirements outlined in the Servicing Bylaw.

.5 A study investigating the need to protect the mainline from corrosion should be completed. Mainline replacement costs are high in comparison to preventative measures which can be taken to ensure the mainline longevity.

.6 Capital works required to upgrade the system to meet the Servicing Bylaw and current water system standards, are estimated at $4,350,000. These capital projects should be sufficient for a period of 15 to 20 years.

.7 The outlined expenses are in addition to an annual operating and maintenance budget.

.8 If the entire capital costs are to be borne by the existing users, there will be a 195% rate increase.

.9 The cost estimates are based on limited design and field work, do not include land acquisition, or bedrock and groundwater expenses that may be encountered. Therefore, costs must be considered preliminary and further work should be completed prior to financial commitments.

.10 Projects 1 and 3, the Vernon Creek Intake Screens, as well as the Reservoir and Disinfection Facility, should be considered the highest priority for improvements. From an operation and maintenance point of view, Project 4, PR Stations, is next in terms of priority.

.11 Water Quality details and the recommended improvements are outlined in the following section.

3. WATER QUALITY

Of increasing concern to domestic water users is the issue of water quality. The District of Lake Country has received many complaints regarding poor water quality supplied from the Winfield Okanagan Centre Water System (WOCWS). The system is required to supply good water quality to: a population of 4,800; an industrial park within the City of Kelowna; as well as the Winfield Town Centre, which includes hotels, restaurants, commercial establishments, and institutional and industrial users.

Superior water quality is not necessary for irrigation use, and approximately 65% of the peak summer flow is conveyed for irrigation purposes. However, growth projections indicate domestic use will more than double in the next twenty years, while irrigation demand may decline. When this occurs, the peak flow will be evenly split between domestic and irrigation use.

The principal source of supply, Vernon Creek, contains high turbidity, colour, and coliforms, particularly during spring runoff and storm events. The water consistently fails to meet the Guidelines for Canadian Drinking Water Quality (GCDWQ). The Medical Health Officer has issued ten boil water advisories to the District over the past eight years. Enclosed in Annex 8, is correspondence from the Okanagan Similkameen Health Region. An analysis of the drinking water bacteriological report for the years from 1994 to 2000, indicate three samples contained faecal coliforms, 23 samples contained total coliforms, and eight samples contained more then ten coliforms per 100 millilitres. Good water quality is available from a secondary source, Okanagan Lake, via an existing pumping facility. The objective is to utilize this source to improve water quality for domestic use.

Table 4
Water Quality Comparison

Parameters	GCDWQ Maximum Recommended Values	Okanagan Lake Pump Station Sample	Vernon Creek Intake Sample
Depth		30 m	
MO Alkalinity as $CaCO_3$		122.0	49.8
Aluminum	0.02*		0.06
Ammonia			0.005
Arsenic	0.025		<0.06
Barium	1.0		0.006
Bicarbonate		148.84	
Calcium		31.2	8.3
Total Carbon			14.4
Total Inorganic Carbon			7.9
Total Organic Carbon			4.2
Carbonate (equivalent to HCO_3)		73.32	
Carbon Dioxide Calculated		2.2	
Chloride	250	2.8	
Chromium	0.05		0.006
Color	15 TCU	5 TCU	28 TCU
Copper	1.0		0.006
Total Hardness as $CaCO_3$	500*	120.0	
Non-Carbonate Hardness as $CaCO_3$		-2.0	
Dissolved Iron		0.02	
Total Iron	0.3	0.03	
Magnesium	500*	10.2	
Dissolved $NO_3 + NO_2$	45		0.048
Nitrate – Nitrogen	10	0.170	
Nitrite	1.0	0.002	
Chemical Oxygen Demand (COD), Unfiltered		10.0	
Dissolved Oxygen (measured at site)		11.0	10.0
PH	6.5 (min) to 8.5 (max)	8.2	7.6
Ortho Phosphate		0.01	
Total Phosphate		0.01	0.03
Potassium		1.0	
Non-Filterable Residues			5.6
Silica		5.40	
Specific Conductance	700 µS/cm		72.5 µS/cm
Sodium	20.0	10.0	
Dissolved Solids	500	155	
Suspended Solids		5.0	
Total Solids		160.0	
Volatile Solids		32.0	
Sulphates	500	14.0	
Temperature	15°C	4.6°C (at 31 m depth)	
Turbidity	1 NTU	0.1 NTU	2.28 NTU

NOTES: 1 - Unless otherwise noted, all values are milligrams/litre, µg/l = micrograms per litres.
2 – Okanagan Lake Data is from one sample
3 – Vernon Creek data is a 4-year average

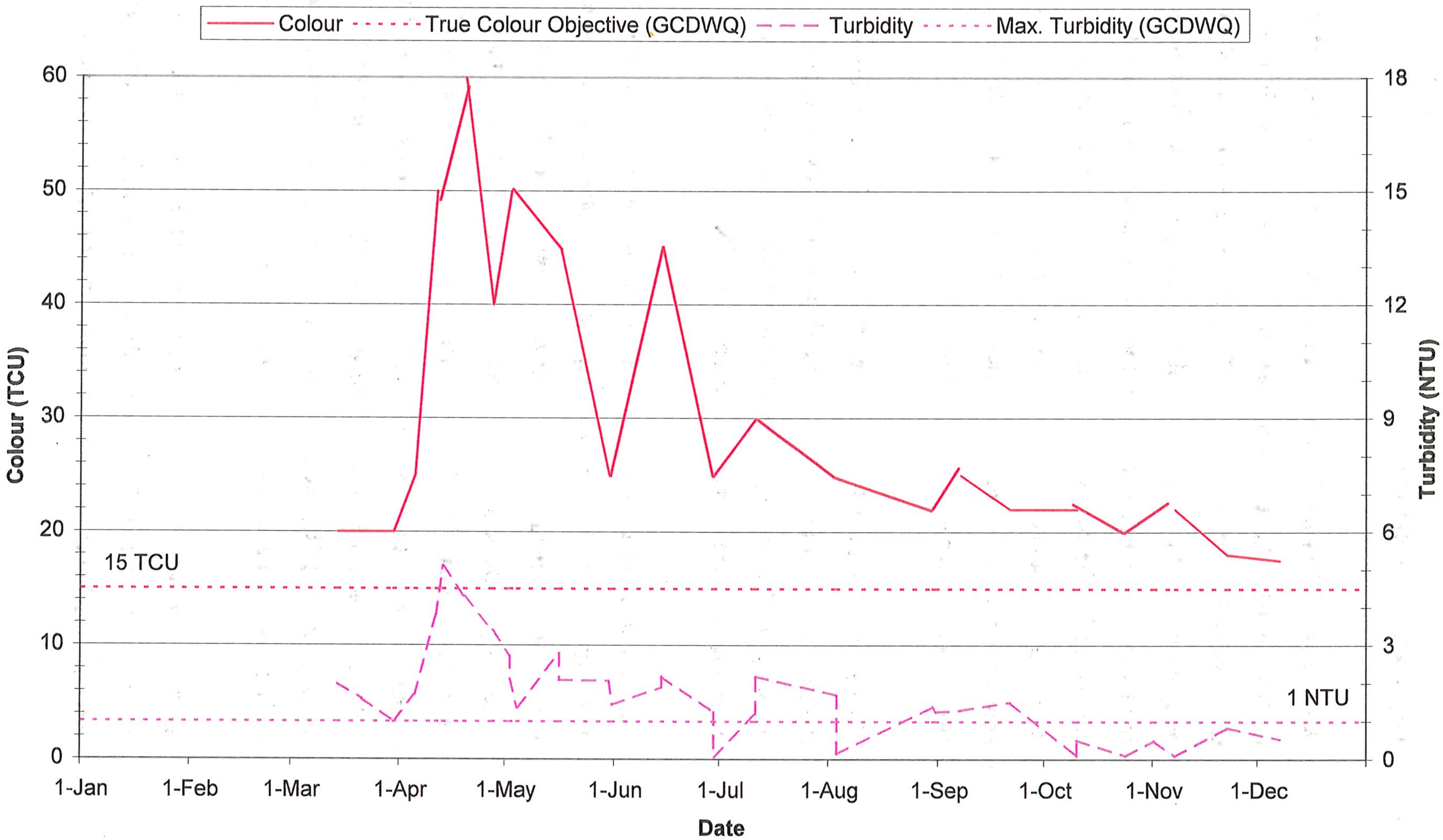
* Standard from the British Columbia Water Quality Guidelines

One option that has been reviewed, is the possibility of installing a separate distribution system to supply domestic water. The estimated costs have been prepared and are enclosed. A second option to improve water quality, involves piping the water from Beaver Lake to the distribution system, rather than using Vernon Creek. A preliminary review reveals that piping the water down the hillside has some benefits but does not meet the desired water quality objectives. As a result, discussions and cost estimates are not included in the Master Plan. However, a detailed study is warranted, as significant revenues could be obtained from this project by generating power.

The capital projects and estimated costs for the water quality improvements are outlined separately in order to apply for funding assistance from the Federal/Provincial Infrastructure Program.

FIGURE 4

Vernon Creek Colour and Turbidity for 2000



3.1 Vernon Creek Water Quality

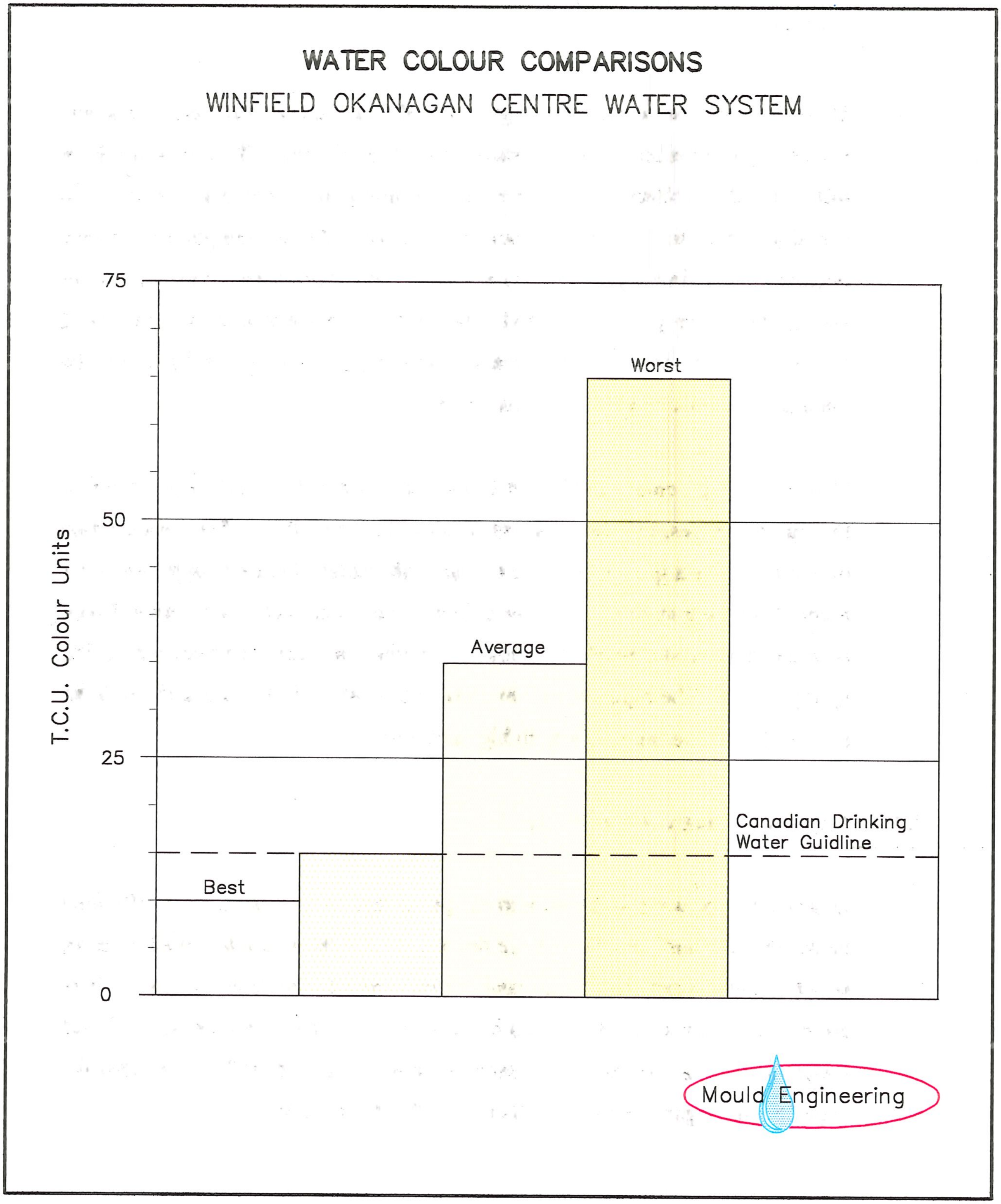
Water quality data on Vernon Creek has been recorded since 1996. A water quality monitoring program was undertaken by Summitt Environmental Consultants Ltd. in 1996 and 1997 as part of a larger watershed assessment program funded by Forest Renewal BC. Samples were taken at the intake and results are shown in Annex 7. A continuous monitoring program has also been conducted by the Ministry of Water, Land, and Air Protection from 1997 to 2000, but the monitoring results are not available at this time. However, in conjunction with this program, grab samples were taken approximately every two weeks, and are included in Annex 7.

Grab sample data has been analyzed for the year 2000, as this is considered a typical year for water quality. As shown in Figure 4, opposite, colour and turbidity in Vernon Creek exceeds the GCDWQ. As well, temperature in the creek exceeds the recommended maximum value.

Colour and temperature are important water quality parameters but primarily for aesthetic reasons. The public perception is that coloured and/or warm water may not be safe. Although warm water does have increased potential for algae and bacterial growth, it does not generally compromise chlorine disinfection. For aesthetic reasons, the GCDWQ stipulate a maximum colour of 15 TCU and a maximum water temperature of 15° Celsius. The data recorded from 1996 to 2000 indicates a minimum colour of 10 TCU, a maximum of 65 TCU and an average of 35 TCU. As well, temperature on the Creek typically exceeds 15° Celsius during the months of July and August.

Turbidity, however, is both an aesthetic and health problem, as suspended particular matter shields pathogens from the disinfection process. The GCDWQ turbidity maximum of 1 NTU is important for aesthetic and health reasons. The

FIGURE 5


WATER COLOUR COMPARISONS
WINFIELD OKANAGAN CENTRE WATER SYSTEM
75
50
25
0
T.C.U. Colour Units
Worst
Average
Best
Canadian Drinking
Water Guidline
Mould Engineering

data shows a minimum of 0.09 NTU, a maximum of 29 NTU, and an average of 3.3 NTU.

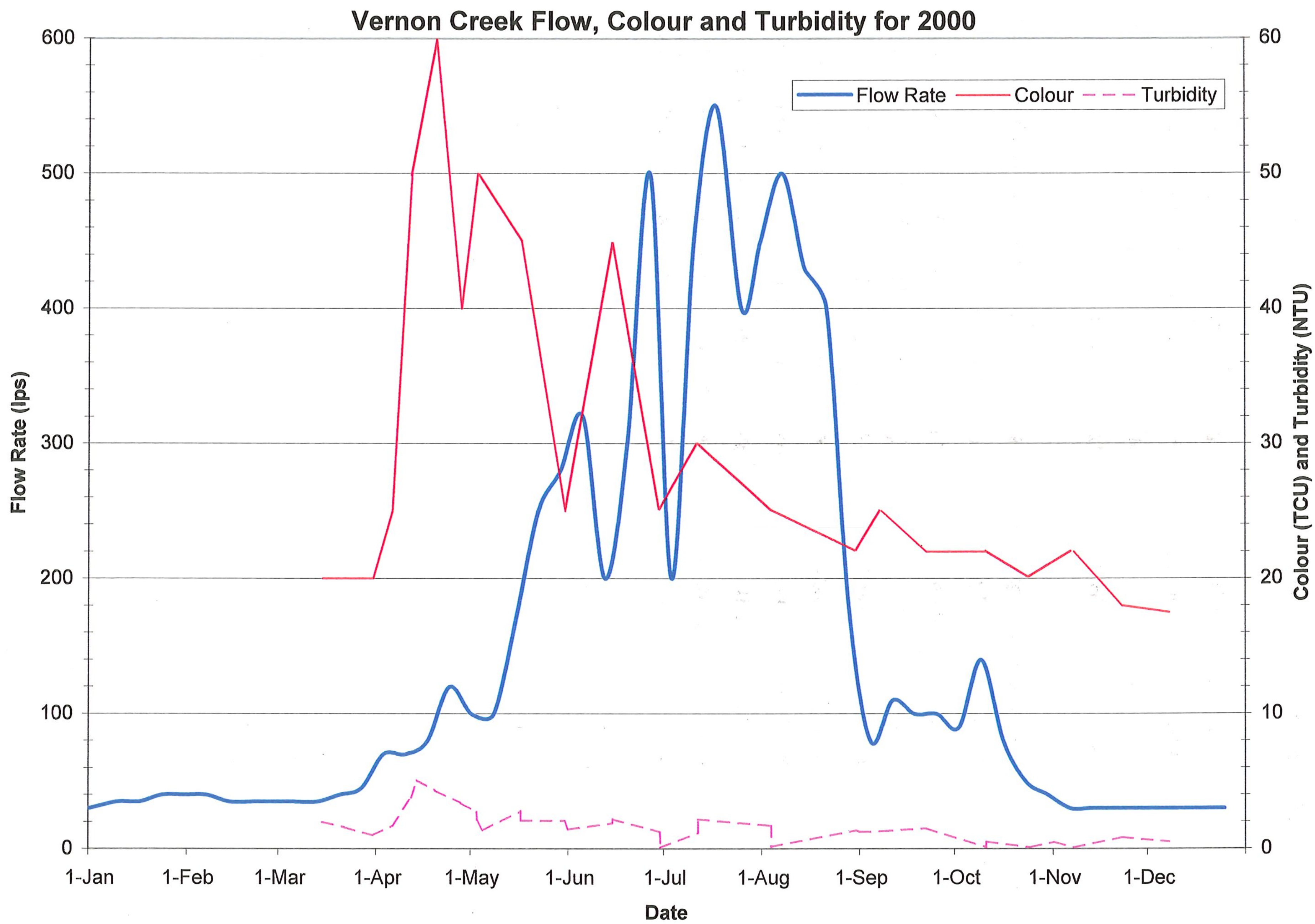
Unfortunately, the results of the grab sample data most likely provide a less severe representation of actual water quality conditions. This is a result of infrequent data collection. Storm events causing poor water quality could be a few days or as short as a few hours in duration. As the sampling frequency occurred approximately every two weeks, many storm events and poor water quality data were probably missed. The automated water quality data should provide a more accurate representation, and the proceeding results should be updated when this information is available.

Year round high colour in Vernon Creek stems from the runoff water filtering through the leaves, pine needles and soils on the forest floor. The soils are rich in organic content giving a tea-like colour to the water. Figure 5, opposite, gives a visual representation of the water colour. The lower section of Vernon Creek is situated in a steep-walled valley susceptible to slides, particularly during spring runoff. The high velocity and volume of water in the creek through the spring and summer months lead to high turbidity.

3.2 Okanagan Lake Water Quality

Okanagan Lake water is drawn into the pump station from 31 metres (102 feet) below the lake surface. This intake depth is likely below the thermocline zone, which results in excellent water quality throughout the seasons. As well, there are no significant creek discharges in the area, which can sometimes deteriorate water quality. A representative sample, shown opposite in Table 4, opposite page 26, Okanagan Lake water falls well within the GCDWQ.

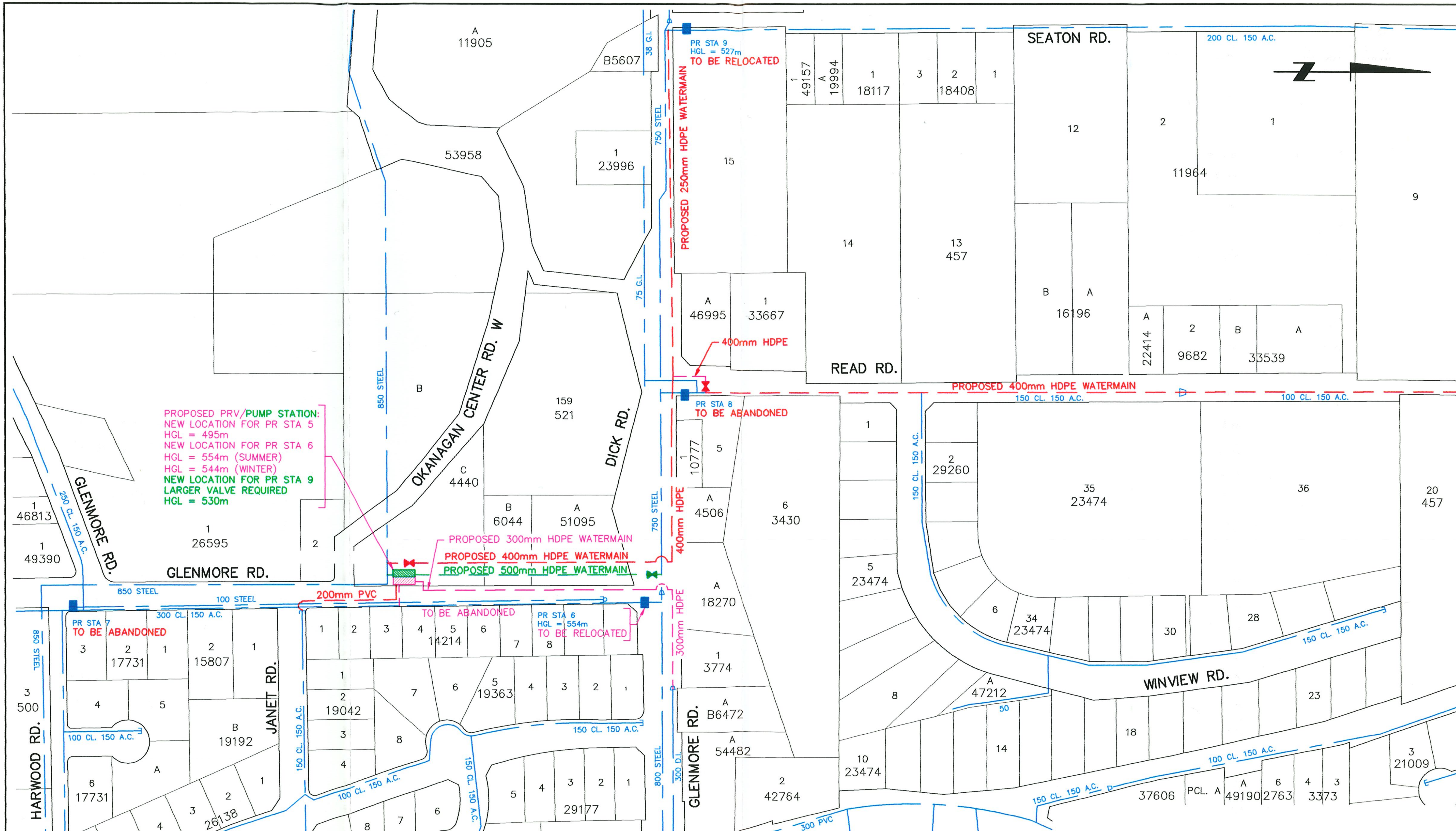
FIGURE 6


Vernon Creek Flow, Colour and Turbidity for 2000
Flow Rate
Colour
Turbidity
Flow Rate (lps)
Colour (TCU) and Turbidity (NTU)
Date
0
100
200
300
400
500
600
10
20
30
40
50
60
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec

3.3 *Correlation Between Water Quality and Water Use*

The purpose of this section is to outline the relationship between Vernon Creek water quality and the water use within the system. Understanding the relationship will assist with prioritizing and establishing water quality improvement projects that will be most beneficial.

Figure 6, on the opposite page plots water demand versus colour and turbidity for the Year 2000. Clearly, the severe colour and turbidity events in Vernon Creek occur during the spring when there is little demand in the water system. Periods of June and the beginning of July can be characterized with an increase in rainfall, and the graph shows the colour rises while the water use declines. If the Year 2000 is considered a typical year, good water quality at the rate of 300 l/s would be sufficient to supply the entire water system through the spring turbidity events. Additional water at a rate of approximately 400 l/s could meet the demand through the month of June when poor water quality events reoccur. Water demand typically exceeds 300 to 400 l/s from mid-June to the end of August.



DISTRICT OF LAKE COUNTRY

WATER QUALITY IMPROVEMENTS
PROPOSED PRV/PUMP STATION

SCALE 1:2500

FIGURE 7

Mould Engineering

LEGEND

- PHASE 1 PROPOSED WORKS
- PHASE 2 PROPOSED WORKS
- PHASE 4 PROPOSED WORKS

3.4 *WATER QUALITY IMPROVEMENTS*

Inclusive in this section are solutions to meet the water quality deficiencies. The works will improve the water quality to meet the GCDWQ for the existing users. As existing users should not be expected to bare costs for future users, the works have not been sized to allow for growth. The Infrastructure for New Development section will include costs to improve water quality for future users.

.1 *Okanagan Lake Reservoir Gravity Supply*

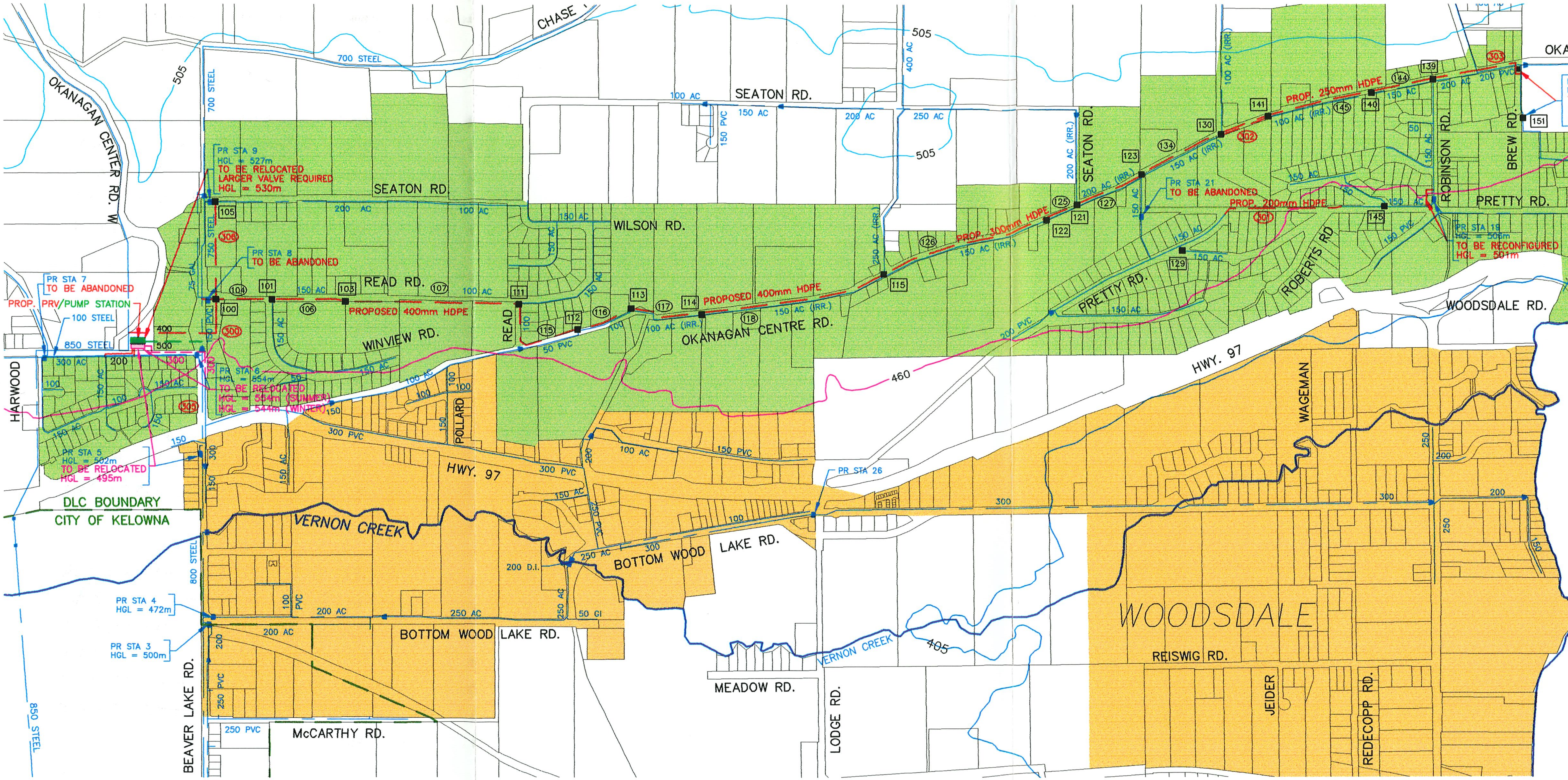
Following is a description of the areas that could receive a gravity or pressure reduced supply from the Okanagan Lake reservoir.

.1 *Phase 1 – Town Centre / Woodsdale*

Additional supply is required to improve the service for the Town Centre / Woodsdale areas. Okanagan Lake water is already conveyed to this area year round, however, the peak demand cannot be met. The deficiency is a result of the pressure loss that occurs through the single supply provided via the Jim Bailey Road pipeline.

Phase 1, as shown on Figure 7 opposite, involves the construction of a PR station on Glenmore Road near Okanagan Centre Road West. A pipeline will be installed from the 850 mm diameter Okanagan lake mainline to the 300 mm diameter pipe on Glenmore Road. These works will allow the abandonment of PR stations 5 and 6; the PR valves will be relocated to the new PR station. The new station will be large enough to house all works proposed at this location.

In addition to supplying the Town Centre / Woodsdale areas, approximately 90 users on Shanks and Glenmore Roads could also receive Okanagan Lake water. However, superior water quality can be provided for only eight or nine months of the year. This duration should be long enough to avoid supplying Vernon Creek water during spring



FEB. 2002

DISTRICT OF LAKE COUNTRY

WATER QUALITY IMPROVEMENTS
ANNUAL SUPPLY AREAS

FIGURE 8

Mould Engineering

SCALE: 1:10,000

LEGEND

EXISTING WATERMAIN	105 NODE
PHASE 1 PROPOSED WORKS	105 PIPE
PHASE 2 PROPOSED WORKS	TOWN CEN
PHASE 4 PROPOSED WORKS	OKANAGAN

3.4 *Water Quality Improvements*

Inclusive in this section are solutions to meet the water quality deficiencies. The works will improve the water quality to meet the GCDWQ for the existing users. As existing users should not be expected to bare costs for future users, the works have not been sized to allow for growth. The Infrastructure for New Development section will include costs to improve water quality for future users.

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Estimated Cost ***$241,000***

.2 *Phase 2 – Okanagan Centre Road*

The Okanagan Lake reservoir is well situated to supply this area year round without requiring pump or pressure reducing works on Glenmore Road. The Okanagan Centre Road area encompasses approximately 530 users, and is shaded in green on Figure 8, opposite. Thirty percent of the total domestic connections are accounted for in this phase.

Required works include installing a large diameter pipe along Read and Okanagan Centre Roads, from the Okanagan Lake mainline to Brew Road. Portions of the existing pipeline along Okanagan Centre Road will remain in service to supply the irrigation demand. Eight PR stations presently supply the area, of which four will be eliminated. A back up supply from Vernon Creek will be provided at two locations to ensure fire flow requirements are met. The proposed works and PR station changes are outlined in Figure 8 and Table 5.

The total length of pipeline to be installed is almost 4.9 kilometres, which includes the looping of segregated areas. The first of these is a 250 mm diameter pipe along Dyck Road between Read and Seaton Roads. It is a necessary installation for the removal of PR station 9 and provides additional capacity to Seaton Road. The second looping project is along Pretty Road, south of Roberts Road. A 200 mm diameter pipe installation will eliminate two dead-end watermains, and improve water quality and fire flow to the surrounding area. The third installation is on Okanagan Centre Road and connects the existing dead-end watermains

TABLE 5

PR Number	PR Station Name / Location	Valve Sizes (in)	ESI* D/S Pressure (psi)	ESI* D/S HGL (m)	New D/S Pressure (psi)	New D/S HGL (m)	Comments
Pressure Reducing Stations Water Quality Improvements							
1	Upper Range	12, 10, 8, 4	59	744			
2	Lower Range (Beaver Lake Rd)	12, 10, 8, 4	93	617			
3	Beaver Lake / Bottom Wood Lake Rd (East)	6, 2	90	486			
4	Beaver Lake / Bottom Wood Lake Rd (West)	6, 2	70	472			
5	Kobayashi - Beaver Lake Rd	4, 2	75	491	35	495	To be relocated
6	Glenmore Rd / Beaver Lake Rd	6, 2.5	133	554	120	554	To be relocated. Summer setting.
					105	544	Winter setting
7	Harwood Rd (Glenmore Rd)	6, 2	80	523			To be abandoned
8	Read Rd / Dyck Rd	3, 2	80	527			To be abandoned
9	Seaton Rd / Dyck Rd	4, 2	75	531	85	530	To be relocated, larger valve required
10	Bond Rd / Camp Rd	8, 3	50	568			
11	Tepper - Bond Rd / Davidson Rd	8, 6, 3	50	570			
12	Amundsen - McGowan Rd	4, 2	44	559			
13a	Brew Rd	4, 2	30	506	15	506	To be relocated
13b	Okanagan Centre Rd / Brew Rd				45	527	NEW
14	Camp Rd / Hare Rd	4, 2	50	426			
15	6th Street	4, 2	58	421			
16	Tyndall Rd	4, 2	40	553			
17	Dobson - Camp Rd	6, 2	70	478			
18	Davidson Rd / Camp Rd	6, 2, 1.5	41	527			
19	Robinson Rd / Pretty Rd	3, 2	77	506	70	501	To be relocated
20	Pretty Rd / Middleton Rd	2, 2	57	463	85	483	
21	Jardine Rd	4, 2	60	537			To be abandoned
22	Hikichi - Goldie Rd	6, 2	40	479			
23	McFarlane - Carrs Landing Rd	4, 1.5	83	450			
24	Jim Bailey Rd / Beaver Lake Rd	10, 8	85	493	80	489	
25	HRI - Jim Bailey Rd	8	75	496			
26	Taiji Ct	8, 2	OPEN				
27	Camp Rd / Tyndall Road	N/A	85	588			
28	Bond Rd / Lacresta Rd	N/A	40	528			
29	Dyck Rd / Chase Rd	N/A	105	576			

NOTE: Red text indicates change dependent upon new works completion

* ESI - Existing System Improvements, except where ESI setting changed upon relocation, then it is existing system.
That is, the settings here assume the ESI works have not been performed, other than the simple task of changing PR settings.

near Williams Road. Pressure zones downstream of PR stations 10 and 11 will then be integrated.

Estimated Cost ***$1,254,000***

.3 *Phase 3 – Okanagan Centre and Oceola Roads Interconnect*

The topography and water demand of Oceola, Goldie and Carr's Landing Roads will allow the 115 users to receive supply from Okanagan Lake reservoir for approximately eight months of the year, during non-irrigation times. A 200 mm diameter pipe, 390 m long, will connect the dead-end watermains on Okanagan Centre and Oceola Roads. Okanagan Lake water will then flow through the Phase 2 works to Oceola Road. The pipeline location and supply area is shown on Drawing No. DLC-109.

The pipeline is the only installation necessary for this phase. However, the installation of a PR station at the north-end of Bond Road should have been completed, as proposed in the Existing System Improvements section.

Estimated Cost ***$55,000***

.4 *Phase 4 – PR 22 and PR 17 Interconnect*

Similar to Phase 3, this project will supply 180 users in the Okanagan Centre area for approximately eight months of the year. Projects outlined in Phases 2 and 3 must be complete, along with a 200 mm diameter pipeline connecting PR station 22 and PR station 17. The pipeline will be approximately 850 m long and will require an easement across private property. The pipeline route and supply area is shown on Drawing No. DLC-109.

Estimated Cost ***$130,000***

.2 *Okanagan Lake Pumped Supply*

Outlined in this section are upgrades to the Okanagan Lake pump station, an ultraviolet (UV) disinfection facility, and a booster pump station on Glenmore Road. The location of the works are shown on Drawing No. DLC-109. Upon completion of these works, Okanagan Lake pump station will be fully utilized and half of the theoretical demand of the Winfield system could be supplied with superior water quality. Increasing the capacity of the pumping facility above the original design value of 464 lps is not recommended and will be discussed in the Infrastructure for New Development section. Following is a description of the works required to supply additional flow.

.1 *Okanagan Lake Pump Station*

The Okanagan lake pump station will require upgrading prior to servicing additional areas than those previously outlined in the Okanagan Lake Reservoir Gravity Supply section. The rebowled 350 hp pump in Okanagan Lake Pump Station supplies the majority of current water demands. The two 750 hp pumps are rarely used. In order to use the station to its full capacity, components installed in the 1970's will require upgrading to current standards. This will include replacement of the pump station control panel. As well, the intake screens located inside the station do not meet current Ministry of Water, Land and Air Protection standards. The screens are too coarse, do not provide sufficient surface area, and should likely be situated at the intake entrance, rather than in the wet well.

The second 750 hp pump (Pump #2) in the station is not equipped with a pump control valve, resulting in the entire volume of water being immediately directed into the mainline at start up. The resulting water hammer stresses the system unnecessarily. In general, the pump station is well built, however, some facilities could be damaged over time. It is recommended a variable frequency drive be installed on Pump #2 to gradually engage and disengage the motor on start-up and shutdown. As well, the 750 hp pumps should be removed, cleaned and serviced prior to full time use.

Furthermore, chlorine contact time provided during full capacity will be only nine minutes at the first distribution lateral, Stubbs Road. It is recommended the chlorine injection point be relocated from the wet well to the entrance of the intake pipe, which will increase the chlorine contact time to 15 minutes.

Estimated Cost ***$48,000***

.2 *Ultraviolet Disinfection Facility*

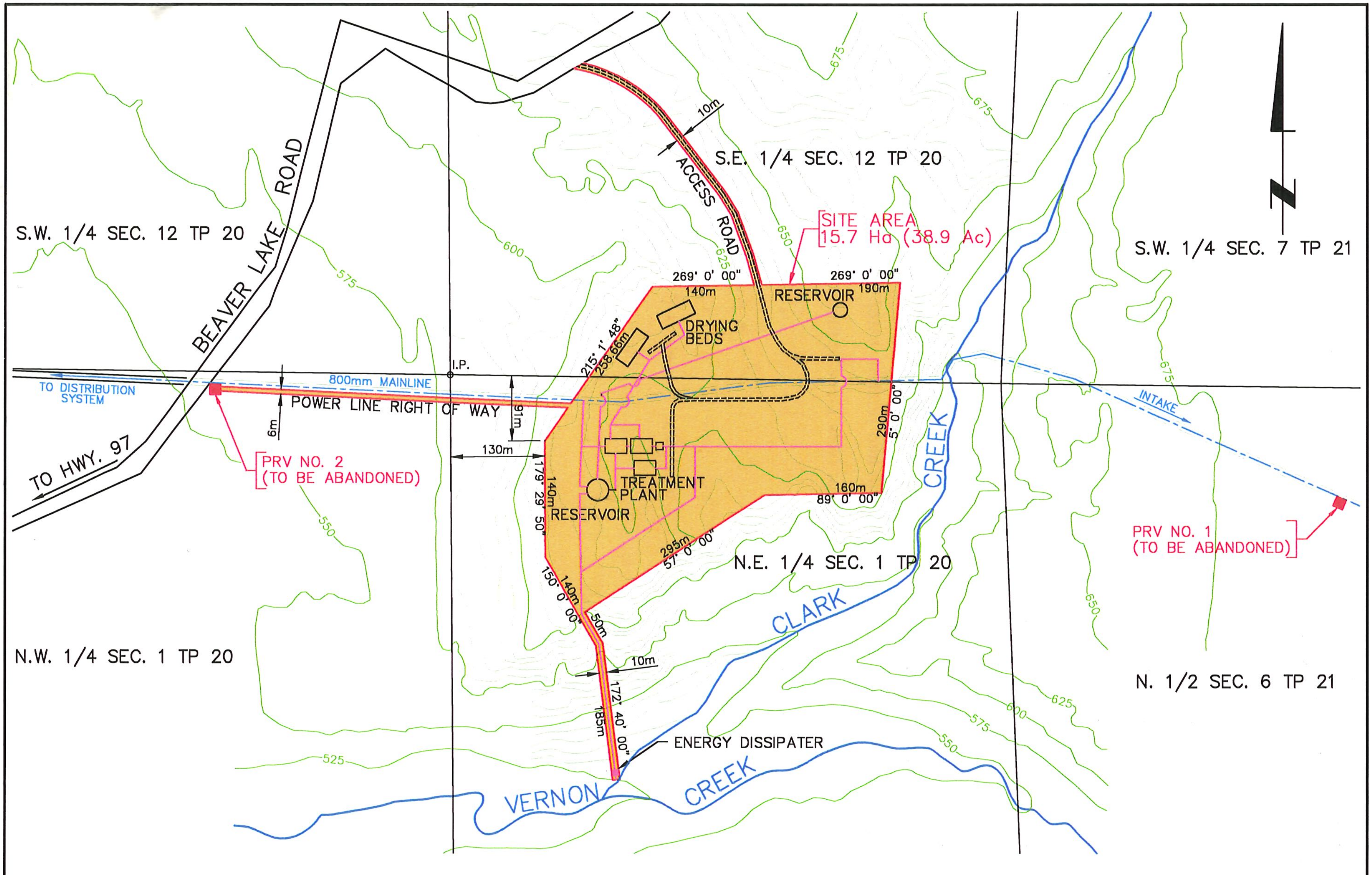
In order to qualify for Federal/Provincial Infrastructure Funding of Water Quality Improvement projects, proposed water treatment facilities must achieve 3.0 log removal of giardia cysts, and 4.0 log removal of viruses and bacteria. This requirement is not currently met by the Okanagan Lake pump station chlorine disinfection facility. Proposed is an UV disinfection facility located at the Okanagan Lake reservoir, which will meet the requirement and achieve a multi-barrier approach to disinfection. UV disinfection is relatively inexpensive, no additional chemicals are added to the water, and the exceptional clarity of Okanagan Lake water makes this process an optimal solution.

Estimated Cost ***$940,000***

.3 *Glenmore Road Pump Station*

The purpose of this installation is to supply Okanagan Lake water to the upper pressure zones of the Winfield system. The booster pumps total 350 hp and will be housed in the proposed PR station on Glenmore Road near Okanagan Centre Road West (see Section 3.4.1). Sized for a maximum flow of 200 lps (3,200 USgpm), the facility will be able to meet the water demands for approximately 8 months, from mid-September to mid-May. The pumps will boost into the mainline and operation will be controlled by the proposed Vernon Creek reservoir. The pumping facility will provide many operating options, and act as a secondary source in times of emergency or maintenance.

The pump station could be increased in size to 300 lps (4,800 USgpm), which will add capital and operating costs, but will supply the upper pressure zones for approximately four additional weeks each year. However, if growth occurs as expected in the Town Centre / Woodsdale areas, the supply to the pump station will slowly diminish to 200 lps over approximately 20 years. Growth and related water supply issues will be discussed in the Infrastructure for New Development section.



FEB. 2002

DISTRICT OF LAKE COUNTRY

PROPOSED WATER TREATMENT FACILITY

SCALE: 1:7,500

FIGURE 9

Mould Engineering

.3 *Vernon Creek Water Treatment Facility*

In conjunction with the preceding projects, a water treatment facility is needed on the Vernon Creek supply main to provide superior water quality year round. The proposed water treatment facility meets the requirements to obtain Federal/Provincial Infrastructure Funding.

The facility will be designed to supply 440 lps (7,000 USgpm) and will be located at the proposed Vernon Creek reservoir site, as shown on Figure 9, opposite.

The treatment process involves flocculation, clarification, and filtration. Additional required works include construction and operation of a pilot plant; a treated water reservoir; a backwash water storage reservoir, and sludge storage ponds. Pilot studies are needed to determine the best treatment process. The cost estimate outlined in Section 3 of Annex 4 is based on a dissolved air flotation or settling process. A schematic of the processes is enclosed in Annex 9.

Estimated Cost ***$8,400,000***

3.5 *Separate Domestic System*

The merits of a separate domestic system have been analyzed and cost estimates prepared. The system could provide year round domestic water from Okanagan Lake. The extent of the separate system does not include the Town Centre / Woodsdale areas already supplied by Okanagan Lake, or the Okanagan Centre Road area discussed in Phase Two of Water Quality Improvements

For the purposes of this discussion, the term "domestic" is used for normal residential water uses including outside demand, such as irrigation of lawns and gardens up to 0.2 hectares (0.5 acres) in size.

The domestic system consists of the following works.

- A 5.0 million litre balancing reservoir complete with valve chamber and overflow piping to be constructed on the hillside, west of Dick Road;
- Seven PR stations;
- 15 air valve chambers;
- Approximately 21.5 kilometres of new watermain, ranging in size from 500 mm to 100 mm diameter and;
- Cross connection control devices.

The total estimated cost of a separate domestic system to supply superior water quality year round is $10,950,000. Details of the estimate are contained in Annex 5. The estimate includes the total values from the Okanagan Lake Reservoir Gravity Supply and the Okanagan Lake Pumped Supply. The works outlined in these two sections are necessary to complete the separate domestic system. The cost estimate does not include land acquisition for the reservoir site or subsurface materials, such as bedrock or groundwater that may be encountered during construction. Based on limited design and field work, the estimate should be considered preliminary.

Estimated Cost ***$10,950,000***

The advantages of a separate domestic system are as follows:

- The estimated cost is $2,580,000 less than the works outlined in the Water Quality Improvements section. The cost saving are $1,150,000 between the separate domestic system and the Vernon Creek water treatment facility. The remaining $1,430,000 cost savings are a result of not needing to replace approximately seven kilometres of 100 mm diameter pipe, as included in the Existing System Improvements Section.
- There will be no treatment plant to operate and maintain, eliminating the need for specialized staff.
- No additional chemicals will be added to the water.

The disadvantages of a separate domestic system are as follows:

- The new works will essentially add another underground utility for the District of Lake Country to protect, operate, maintain, and upgrade as growth occurs.
- Accurate identification will be required for domestic pipelines versus irrigation pipelines, likely requiring the use of a special pipe type and exterior colour for all new domestic system installations.
- There is an inherent potential for cross connections between the domestic system and the irrigation system.
- There will be an additional 21.5 kilometres of pipe and seven PR stations to operate.
- The capacity of the Okanagan Lake Pump Station is expected to be exceeded in approximately twenty years. At this time, either a new lake pump station, mainline, and reservoir will need to be constructed, or treatment of Vernon Creek water will need to begin.
- The accuracy of water system mapping will need to be increased considerably, so when the new services are installed the correct pipe is exposed and tapped.
- The cost of servicing developments will increase, as there will be two pipelines to upgrade and extend.

- Removal of the domestic flows from the existing irrigation system will result in surplus distribution system capacity, water licenses, and mountain storage. If there is no growth in the irrigation sector, the surplus will remain.
- The works outlined in the Existing System Improvements section will still be required, other than the $1,430,000 to replace 100 mm diameter pipe.

3.6 COST ESTIMATE SUMMARY

The estimated cost of the works required to improve the water quality to meet the GCDWQ is summarized below. Details of the estimates are contained in Annex 4. The cost estimates do not included land acquisition, are based on limited design and fieldwork, and should therefore be considered preliminary. Subsurface materials, such as bedrock or groundwater that may be encountered during construction, have not been included in the estimates.

Water Quality Improvements

1.	Okanagan Lake Reservoir Gravity Supply	
	1.1 Phase 1 – Town Centre / Woodsdale	$ 241,000
	1.2 Phase 2 – Okanagan Centre Road	$1,254,000
	1.3 Phase 3 – Okanagan Centre & Oceola Road Interconnect	$ 55,000
	1.4 Phase 4 – PR 22 & PR 17 Interconnection	$ 130,000
	1.5 Total	***$1,680,000***
2.	Okanagan Lake Pumped Supply	***$2,020,000***
3.	Vernon Creek Water Treatment Facility	***$8,400,000***
4.	TOTAL	$12,100,000

3.7 ANNUAL COSTS

The estimated annual costs of constructing, operating and maintaining the Glenmore Road Pumping facilities, plus the additional costs required to operate the Okanagan Lake pump station are shown in Table 6. Only the power costs for the Okanagan Lake station are shown, as the maintenance and operating costs will essentially be the same as current costs. The costs of operating the Okanagan Lake and Glenmore Road pump station will vary widely from one year to another, as pumping rates are dependent on weather and water quality. For the purposes of calculating the power rates, Year 2000 flow values (shown in Figure 6) have been used, as it is considered an average year. The annual costs have not been estimated for the Vernon Creek water treatment facility, as the most economical treatment process is unknown at this time.

Annual debt payments assume the capital cost will be financed through a Municipal Finance Authority debenture issue, amortized over 20 years with an interest rate of 5%. Following are two options for which the annual costs have been estimated:

- **Option 1**
  Construct the Okanagan Lake Reservoir Gravity Supply and Okanagan Lake Pumped Supply works, other than the Phase 4 Interconnect and the Ultraviolet Disinfection Facility ($2,630,000 capital cost). Operate the pump stations to supply through April, May, and June (approximately 90% demand).
- **Option 2**
  Same works as Option 1 ($2,630,000 capital cost) but operate the pump stations to supply as much demand as possible.

Table 6
Annual Costs – Year 2002

Option Number	**1**	**2**
1. Okanagan Lake		
a) Increased Power	$44,900	$136,500
2. Glenmore Road		
a) Power	17,900	49,100
b) Maintenance	800	3,200
c) Operations	1,200	4,800
3. Annual Debt Payment	207,400	207,400
4. Total	***272,200***	***401,000***
5. Equivalent Rural Residential Connections	1,830	1,830
6. Increased Annual Cost per Connection	149	219

3.8 CONCLUSIONS AND RECOMMENDATIONS

These conclusions and recommendations are made following an analysis of the water quality within the Winfield system.

.1 The Vernon Creek water quality consistently fails to meet the Guidelines for Canadian Drinking Water Quality (GCDWQ), while the Okanagan Lake source always meets the criteria.

.2 The worst water quality problems in Vernon Creek occur in the Spring, or during major storm events. During this period, the demand in the system is less than the peak water use. Colour and turbidity are the main problems, with colour averaging 35 TCU over the year and turbidity averaging 3.3 NTU. Colour is an aesthetic problem, but turbidity is both an aesthetic and a health problem as suspended particulate matter shields pathogens from the disinfection process.

.3 The Health Officer has issued ten Boil Water Advisories on the Winfield System over the past eight years. An analysis of the drinking water bacteriological report for the years 1994 to 2000, indicate three samples contained faecal coliforms, 23 samples contained total coliforms, and eight samples contained more than ten coliforms per 100 millilitres.

.4 Good water quality is available from Okanagan Lake and the existing pumping facility has surplus capacity, however, only enough for half the peak demand (464 lps). It is recommended this source be used to improve water quality for domestic use.

.5 The theoretical peak demand of the users is 900 lps, of which approximately 65% is the irrigation component and 35% is the domestic component. The irrigation demand occurs from approximately June to August. The demand for the remainder of the year could be supplied from Okanagan Lake via the proposed pumping and gravity supply works. The estimated cost of these works is $3,700,000.

6. The proposed PR / pumping facility on Glenmore Road is a key component in the Master Plan. It is recommended the District of Lake Country representatives begin negotiations to secure a suitable site for the facility.

7. In order to provide the entire peak demand (900 lps) of the Winfield system with superior water quality, a treatment facility is also required on the Vernon Creek mainline. The facility will be located at the site of the proposed Vernon Creek reservoir and is estimated to cost $8,400,000. It is recommended the District of Lake Country representatives begin negotiations to secure a suitable site.

8. Prior to determining the final treatment process for the Vernon Creek water source, pilot studies must be completed. Piloting should be conducted for a duration of three to six months, and should include a spring freshet event. The time required between the pilot study and the construction of a treatment facility would be approximately two years.

9. The feasibility and estimated cost of installing a separate domestic system has been reviewed. The estimated cost to install a separate domestic system is $10,950,000. The capital cost is $2,580,000 less than the recommended Water Quality Improvements, however, there are numerous complications and future costs related to a separate domestic system.

10. The option of piping water from Beaver Lake to the proposed Vernon Creek Reservoir has been reviewed, but the water quality benefits do not meet the improvement objectives. Further study is warranted though, as significant revenues could be obtained from this project by generating power.

ANNEX 1

Existing System Improvements
Cost Estimate

ANNEX 1
MASTER WATER SERVICING PLAN

EXISTING SYSTEM IMPROVEMENTS
COST ESTIMATES

1. *VERNON CREEK*

1.1 *Intake Screens*

.1	Bypass Works	$ 17,000
.2	Excavation & Sharing	$ 5,000
.3	Concrete Structural Works	$ 14,000
.4	Screens (12 m^2)	$ 15,000
.5	Mechanical Works	$ 20,000
.6	Gate Actuator , Telemetry, Level Sensor	$ 20,000
.7	*Sub-total*	*$ 91,000*
.8	Engineering & Contingencies @ 25%	$ 23,000
.9	District Administration @ 10%	$ 11,000
.10	**TOTAL**	**$ 125,000**

2. *MAINLINE CORROSION PROTECTION* — **TOTAL** — **$ N/A**

3. *VERNON CREEK RESERVOIR & DISINFECTION FACILITY*

3.1 *Storage / Balancing Reservoir*

.1	Access Road and Fencing	$ 30,000
.2	Excavation:	
	Cut: 55,000 m^3 @ $5/ m^3	$ 275,000
	Fill: 55,000 m^3 @ $9/ m^3	$ 495,000
.3	Concrete Headwall	$ 15,000
.4	Sluice Gate	$ 23,000
.5	Overflow:	
	.1 500 mm HDPE, 200 m @ $200/m	$ 40,000
	.2 300 mm HDPE, 300 m @ $185/m	$ 55,000
.6	Clark Creek Energy Dissipater	$ 50,000
.7	Miscellaneous Onsite Piping:	
	.1 800 mm HDPE, 350 m @ $250/m	$ 88,000
	.2 Mainline Tie-Ins, 2 @ $10,000	$ 20,000
.8	*Sub-total*	*$1,091,000*
.9	Engineering & Contingencies @ 25%	$ 272,750
.10	District Administration @ 10%	$ 136,250
.11	**Sub-total**	**$1,500,000**

3.2 *Energy Dissipator @ Balancing Reservoir*

.1	Excavation & Backfill	$ 15,000
.2	Concrete Structure	$ 55,000
.3	Steel Piping	$ 10,000
.4	Valves and Fittings	$ 21,000
.5	Miscellaneous Metalwork	$ 8,000
.6	*Sub-total*	*$ 109,000*
.7	Engineering & Contingencies @ 25%	$ 27,000
.8	District Administration @ 10%	$ 14,000
.9	**Sub-total**	**$ 150,000**

3.3 *Chlorinator*

.1	Excavation & Site Preparation	$ 5,000
.2	Building, 90 m^2 @ $600/$m^2$	$ 54,000
.3	Chlorination System	$ 60,000
.4	Piping & Flow Meter	$ 40,000
.5	Site Power Supply	$ 30,000
.6	Electrical Equipment	$ 25,000
.7	Backfilling & Landscaping	$ 4,000
.8	*Sub-total*	*$ 218,000*
.9	Engineering & Contingencies @ 25%	$ 54,500
.10	District Administration @ 10%	$ 27,500
.11	**Sub-total**	**$ 300,000**

3.4 *Abandoning of PR's 1 & 2*

.1	Abandon PR 1	$ 10,000
.2	Abandon PR 2	$ 18,000
.3	Mainline Air Valve Replacement, 2 @ $4,000	$ 8,000
.4	*Sub-total*	*$ 36,000*
.5	Engineering & Contingencies @ 25%	$ 9,000
.6	District Administration @ 10%	$ 5,000
.7	**Sub-total**	**$ 50,000**

3.5	**TOTAL**	**$2,000,000**

4. *PR STATIONS*

.1	Abandon PR's 3,4, 25 & 26	$ 16,000
.2	Upsize PR's 5, 15, 19 & Reconfigure PR 24	$ 40,000
.3	Relocate PR's 12 & 23	$ 85,000
.4	New PR's 27, 28 & 29	$ 135,000
.5	Upgrade Remaining PR Stations, 10 @ $4,000	$ 50,000
.6	*Sub-total*	*$ 326,000*
.7	Engineering & Contingencies @ 25%	$ 82,000
.8	District Administration @ 10%	$ 42,000
.9	**TOTAL**	**$ 450,000**

5. *DISTRIBUTION SYSTEM*

5.1 *100 mm Diameter Pipe Replacement*

.1	150 mm PVC Pipe, 7,000 @ $90/m	$ 630,000
.2	Valves and Fittings	$ 162,500
.3	Service Reconnections:	
	.1 Domestic, 270 @ $500	$ 135,000
	.2 Irrigation, 60 @ $750	$ 45,000
.4	Fire Hydrant Reconnections, 25 @ $2,000	$ 50,000
.5	Air Valves, 5@ $3,500	$ 17,500
.6	*Sub-total*	*$1,040,000*
.7	Engineering & Contingencies @ 25%	$ 260,000
.8	District Administration @ 10%	$ 130,000
.9	**Sub-total**	**$1,430,000**

5.2 *McCoubry Road Supply Main*

.1	250 mm PVC Pipe, 970 m @ $130/m		$ 126,000
.2	Valves & Fittings		$ 18,000
.3	PR Station		$ 45,000
.4	Service Reconnections		
	.1 Domestic 2 @ $500		$ 1,000
	.2 Irrigation 3 @ $750		$ 2,500
.5	Air Valve Assembly, 1 @ $3,500		$ 3,500
.6	*Sub-total*		*$ 196,000*
.7	Engineering & Contingencies @ 25%		$ 49,000
.8	District Administration @ 10%		$ 25,000
.9		**Sub-total**	**$ 270,000**

5.3 *Hare Road Watermain Upgrade*

.1	200 mm PVC Pipe, 350 m @ $110/m		$ 38,500
.2	Valves & Fittings		$ 5,500
.3	Service Reconnections		
	.1 Domestic, 9 @ $500		$ 4,500
	.2 Irrigation, 8 @ $750		$ 6,000
.4	*Sub-total*		*$ 54,500*
.5	Engineering & Contingencies @ 25%		$ 13,500
.6	District Administration @ 10%		$ 7,000
.7		**Sub-total**	**$ 75,000**

5.4 TOTAL $1,775,000

6. EXISTING SYSTEM IMPROVEMENTS GRAND TOTAL $4,350,000

ANNEX 2

Distribution System Analysis

1. **Existing System Modeled at 75% of Theoretical – Peak Hour Demand**

2. **Existing System with the Vernon Creek Source at 428 lps, Calibrated to Match Field Conditions on August 8, 2001**

District of Lake Country
Existing System
Modeled at 75% of Theoretical Peak Hour
February 2002

PIPE TABLE										
Pipe	Up Node	Down Node	Length m	Diameter mm	Roughness C	Flow l/s	Velocity m/sec	HeadLoss m	Status	Pipe Description
1	1	2	2182	800	90	729.7	1.5	9.41	Open	
2	2	3	10	300	80	729.7	10.3	65.91	Open	PR1
3	3	4	1044	800	100	729.7	1.5	3.70	Open	
4	4	5	537	800	100	729.7	1.5	1.90	Open	
5	5	6	10	300	80	729.7	10.3	121.30	Open	PR2
6	6	7	1615	800	100	729.7	1.5	5.73	Open	
7	7	9	10	250	120	0.0	0.0	0.00	Closed	PR24
9	9	10	389	250	140	8.3	0.2	0.05	Open	
10	9	11	292	250	140	75.9	1.5	2.43	Open	
11	11	12	524	250	140	8.3	0.2	0.07	Open	
12	11	13	147	250	140	66.3	1.4	0.95	Open	
13	13	15	104	200	140	66.0	2.1	1.97	Open	
14	7	14	562	800	100	729.7	1.5	1.99	Open	
15	14	15	10	150	100	0.0	0.0	0.00	Closed	PR3
16	14	16	10	150	100	6.5	0.4	137.20	Open	PR4
17	15	18	495	200	130	63.7	2.0	10.11	Open	
18	16	17	245	200	130	6.5	0.2	0.07	Open	
19	17	19	250	200	130	4.9	0.2	0.04	Open	
20	18	20	585	250	130	60.3	1.2	3.64	Open	
21	19	20	660	200	140	0.0	0.0	0.00	Closed	
22	20	21	236	250	130	54.1	1.1	1.20	Open	
23	21	22	60	250	130	18.1	0.4	0.04	Open	
24	22	23	507	100	130	3.8	0.5	1.64	Open	
25	22	24	513	300	130	8.4	0.1	0.03	Open	
26	24	25	10	200	100	5.3	0.2	14.72	Open	PR26
27	25	26	922	300	130	5.2	0.1	0.02	Open	
28	26	27	528	300	130	5.0	0.1	0.01	Open	
29	27	28	197	300	130	2.4	0.0	0.00	Open	
30	28	29	214	250	130	0.4	0.0	0.00	Open	
31	28	30	253	200	130	1.9	0.1	0.01	Open	
32	30	31	207	150	130	0.6	0.0	0.00	Open	
33	28	32	198	250	130	0.2	0.0	0.00	Open	
34	14	33	465	800	100	723.3	1.4	1.62	Open	
35	33	34	10	100	100	0.0	0.0	0.00	Closed	PR5
36	34	35	168	200	140	0.5	0.0	0.00	Open	
37	34	36	119	300	120	-4.1	-0.1	0.00	Open	
38	36	37	221	300	140	-5.4	-0.1	0.01	Open	
39	37	38	195	150	130	0.5	0.0	0.00	Open	
40	37	39	44	300	140	-9.7	-0.1	0.00	Open	
41	39	40	391	300	140	-12.6	-0.2	0.05	Open	
42	40	41	365	300	140	-22.4	-0.3	0.13	Open	
43	41	42	71	250	140	-34.6	-0.7	0.14	Open	
44	42	21	145	250	140	-36.0	-0.7	0.30	Open	
45	42	43	240	200	140	1.4	0.0	0.00	Open	
46	41	44	104	200	140	5.7	0.2	0.02	Open	
47	44	45	255	100	130	5.7	0.7	1.75	Open	
48	45	46	356	150	140	3.9	0.2	0.14	Open	
49	39	47	414	100	130	0.7	0.1	0.05	Open	
50	47	48	68	100	130	-1.3	-0.2	0.03	Open	
51	48	40	139	150	140	-4.4	-0.2	0.07	Open	
52	47	49	195	100	130	2.0	0.3	0.19	Open	
53	33	50	238	800	100	723.3	1.4	0.83	Open	
54	50	51	10	150	100	95.6	5.4	53.41	Open	PR6
55	51	52	388	300	130	94.0	1.3	2.26	Open	
56	52	53	10	150	100	61.3	3.5	40.86	Open	PR7
57	53	54	392	100	100	0.3	0.0	0.01	Open	
58	53	55	197	150	130	6.7	0.4	0.25	Open	
59	55	56	174	150	130	4.0	0.2	0.09	Open	
60	56	57	130	150	130	1.2	0.1	0.01	Open	

PIPE TABLE

Pipe	Up Node	Down Node	Length m	Diameter mm	Roughness C	Flow l/s	Velocity m/sec	HeadLoss m	Status	Pipe Description
61	56	58	145	100	130	2.0	0.3	0.14	Open	
62	58	59	122	150	130	0.8	0.0	0.00	Open	
63	53	60	163	250	130	52.0	1.1	0.77	Open	
64	60	61	280	250	130	45.3	0.9	1.03	Open	
65	61	62	484	200	130	30.5	1.0	2.52	Open	
66	62	63	266	150	130	18.2	1.0	2.16	Open	
67	63	64	290	100	130	8.5	1.1	4.13	Open	
68	64	65	180	100	130	2.0	0.3	0.18	Open	
69	52	66	475	250	130	32.8	0.7	0.95	Open	
70	66	67	681	250	130	20.5	0.4	0.57	Open	
71	67	68	134	150	140	6.0	0.3	0.12	Open	
72	68	69	96	150	140	5.6	0.3	0.08	Open	
73	69	70	178	150	140	1.7	0.1	0.02	Open	
74	67	71	186	50	140	2.4	1.2	6.65	Open	
75	67	72	138	150	130	1.8	0.1	0.02	Open	
76	72	73	165	150	140	0.9	0.1	0.00	Open	
77	74	75	695	850	100	-34.5	-0.1	0.01	Open	
78	75	76	52	300	100	123.1	1.7	0.81	Open	
79	76	77	10	200	100	123.1	3.9	28.20	Open	PR25
80	75	78	71	850	100	-157.6	-0.3	0.01	Open	
81	77	9	674	250	140	91.7	1.9	7.94	Open	
82	78	79	766	850	100	-165.1	-0.3	0.13	Open	
83	79	80	737	850	100	-165.1	-0.3	0.12	Open	
84	80	81	286	850	100	-165.1	-0.3	0.05	Open	
85	81	82	614	850	100	-165.1	-0.3	0.10	Open	
86	82	83	496	850	100	-165.5	-0.3	0.08	Open	
87	83	84	342	200	130	3.9	0.1	0.04	Open	
88	84	85	146	150	140	1.0	0.1	0.01	Open	
89	84	86	388	200	130	1.3	0.0	0.01	Open	
90	83	87	69	850	100	-169.4	-0.3	0.01	Open	
91	87	88	214	850	100	-68.0	-0.1	0.01	Open	
92	87	89	409	850	100	-102.3	-0.2	0.03	Open	
93	89	90	149	850	100	-102.9	-0.2	0.01	Open	
94	90	91	196	200	140	2.3	0.1	0.01	Open	
95	91	92	492	200	140	1.9	0.1	0.01	Open	
96	90	93	99	850	100	-105.2	-0.2	0.01	Open	
97	93	94	343	850	100	-105.5	-0.2	0.03	Open	
98	50	95	148	750	100	627.7	1.4	0.54	Open	
99	95	96	258	750	100	604.2	1.4	0.88	Open	
100	96	97	411	700	100	572.0	1.5	1.78	Open	
101	97	98	664	700	100	565.7	1.5	2.82	Open	
102	98	99	801	700	100	555.2	1.4	3.28	Open	
103	95	100	10	75	100	23.5	5.3	93.19	Open	PR8
104	100	101	177	150	130	19.0	1.1	1.56	Open	
105	101	102	334	150	130	3.0	0.2	0.10	Open	
106	101	103	176	150	130	12.9	0.7	0.76	Open	
107	103	104	473	100	130	5.1	0.6	2.62	Open	
108	96	105	10	100	100	32.2	4.1	78.27	Open	PR9
109	105	106	398	200	130	24.8	0.8	1.42	Open	
110	106	107	446	100	130	14.1	1.8	16.27	Open	
111	107	108	108	150	130	12.1	0.7	0.41	Open	
112	108	109	186	150	130	2.2	0.1	0.03	Open	
113	108	110	97	150	130	9.2	0.5	0.22	Open	
114	110	111	367	150	130	5.6	0.3	0.34	Open	
115	111	112	258	100	130	4.3	0.6	1.05	Open	
116	112	113	175	100	130	0.0	0.0	0.00	Closed	
117	113	114	188	100	130	-8.3	-1.1	2.60	Open	
118	114	115	493	150	130	-22.9	-1.3	6.14	Open	
119	115	116	462	250	130	-45.5	-0.9	1.70	Open	
120	116	117	329	200	130	19.1	0.6	0.72	Open	
121	117	118	184	150	130	6.1	0.3	0.19	Open	
122	118	119	82	100	130	2.3	0.3	0.11	Open	
123	116	120	462	250	130	42.6	0.9	1.51	Open	
124	120	121	247	200	130	32.2	1.0	1.42	Open	
125	121	122	110	150	130	-2.4	-0.1	0.02	Open	

PIPE TABLE										
Pipe	Up Node	Down Node	Length m	Diameter mm	Roughness C	Flow l/s	Velocity m/sec	HeadLoss m	Status	Pipe Description
126	122	115	436	150	130	-10.2	-0.6	1.21	Open	
127	121	123	185	200	130	30.2	1.0	0.95	Open	
128	123	124	97	150	130	13.4	0.8	0.44	Open	
129	124	125	10	100	100	13.4	1.7	31.31	Open	PR21
130	125	126	115	150	130	13.4	0.8	0.53	Open	
131	126	127	290	150	130	10.4	0.6	0.84	Open	
132	127	128	406	150	130	6.0	0.3	0.42	Open	
133	126	129	87	150	130	2.2	0.1	0.01	Open	
134	123	130	238	150	130	10.5	0.6	0.70	Open	
135	130	131	341	100	130	6.0	0.8	2.57	Open	
136	131	132	17	100	130	0.0	0.0	0.00	Closed	
137	132	133	431	100	130	-3.6	-0.5	1.23	Open	
138	133	134	130	100	130	-7.7	-1.0	1.54	Open	
139	134	135	340	150	140	-13.1	-0.7	1.30	Open	
140	135	136	10	200	100	197.1	6.3	14.58	Open	PR11
141	136	137	278	250	130	76.6	1.6	2.70	Open	
142	137	138	236	250	130	68.5	1.4	1.85	Open	
143	138	139	122	200	130	31.5	1.0	0.67	Open	
144	139	140	163	150	130	11.2	0.6	0.54	Open	
145	140	141	277	100	130	5.5	0.7	1.74	Open	
146	139	142	227	150	130	18.9	1.1	1.97	Open	
147	142	143	95	150	130	15.0	0.9	0.54	Open	
148	143	144	10	75	100	15.0	3.4	63.31	Open	PR19
149	144	145	140	150	130	5.2	0.3	0.11	Open	
150	145	146	182	150	130	3.0	0.2	0.05	Open	
151	144	147	243	150	140	3.2	0.2	0.07	Open	
152	144	148	361	150	130	3.0	0.2	0.10	Open	
153	138	149	112	200	140	32.8	1.0	0.58	Open	
154	149	150	125	200	140	14.0	0.4	0.13	Open	
155	150	151	10	100	100	14.0	1.8	65.32	Open	PR13
156	151	152	246	200	140	14.0	0.4	0.26	Open	
157	152	153	341	200	140	12.1	0.4	0.28	Open	
158	153	148	270	150	130	1.1	0.1	0.01	Open	
159	153	154	10	100	100	8.1	1.0	42.47	Open	PR20
160	154	155	179	200	140	7.4	0.2	0.06	Open	
161	155	156	306	100	140	1.3	0.2	0.11	Open	
162	149	157	400	150	130	11.5	0.7	1.40	Open	
163	136	158	260	400	130	119.1	0.9	0.58	Open	
164	158	159	60	400	130	110.0	0.9	0.12	Open	
165	159	162	240	400	130	101.8	0.8	0.40	Open	
166	159	160	135	150	130	7.6	0.4	0.22	Open	
167	160	161	127	150	130	5.8	0.3	0.13	Open	
168	161	162	209	150	130	2.8	0.2	0.05	Open	
169	162	164	200	400	130	95.5	0.8	0.30	Open	
170	162	163	168	150	130	4.4	0.2	0.10	Open	
171	163	164	277	100	130	1.7	0.2	0.20	Open	
172	164	165	164	400	130	92.9	0.7	0.23	Open	
173	165	166	259	200	130	26.5	0.8	1.04	Open	
174	166	167	427	200	140	7.0	0.2	0.13	Open	
175	166	168	169	200	130	17.4	0.6	0.31	Open	
176	168	169	655	150	130	12.3	0.7	2.58	Open	
177	165	170	830	300	130	61.9	0.9	2.23	Open	
178	170	171	10	150	100	43.4	2.5	81.35	Open	PR22
179	171	172	352	250	130	43.4	0.9	1.19	Open	
180	172	173	548	200	130	31.9	1.0	3.10	Open	
181	173	174	10	100	100	23.2	3.0	37.34	Open	PR23
182	174	175	177	200	130	23.2	0.7	0.56	Open	
183	175	176	601	150	130	20.6	1.2	6.16	Open	
184	176	177	141	100	130	6.3	0.8	1.16	Open	
185	177	178	240	100	130	6.3	0.8	1.99	Open.	
186	176	179	201	150	130	11.6	0.7	0.71	Open	
187	179	180	549	100	130	8.5	1.1	7.85	Open	
188	180	181	142	100	130	3.4	0.4	0.37	Open	
189	99	182	273	700	100	542.9	1.4	1.07	Open	
190	182	183	324	150	130	1.5	0.1	0.03	Open	

PIPE TABLE

Pipe	Up Node	Down Node	Length m	Diameter mm	Roughness C	Flow l/s	Velocity m/sec	HeadLoss m	Status	Pipe Description
191	182	184	428	150	130	7.4	0.4	0.65	Open	
192	182	185	395	700	100	526.6	1.4	1.47	Open	
193	185	186	10	200	100	118.5	3.8	17.57	Open	PR10
194	186	116	553	400	130	115.4	0.9	1.16	Open	
195	185	187	844	600	110	322.7	1.1	2.25	Open	
196	187	135	617	600	110	313.5	1.1	1.56	Open	
197	185	188	279	400	130	67.5	0.5	0.22	Open	
198	188	189	160	150	140	2.7	0.2	0.03	Open	
199	188	190	159	400	130	51.2	0.4	0.07	Open	
200	190	191	237	400	130	0.0	0.0	0.00	Open	
201	227	192	420	400	130	42.2	0.3	0.14	Open	
202	192	193	381	400	140	18.6	0.1	0.02	Open	
203	193	194	671	300	140	6.0	0.1	0.02	Open	
204	194	195	10	100	100	6.0	0.8	41.92	Open	PR16
205	195	196	553	200	140	6.0	0.2	0.12	Open	
206	192	197	92	400	130	19.5	0.2	0.01	Open	
207	198	197	275	150	130	-4.4	-0.2	0.16	Open	
208	198	199	225	150	130	-2.5	-0.1	0.05	Open	
209	198	200	195	150	130	3.3	0.2	0.07	Open	
210	197	201	261	150	130	15.1	0.9	1.51	Open	
211	193	201	467	150	130	11.0	0.6	1.49	Open	
212	201	202	346	150	130	21.4	1.2	3.79	Open	
213	202	203	377	150	130	14.7	0.8	2.06	Open	
214	203	204	10	150	100	72.7	4.1	60.39	Open	PR18
215	203	205	444	300	130	-66.8	-0.9	1.37	Open	
216	205	206	353	200	130	10.6	0.3	0.26	Open	
217	206	207	10	100	100	8.5	1.1	29.40	Open	PR12
218	206	208	472	150	140	2.1	0.1	0.06	Open	
219	205	209	233	300	130	-85.2	-1.2	1.13	Open	
220	209	135	484	350	130	-101.9	-1.1	1.54	Open	
221	209	210	146	150	140	11.3	0.6	0.43	Open	
222	210	211	442	150	140	2.0	0.1	0.05	Open	
223	204	212	895	250	130	66.5	1.4	6.67	Open	
224	212	213	10	150	100	54.8	3.1	36.62	Open	PR17
225	213	214	256	250	130	53.5	1.1	1.28	Open	
226	214	215	191	200	130	47.5	1.5	2.26	Open	
227	215	216	10	100	100	3.5	0.4	45.62	Open	PR14
228	216	217	296	150	140	1.9	0.1	0.03	Open	
229	215	218	396	200	130	40.4	1.3	3.47	Open	
230	218	219	346	150	130	35.5	2.0	9.68	Open	
231	219	220	375	100	130	8.8	1.1	5.67	Open	
232	220	221	228	150	130	4.6	0.3	0.14	Open	
233	219	222	191	150	130	22.4	1.3	2.29	Open	
234	222	223	10	100	100	19.3	2.5	43.29	Open	PR15
235	223	224	137	150	130	18.8	1.1	1.18	Open	
236	224	225	576	100	130	7.6	1.0	6.63	Open	
237	224	226	589	100	130	10.0	1.3	11.49	Open	
238	190	227	130	400	130	51.2	0.4	0.06	Open	
239	199	227	135	150	140	-9.0	-0.5	0.26	Open	
1001	104	111	2	100	130	0.0	0.0	0.00	Closed	
1002	1000	94	10	600	100	0.0	0.0	0.00	Open	

File Name: Ex-Theoretical.xls

NODE TABLE						
Node	Elevation m	Demand l/s	Pressure psi	HGL m	Status	Comments
1	819.3	0.00	0	819.3	Open	Vernon Creek Intake
2	702.5	0.00	153	809.9	Open	PR 1 - U/S
3	702.5	0.00	59	744.0	Open	PR 1 - D/S
4	616.3	0.00	176	740.3	Open	
5	551.7	0.00	265	738.4	Open	PR 2 - U/S
6	551.7	0.00	93	617.1	Open	PR 2 - D/S
7	433.0	0.00	253	611.4	Open	PR 24 - U/S
9	433.0	7.50	91	496.9	Open	PR 24 - D/S
10	442.0	8.25	78	496.9	Open	
11	428.0	1.28	94	494.5	Open	
12	418.0	8.33	109	494.4	Open	
13	426.5	0.36	95	493.6	Open	
14	423.0	0.00	265	609.4	Open	PR 3 / PR 4 - U/S
15	423.0	2.25	97	491.6	Open	PR 3 - D/S
16	423.0	0.00	70	472.2	Open	PR 4 - D/S
17	422.5	1.53	71	472.1	Open	
18	423.0	3.40	83	481.5	Open	
19	423.0	4.94	70	472.1	Open	
20	414.6	6.21	90	477.8	Open	
21	410.0	0.00	95	476.6	Open	
22	408.0	5.96	97	476.6	Open	
23	407.0	3.81	97	474.9	Open	
24	407.0	3.03	99	476.6	Open	PR 26 - U/S
25	407.0	0.15	78	461.8	Open	PR 26 - D/S
26	396.0	0.15	94	461.8	Open	
27	393.0	2.61	98	461.8	Open	
28	392.0	0.00	99	461.8	Open	
29	392.0	0.36	99	461.8	Open	
30	390.0	1.34	102	461.8	Open	
31	390.0	0.56	102	461.8	Open	
32	393.0	0.15	98	461.8	Open	
33	439.0	0.00	240	608.0	Open	PR 5 - U/S
34	439.0	3.64	53	476.0	Open	PR 5 - D/S
35	435.1	0.47	58	476.0	Open	
36	436.0	1.28	57	476.0	Open	
37	440.0	3.86	51	476.0	Open	
38	428.0	0.47	68	476.0	Open	
39	440.0	2.25	51	476.0	Open	
40	428.0	5.30	68	476.1	Open	
41	422.0	6.51	77	476.2	Open	
42	420.0	0.00	80	476.3	Open	
43	419.4	1.41	81	476.3	Open	
44	433.0	0.00	61	476.2	Open	
45	434.0	1.86	57	474.4	Open	
46	428.0	3.86	66	474.3	Open	
47	445.0	0.00	44	476.0	Open	
48	435.0	3.08	58	476.0	Open	
49	455.0	2.00	30	475.8	Open	
50	460.0	0.00	209	606.9	Open	PR 6 - U/S
51	460.0	1.53	133	553.5	Open	PR 6 - D/S
52	467.5	0.00	119	551.2	Open	PR 7 - U/S
53	467.5	2.42	61	510.4	Open	PR 7 - D/S
54	462.5	0.26	68	510.4	Open	
55	456.0	2.61	77	510.1	Open	
56	458.0	0.83	74	510.1	Open	
57	468.5	1.19	59	510.0	Open	
58	458.0	1.19	74	509.9	Open	
59	455.0	0.83	78	509.9	Open	
60	466.0	6.69	62	509.6	Open	

File Name: Ex-Theoretical.xls

NODE TABLE						
Node	Elevation m	Demand l/s	Pressure psi	HGL m	Status	Comments
61	461.0	14.80	68	508.6	Open	
62	458.0	12.29	68	506.1	Open	
63	459.0	9.71	64	503.9	Open	
64	467.0	6.47	47	499.8	Open	
65	484.5	2.00	21	499.6	Open	Shanks Rd. South End B.O.
66	472.0	12.25	111	550.3	Open	
67	487.0	10.28	89	549.7	Open	
68	487.0	0.47	89	549.6	Open	
69	492.0	3.86	82	549.5	Open	
70	495.0	1.69	77	549.5	Open	
71	513.0	2.42	43	543.1	Open	
73	503.0	0.89	66	549.7	Open	
72	497.0	0.89	75	549.7	Open	
74	439.0	34.50	135	533.9	Open	
75	438.0	0.00	136	533.9	Open	
76	443.0	0.00	128	533.1	Open	PR 25 - U/S
77	443.0	31.45	88	504.9	Open	PR 25 - D/S
78	437.0	7.50	138	533.9	Open	
79	425.0	0.00	155	534.0	Open	
80	465.0	0.00	98	534.1	Open	
81	493.0	0.00	59	534.2	Open	
82	500.0	0.41	49	534.3	Open	
83	497.0	0.00	53	534.4	Open	
84	525.0	1.53	13	534.3	Open	
85	516.0	1.04	26	534.3	Open	
86	525.0	1.28	13	534.3	Open	
87	497.0	0.89	53	534.4	Open	
88	534.4	0.00	0	534.4	Open	Okanagan Lake Reservoir
89	465.0	0.66	99	534.4	Open	
90	445.0	0.00	127	534.4	Open	
91	435.0	0.36	141	534.4	Open	
92	475.0	1.91	84	534.4	Open	
93	421.0	0.26	161	534.4	Open	
94	342.0	0.00	273	534.5	Open	OK Lake Pump Station
95	471.0	0.00	192	606.4	Open	PR 8 - U/S
96	478.0	0.00	181	605.5	Open	PR 9 - U/S
97	502.0	6.32	145	603.7	Open	
98	507.0	10.54	133	600.9	Open	
99	525.0	12.29	103	597.6	Open	
100	471.0	4.52	60	513.2	Open	PR 8 - D/S
101	475.0	3.08	52	511.6	Open	
102	460.0	2.99	73	511.5	Open	
103	480.0	7.80	44	510.9	Open	
104	477.0	5.09	44	508.2	Open	
105	478.0	7.34	70	527.2	Open	PR 9 - D/S
106	478.0	10.75	68	525.8	Open	
107	481.0	1.95	41	509.5	Open	
108	485.0	0.83	34	509.1	Open	
109	486.0	2.15	33	509.1	Open	
110	481.0	3.55	40	508.9	Open	
111	477.0	1.28	45	508.5	Open	
112	455.0	4.32	75	507.5	Open	
113	472.0	8.33	133	565.9	Open	
114	479.0	14.55	127	568.5	Open	
115	491.0	12.44	119	574.6	Open	
116	500.0	8.18	109	576.3	Open	
117	497.0	13.06	112	575.6	Open	
118	492.0	3.74	119	575.4	Open	
119	487.0	2.31	126	575.3	Open	

NODE TABLE

Node	Elevation m	Demand l/s	Pressure psi	HGL m	Status	Comments
120	504.0	10.37	101	574.8	Open	
121	498.0	4.37	107	573.4	Open	
122	493.0	7.80	114	573.4	Open	
123	502.0	6.32	100	572.5	Open	
124	495.0	0.00	109	572.0	Open	PR 21 - U/S
125	495.0	0.00	65	540.7	Open	PR 21 - D/S
126	478.0	0.83	88	540.2	Open	
127	472.0	4.43	96	539.3	Open	
128	452.0	5.96	124	538.9	Open	
129	483.0	2.15	81	540.2	Open	
130	501.0	4.52	101	571.8	Open	
131	518.0	6.01	73	569.2	Open	
132	518.0	3.55	98	587.2	Open	
133	541.0	4.11	67	588.4	Open	
134	541.0	5.39	70	590.0	Open	
135	534.5	1.43	81	591.3	Open	PR 11 - U/S
136	534.5	1.41	60	576.7	Open	PR 11 - D/S
137	518.0	8.12	80	574.0	Open	
138	495.0	4.17	110	572.1	Open	
139	495.0	1.41	109	571.5	Open	
140	498.0	5.76	104	570.9	Open	
141	499.0	5.45	100	569.2	Open	
142	466.0	3.81	147	569.5	Open	
143	451.5	0.00	167	568.9	Open	PR 19 - U/S
144	451.5	3.64	77	505.6	Open	PR 19 - D/S
145	445.0	2.25	86	505.5	Open	
146	467.0	2.99	55	505.5	Open	
147	420.0	3.19	122	505.6	Open	
148	436.0	4.05	99	505.5	Open	
149	495.0	7.30	109	571.6	Open	
150	485.0	0.00	123	571.4	Open	PR 13 - U/S
151	485.0	0.00	30	506.1	Open	PR 13 - D/S
152	457.0	1.86	69	505.8	Open	
153	423.0	2.99	117	505.5	Open	PR 20 - U/S
154	423.0	0.72	57	463.1	Open	PR 20 - D/S
155	404.5	6.07	83	463.0	Open	
156	395.0	1.28	96	462.9	Open	
157	479.0	11.51	130	570.2	Open	
158	536.0	9.16	57	576.1	Open	
159	530.0	0.56	65	576.0	Open	
160	520.0	1.81	79	575.8	Open	
161	515.0	2.99	86	575.6	Open	
162	513.0	4.75	89	575.6	Open	
163	506.0	2.69	99	575.5	Open	
164	500.0	4.27	107	575.3	Open	
165	487.0	4.52	125	575.1	Open	
166	467.0	2.06	152	574.0	Open	
167	467.0	7.04	152	573.9	Open	
168	475.5	5.09	140	573.7	Open	
169	463.0	12.29	154	571.1	Open	
170	450.0	18.55	175	572.8	Open	PR 22 - U/S
171	450.0	0.00	59	491.5	Open	PR 22 - D/S
172	404.0	11.51	123	490.3	Open	
173	391.5	8.63	136	487.2	Open	PR 23 - U/S
174	391.5	0.00	83	449.9	Open	PR 23 - D/S
175	404.5	2.61	64	449.3	Open	
176	402.5	2.69	58	443.1	Open	
177	375.0	0.00	95	442.0	Open	
178	356.0	6.32	119	440.0	Open	

File Name: Ex-Theoretical.xls

NODE TABLE						
Node	Elevation m	Demand l/s	Pressure psi	HGL m	Status	Comments
179	398.0	3.12	63	442.4	Open	
180	385.5	5.09	70	434.6	Open	
181	377.5	3.40	81	434.2	Open	Hyd # 98 - M^c^Creight Rd.
182	529.5	7.35	95	596.5	Open	
183	529.0	1.53	96	596.5	Open	
184	552.0	7.35	62	595.9	Open	Hyd # 58 - Monte Bella Rd.
185	532.5	17.99	89	595.1	Open	PR 10 - U/S
186	532.5	3.12	64	577.5	Open	PR 10 - D/S
187	541.0	9.25	74	592.8	Open	
188	548.0	13.52	67	594.9	Open	
189	564.0	2.69	44	594.8	Open	
190	553.0	0.00	59	594.8	Open	
191	588.4	0.00	9	594.8	Open	Camp Road Reservoir
192	546.5	4.11	68	594.6	Open	
193	528.0	1.65	95	594.6	Open	
194	524.5	0.00	100	594.5	Open	PR 16 - U/S
195	524.5	0.00	40	552.6	Open	PR 16 - D/S
196	492.0	5.96	86	552.5	Open	
197	537.0	0.00	82	594.6	Open	
198	550.0	3.64	63	594.4	Open	
199	554.0	6.51	58	594.5	Open	
200	557.0	3.25	53	594.3	Open	
201	529.0	4.77	91	593.1	Open	
202	518.5	6.69	101	589.3	Open	
203	498.0	8.78	127	587.2	Open	PR 18 - U/S
204	498.0	6.17	41	526.8	Open	PR 18 - D/S
205	532.0	7.86	80	588.6	Open	
206	528.0	0.00	86	588.3	Open	PR 12 - U/S
207	528.0	8.54	44	558.9	Open	PR 12 - D/S
208	530.0	2.06	83	588.3	Open	
209	548.5	5.33	59	589.7	Open	
210	547.0	9.30	60	589.3	Open	
211	555.0	2.00	49	589.2	Open	Hyd # 85 - Nygren / Cemetary
212	428.0	11.71	131	520.2	Open	PR 17 - U/S
213	428.0	1.28	79	483.5	Open	PR 17 - D/S
214	409.0	5.96	104	482.3	Open	
215	391.5	3.71	126	480.0	Open	PR 14 - U/S
216	391.5	1.53	61	434.4	Open	PR 14 - D/S
217	382.5	1.94	74	434.4	Open	
218	417.5	4.90	84	476.5	Open	
219	415.5	4.27	73	466.9	Open	
220	420.0	4.17	59	461.2	Open	
221	425.0	4.58	51	461.0	Open	
222	380.5	3.12	119	464.6	Open	PR 15 - U/S
223	380.5	0.56	58	421.3	Open	PR 15 - D/S
224	349.5	1.16	100	420.1	Open	
225	343.0	7.55	100	413.5	Open	
226	353.0	10.04	79	408.6	Open	
227	554.0	0.00	58	594.7	Open	
1000	342.0	0.00	273	534.5	Open	OK Lake Pump Station

PUMPED SOURCES TABLE						
Node	Pumps	Op Curve	Estimate %	Actual %	Inflow l/s	Status
94	1	Pump3	0.1	0.1	-105.5	Open
1000	2	Pump1	0.5	0.0	0.0	Closed

FIXED GRADE SOURCES TABLE					
Node	Top of Water m	Estimate %	Actual %	Inflow l/s	Status
1	819.3	0.8	0.8	-729.7	Open
88	534.4	0.3	0.1	-68.0	Open
191	588.4	0.0	0.0	0.0	Closed

PRV TABLE								
Pipe	Source Node	Pressure psi	Check Valve	PRV Loss psi	Chk. Valve State	Status	PRV No.	PRV Name
2	1	59	Yes	60	Open	Open	1	
5	1	93	Yes	115	Open	Open	2	
7	1		Yes				24	Jim Bailey
15	1	98	Yes				3	Beaver
16	1	70	Yes	137	Open	Open	4	Bottom
26	88	78	Yes	15	Open	Open	26	Taiji
35	1	86	Yes				5	Kobayashi
54	1	133	Yes	51	Open	Open	6	Glenmore
56	1	61	Yes	40	Open	Open	7	Harwood
79	88	88	Yes	27	Open	Open	25	HRI
103	1	60	Yes	87	Open	Open	8	Read
108	1	70	Yes	76	Open	Open	9	Seaton
129	1	65	Yes	31	Open	Open	21	Jardine
140	1	60	Yes	12	Open	Open	11	Tepper
148	1	77	Yes	61	Open	Open	19	Robinson
155	1	30	Yes	65	Open	Open	13	Brew
159	1	57	Yes	42	Open	Open	20	Pretty / Middle
178	1	59	Yes	81	Open	Open	22	Hikichi
181	1	83	Yes	36	Open	Open	23	M^{c}Farlene
193	1	64	Yes	17	Open	Open	10	Bond / Camp
204	1	40	Yes	42	Open	Open	16	Tyndall
214	1	41	Yes	59	Open	Open	18	Davidson
217	1	44	Yes	29	Open	Open	12	Admusen
224	1	79	Yes	36	Open	Open	17	Dobson
227	1	61	Yes	46	Open	Open	14	Hare
234	1	58	Yes	42	Open	Open	15	6th

PUMP 1		PUMP 2		PUMP 3	
Flow l/s	Head m	Flow l/s	Head m	Flow l/s	Head m
0.0	292.6	0.0	292.6	0.0	260.6
126.2	237.7	126.2	237.7	15.8	244.4
189.3	216.4	189.3	216.4	31.5	232.7
220.8	201.2	220.8	201.2	47.3	223.3
252.4	179.2	252.4	179.2	63.1	218.5
283.9	154.4	283.9	154.4	78.9	211.5
315.5	126.5	315.5	126.5	94.6	202.1
				110.4	188.1
				142.0	153.4
				173.5	95.8

District of Lake Country
Existing System
Vernon Creek Sourced at 428 Lps,
Calibrated to Match Field Conditions on August 8, 2001
February 2002

PIPE TABLE

Pipe	Up Node	Down Node	Length m	Diameter mm	Roughness C	Flow l/s	Velocity m/sec	HeadLoss m	Status	Pipe Description
1	1	2	2182	800	90	428.0	0.9	3.5	Open	
2	2	3	10	300	80	428.0	6.1	71.8	Open	PR1
3	3	4	1044	800	100	428.0	0.9	1.4	Open	
4	4	5	537	800	100	428.0	0.9	0.7	Open	
5	5	6	10	300	80	428.0	6.1	124.8	Open	PR2
6	6	7	1615	800	100	428.0	0.9	2.1	Open	
7	7	9	10	250	120	0.0	0.0	0.0	Closed	PR24
9	9	10	389	250	140	5.4	0.1	0.0	Open	
10	9	11	292	250	140	47.4	1.0	1.0	Open	
11	11	12	524	250	140	5.4	0.1	0.0	Open	
12	11	13	147	250	140	41.2	0.8	0.4	Open	
13	13	15	104	200	140	41.0	1.3	0.8	Open	
14	7	14	562	800	100	428.0	0.9	0.7	Open	
15	14	15	10	150	100	0.0	0.0	0.0	Closed	PR3
16	14	16	10	150	100	4.2	0.2	142.0	Open	PR4
17	15	18	495	200	130	39.5	1.3	4.2	Open	
18	16	17	245	200	130	4.2	0.1	0.0	Open	
19	17	19	250	200	130	3.2	0.1	0.0	Open	
20	18	20	585	250	130	37.3	0.8	1.5	Open	
21	19	20	660	200	140	0.0	0.0	0.0	Closed	
22	20	21	236	250	130	33.3	0.7	0.5	Open	
23	21	22	60	250	130	11.8	0.2	0.0	Open	
24	22	23	507	100	130	2.5	0.3	0.7	Open	
25	22	24	513	300	130	5.4	0.1	0.0	Open	
26	24	25	10	200	100	3.5	0.1	31.3	Open	PR26
27	25	26	922	300	130	3.4	0.0	0.0	Open	
28	26	27	528	300	130	3.3	0.0	0.0	Open	
29	27	28	197	300	130	1.6	0.0	0.0	Open	
30	28	29	214	250	130	0.2	0.0	0.0	Open	
31	28	30	253	200	130	1.2	0.0	0.0	Open	
32	30	31	207	150	130	0.4	0.0	0.0	Open	
33	28	32	198	250	130	0.1	0.0	0.0	Open	
34	14	33	465	800	100	423.8	0.8	0.6	Open	
35	33	34	10	100	100	0.0	0.0	0.0	Closed	PR5
36	34	35	168	200	140	0.3	0.0	0.0	Open	
37	34	36	119	300	120	-2.7	0.0	0.0	Open	
38	36	37	221	300	140	-3.5	0.0	0.0	Open	
39	37	38	195	150	130	0.3	0.0	0.0	Open	
40	37	39	44	300	140	-6.3	-0.1	0.0	Open	
41	39	40	391	300	140	-8.2	-0.1	0.0	Open	
42	40	41	365	300	140	-12.7	-0.2	0.0	Open	
43	41	42	71	250	140	-20.6	-0.4	0.1	Open	
44	42	21	145	250	140	-21.5	-0.4	0.1	Open	
45	42	43	240	200	140	0.9	0.0	0.0	Open	
46	41	44	104	200	140	3.7	0.1	0.0	Open	
47	44	45	255	100	130	3.7	0.5	0.8	Open	
48	45	46	356	150	140	2.5	0.1	0.1	Open	
49	39	47	414	100	130	0.4	0.1	0.0	Open	
50	47	48	68	100	130	-0.9	-0.1	0.0	Open	
51	48	40	139	150	140	-2.9	-0.2	0.0	Open	
52	47	49	195	100	130	1.3	0.2	0.1	Open	
53	33	50	238	800	100	423.8	0.8	0.3	Open	
54	50	51	10	150	100	50.5	2.9	59.8	Open	PR6
55	51	52	388	300	130	49.5	0.7	0.7	Open	
56	52	53	10	150	100	28.2	1.6	42.4	Open	PR7
57	53	54	392	100	100	0.2	0.0	0.0	Open	
58	53	55	197	150	130	4.3	0.2	0.1	Open	
59	55	56	174	150	130	2.6	0.1	0.0	Open	

PIPE TABLE

Pipe	Up Node	Down Node	Length m	Diameter mm	Roughness C	Flow l/s	Velocity m/sec	HeadLoss m	Status	Pipe Description
60	56	57	130	150	130	0.8	0.0	0.0	Open	
61	56	58	145	100	130	1.3	0.2	0.1	Open	
62	58	59	122	150	130	0.5	0.0	0.0	Open	
63	53	60	163	250	130	22.2	0.5	0.2	Open	
64	60	61	280	250	130	18.7	0.4	0.2	Open	
65	61	62	484	200	130	16.7	0.5	0.8	Open	
66	62	63	266	150	130	8.7	0.5	0.6	Open	
67	63	64	290	100	130	2.4	0.3	0.4	Open	
68	64	65	180	100	130	1.3	0.2	0.1	Open	
69	52	66	475	250	130	21.2	0.4	0.4	Open	
70	66	67	681	250	130	13.3	0.3	0.3	Open	
71	67	68	134	150	140	3.9	0.2	0.1	Open	
72	68	69	96	150	140	3.6	0.2	0.0	Open	
73	69	70	178	150	140	1.1	0.1	0.0	Open	
74	67	71	186	50	140	1.6	0.8	3.0	Open	
75	67	72	138	150	130	1.1	0.1	0.0	Open	
76	72	73	165	150	140	0.6	0.0	0.0	Open	
77	74	75	695	850	100	-24.3	0.0	0.0	Open	
78	75	76	52	300	100	86.1	1.2	0.4	Open	
79	76	77	10	200	100	86.1	2.7	28.9	Open	PR25
80	75	78	71	850	100	-110.4	-0.2	0.0	Open	
81	77	9	674	250	140	57.7	1.2	3.4	Open	
82	78	79	766	850	100	-115.2	-0.2	0.1	Open	
83	79	80	737	850	100	-115.2	-0.2	0.1	Open	
84	80	81	286	850	100	-115.2	-0.2	0.0	Open	
85	81	82	614	850	100	-115.2	-0.2	0.1	Open	
86	82	83	496	850	100	-115.5	-0.2	0.0	Open	
87	83	84	342	200	130	2.5	0.1	0.0	Open	
88	84	85	146	150	140	0.7	0.0	0.0	Open	
89	84	86	388	200	130	0.8	0.0	0.0	Open	
90	83	87	69	850	100	-118.0	-0.2	0.0	Open	
91	87	88	214	850	100	-15.1	0.0	0.0	Open	
92	87	89	409	850	100	-103.4	-0.2	0.0	Open	
93	89	90	149	850	100	-103.8	-0.2	0.0	Open	
94	90	91	196	200	140	1.5	0.0	0.0	Open	
95	91	92	492	200	140	1.2	0.0	0.0	Open	
96	90	93	99	850	100	-105.3	-0.2	0.0	Open	
97	93	94	343	850	100	-105.5	-0.2	0.0	Open	
98	50	95	148	750	100	373.3	0.8	0.2	Open	
99	95	96	258	750	100	358.1	0.8	0.3	Open	
100	96	97	411	700	100	337.3	0.9	0.7	Open	
101	97	98	664	700	100	333.2	0.9	1.1	Open	
102	98	99	801	700	100	332.5	0.9	1.3	Open	
103	95	100	10	75	100	15.2	3.4	99.9	Open	PR8
104	100	101	177	150	130	12.3	0.7	0.7	Open	
105	101	102	334	150	130	1.9	0.1	0.0	Open	
106	101	103	176	150	130	8.4	0.5	0.3	Open	
107	103	104	473	100	130	3.3	0.4	1.2	Open	
108	96	105	10	100	100	20.9	2.7	85.5	Open	PR9
109	105	106	398	200	130	16.1	0.5	0.6	Open	
110	106	107	446	100	130	9.1	1.2	7.3	Open	
111	107	108	108	150	130	7.9	0.4	0.2	Open	
112	108	109	186	150	130	1.4	0.1	0.0	Open	
113	108	110	97	150	130	5.9	0.3	0.1	Open	
114	110	111	367	150	130	3.6	0.2	0.2	Open	
115	111	112	258	100	130	2.8	0.4	0.5	Open	
116	112	113	175	100	130	0.0	0.0	0.0	Closed	
117	113	114	188	100	130	-5.4	-0.7	1.2	Open	
118	114	115	493	150	130	-14.8	-0.8	2.8	Open	
119	115	116	462	250	130	-24.3	-0.5	0.5	Open	
120	116	117	329	200	130	12.4	0.4	0.3	Open	
121	117	118	184	150	130	3.9	0.2	0.1	Open	
122	118	119	82	100	130	1.5	0.2	0.0	Open	
123	116	120	462	250	130	26.8	0.5	0.6	Open	
124	120	121	247	200	130	20.1	0.6	0.6	Open	

PIPE TABLE										
Pipe	Up Node	Down Node	Length m	Diameter mm	Roughness C	Flow l/s	Velocity m/sec	HeadLoss m	Status	Pipe Description
125	121	122	110	150	130	-2.4	-0.1	0.0	Open	
126	122	115	436	150	130	-7.4	-0.4	0.7	Open	
127	121	123	185	200	130	19.6	0.6	0.4	Open	
128	123	124	97	150	130	8.7	0.5	0.2	Open	
129	124	125	10	100	100	8.7	1.1	34.5	Open	PR21
130	125	126	115	150	130	8.7	0.5	0.2	Open	
131	126	127	290	150	130	6.7	0.4	0.4	Open	
132	127	128	406	150	130	3.9	0.2	0.2	Open	
133	126	129	87	150	130	1.4	0.1	0.0	Open	
134	123	130	238	150	130	6.8	0.4	0.3	Open	
135	130	131	341	100	130	3.9	0.5	1.2	Open	
136	131	132	17	100	130	0.0	0.0	0.0	Closed	
137	132	133	431	100	130	-2.3	-0.3	0.5	Open	
138	133	134	130	100	130	-5.0	-0.6	0.7	Open	
139	134	135	340	150	140	-8.5	-0.5	0.6	Open	
140	135	136	10	200	100	109.2	3.5	30.7	Open	PR11
141	136	137	278	250	130	43.1	0.9	0.9	Open	
142	137	138	236	250	130	37.8	0.8	0.6	Open	
143	138	139	122	200	130	17.2	0.5	0.2	Open	
144	139	140	163	150	130	7.3	0.4	0.2	Open	
145	140	141	277	100	130	3.5	0.4	0.8	Open	
146	139	142	227	150	130	9.0	0.5	0.5	Open	
147	142	143	95	150	130	6.5	0.4	0.1	Open	
148	143	144	10	75	100	6.5	1.5	68.7	Open	PR19
149	144	145	140	150	130	3.4	0.2	0.1	Open	
150	145	146	182	150	130	1.9	0.1	0.0	Open	
151	144	147	243	150	140	1.1	0.1	0.0	Open	
152	144	148	361	150	130	-0.3	0.0	0.0	Open	
153	138	149	112	200	140	17.9	0.6	0.2	Open	
154	149	150	125	200	140	11.3	0.4	0.1	Open	
155	150	151	10	100	100	11.3	1.4	68.8	Open	PR13
156	151	152	246	200	140	11.3	0.4	0.2	Open	
157	152	153	341	200	140	10.1	0.3	0.2	Open	
158	153	148	270	150	130	2.9	0.2	0.1	Open	
159	153	154	10	100	100	5.2	0.7	42.6	Open	PR20
160	154	155	179	200	140	4.8	0.2	0.0	Open	
161	155	156	306	100	140	0.8	0.1	0.1	Open	
162	149	157	400	150	130	1.9	0.1	0.0	Open	
163	136	158	260	400	130	65.2	0.5	0.2	Open	
164	158	159	60	400	130	59.2	0.5	0.0	Open	
165	159	162	240	400	130	54.6	0.4	0.1	Open	
166	159	160	135	150	130	4.3	0.2	0.1	Open	
167	160	161	127	150	130	3.1	0.2	0.0	Open	
168	161	162	209	150	130	1.2	0.1	0.0	Open	
169	162	164	200	400	130	50.1	0.4	0.1	Open	
170	162	163	168	150	130	2.6	0.1	0.0	Open	
171	163	164	277	100	130	0.8	0.1	0.1	Open	
172	164	165	164	400	130	48.2	0.4	0.1	Open	
173	165	166	259	200	130	15.6	0.5	0.4	Open	
174	166	167	427	200	140	4.6	0.1	0.1	Open	
175	166	168	169	200	130	9.7	0.3	0.1	Open	
176	168	169	655	150	130	8.0	0.5	1.2	Open	
177	165	170	830	300	130	31.3	0.4	0.6	Open	
178	170	171	10	150	100	28.1	1.6	84.1	Open	PR22
179	171	172	352	250	130	28.1	0.6	0.5	Open	
180	172	173	548	200	130	20.7	0.7	1.4	Open	
181	173	174	10	100	100	15.1	1.9	39.7	Open	PR23
182	174	175	177	200	130	15.1	0.5	0.3	Open	
183	175	176	601	150	130	13.4	0.8	2.8	Open	
184	176	177	141	100	130	4.1	0.5	0.5	Open	
185	177	178	240	100	130	4.1	0.5	0.9	Open	
186	176	179	201	150	130	7.5	0.4	0.3	Open	
187	179	180	549	100	130	5.5	0.7	3.5	Open	
188	180	181	142	100	130	2.2	0.3	0.2	Open	
189	99	182	273	700	100	324.5	0.8	0.4	Open	

PIPE TABLE										
Pipe	Up Node	Down Node	Length m	Diameter mm	Roughness C	Flow l/s	Velocity m/sec	HeadLoss m	Status	Pipe Description
190	182	183	324	150	130	1.0	0.1	0.0	Open	
191	182	184	428	150	130	4.8	0.3	0.3	Open	
192	182	185	395	700	100	314.0	0.8	0.6	Open	
193	185	186	10	200	100	70.8	2.3	31.3	Open	PR10
194	186	116	553	400	130	68.8	0.5	0.4	Open	
195	185	187	844	600	110	190.1	0.7	0.8	Open	
196	187	135	617	600	110	184.1	0.7	0.6	Open	
197	185	188	279	400	130	41.4	0.3	0.1	Open	
198	188	189	160	150	140	1.7	0.1	0.0	Open	
199	188	190	159	400	130	30.9	0.2	0.0	Open	
200	190	191	237	400	130	0.0	0.0	0.0	Open	
201	227	192	420	400	130	25.2	0.2	0.1	Open	
202	192	193	381	400	140	11.8	0.1	0.0	Open	
203	193	194	671	300	140	3.9	0.1	0.0	Open	
204	194	195	10	100	100	3.9	0.5	56.0	Open	PR16
205	195	196	553	200	140	3.9	0.1	0.1	Open	
206	192	197	92	400	130	12.4	0.1	0.0	Open	
207	198	197	275	150	130	-2.9	-0.2	0.1	Open	
208	198	199	225	150	130	-1.5	-0.1	0.0	Open	
209	198	200	195	150	130	2.1	0.1	0.0	Open	
210	197	201	261	150	130	9.4	0.5	0.6	Open	
211	193	201	467	150	130	6.8	0.4	0.6	Open	
212	201	202	346	150	130	13.2	0.7	1.5	Open	
213	202	203	377	150	130	8.8	0.5	0.8	Open	
214	203	204	10	150	100	45.1	2.6	78.8	Open	PR18
215	203	205	444	300	130	-42.0	-0.6	0.6	Open	
216	205	206	353	200	130	6.9	0.2	0.1	Open	
217	206	207	10	100	100	5.5	0.7	47.1	Open	PR12
218	206	208	472	150	140	1.3	0.1	0.0	Open	
219	205	209	233	300	130	-54.0	-0.8	0.5	Open	
220	209	135	484	350	130	-65.5	-0.7	0.7	Open	
221	209	210	146	150	140	8.1	0.5	0.2	Open	
222	210	211	442	150	140	2.0	0.1	0.1	Open	
223	204	212	895	250	130	41.1	0.8	2.7	Open	
224	212	213	10	150	100	33.5	1.9	40.5	Open	PR17
225	213	214	256	250	130	32.7	0.7	0.5	Open	
226	214	215	191	200	130	28.9	0.9	0.9	Open	
227	215	216	10	100	100	2.3	0.3	47.7	Open	PR14
228	216	217	296	150	140	1.3	0.1	0.0	Open	
229	215	218	396	200	130	26.2	0.8	1.6	Open	
230	218	219	346	150	130	23.0	1.3	4.3	Open	
231	219	220	375	100	130	5.7	0.7	2.5	Open	
232	220	221	228	150	130	3.0	0.2	0.1	Open	
233	219	222	191	150	130	14.6	0.8	1.0	Open	
234	222	223	10	100	100	12.5	1.6	53.9	Open	PR15
235	223	224	137	150	130	12.2	0.7	0.5	Open	
236	224	225	576	100	130	4.9	0.6	3.0	Open	
237	224	226	589	100	130	6.5	0.8	5.1	Open	
238	190	227	130	400	130	30.9	0.2	0.0	Open	
239	199	227	135	150	140	-5.8	-0.3	0.1	Open	
1001	104	111	2	100	130	0.0	0.0	0.0	Closed	
1002	1000	94	10	600	100	0.0	0.0	0.0	Open	

NODE TABLE						
Node	Elevation m	Demand l/s	Pressure psi	HGL m	Status	Comments
1	819.3	0.00	0	819.3	Open	Vernon Creek Intake
2	702.5	0.00	161	815.8	Open	PR 1 - U/S
3	702.5	0.00	59	744.0	Open	PR 1 - D/S
4	616.3	0.00	179	742.6	Open	
5	551.7	0.00	270	741.9	Open	PR 2 - U/S
6	551.7	0.00	93	617.1	Open	PR 2 - D/S
7	433.0	0.00	259	615.0	Open	PR 24 - U/S
9	433.0	4.87	97	501.5	Open	PR 24 - D/S
10	442.0	5.36	85	501.5	Open	
11	428.0	0.83	103	500.5	Open	
12	418.0	5.40	117	500.5	Open	
13	426.5	0.23	105	500.1	Open	
14	423.0	0.00	272	614.2	Open	PR 3 / PR 4 - U/S
15	423.0	1.46	108	499.3	Open	PR 3 - D/S
16	423.0	0.00	70	472.2	Open	PR 4 - D/S
17	422.5	0.99	71	472.2	Open	
18	423.0	2.20	103	495.1	Open	
19	423.0	3.20	70	472.2	Open	
20	414.6	4.03	112	493.6	Open	
21	410.0	0.00	118	493.1	Open	
22	408.0	3.86	121	493.1	Open	
23	407.0	2.47	121	492.4	Open	
24	407.0	1.97	122	493.1	Open	PR 26 - U/S
25	407.0	0.10	78	461.8	Open	PR 26 - D/S
26	396.0	0.10	94	461.8	Open	
27	393.0	1.69	98	461.8	Open	
28	392.0	0.00	99	461.8	Open	
29	392.0	0.23	99	461.8	Open	
30	390.0	0.87	102	461.8	Open	
31	390.0	0.37	102	461.8	Open	
32	393.0	0.10	98	461.8	Open	
33	439.0	0.00	249	614.6	Open	PR 5 - U/S
34	439.0	2.36	77	492.9	Open	PR 5 - D/S
35	435.1	0.30	82	492.9	Open	
36	436.0	0.83	81	492.9	Open	
37	440.0	2.51	75	492.9	Open	
38	428.0	0.30	92	492.9	Open	
39	440.0	1.46	75	492.9	Open	
40	428.0	1.60	92	492.9	Open	
41	422.0	4.22	101	493.0	Open	
42	420.0	0.00	104	493.0	Open	
43	419.4	0.91	105	493.0	Open	
44	433.0	0.00	85	493.0	Open	
45	434.0	1.20	83	492.2	Open	
46	428.0	2.51	91	492.1	Open	
47	445.0	0.00	68	492.9	Open	
48	435.0	2.00	82	492.9	Open	
49	455.0	1.31	54	492.8	Open	
50	460.0	0.00	218	613.3	Open	PR 6 - U/S
51	460.0	0.99	133	553.5	Open	PR 6 - D/S
52	467.5	0.00	121	552.8	Open	PR 7 - U/S
53	467.5	1.57	61	510.4	Open	PR 7 - D/S
54	462.5	0.16	68	510.4	Open	
55	456.0	1.69	77	510.3	Open	
56	458.0	0.54	74	510.2	Open	
57	468.5	0.77	59	510.2	Open	
58	458.0	0.77	74	510.2	Open	
59	455.0	0.54	78	510.2	Open	
60	466.0	3.46	63	510.2	Open	

NODE TABLE						
Node	Elevation m	Demand l/s	Pressure psi	HGL m	Status	Comments
61	461.0	2.05	70	510.0	Open	
62	458.0	7.97	73	509.2	Open	
63	459.0	6.30	71	508.7	Open	
64	467.0	1.10	59	508.3	Open	
65	484.5	1.30	34	508.2	Open	Shanks Rd. South End B.O.
66	472.0	7.95	114	552.4	Open	
67	487.0	6.67	93	552.1	Open	
68	487.0	0.30	92	552.1	Open	
69	492.0	2.51	85	552.0	Open	
70	495.0	1.10	81	552.0	Open	
71	513.0	1.57	51	549.2	Open	
72	497.0	0.57	78	552.1	Open	
73	503.0	0.57	70	552.1	Open	
74	439.0	24.31	135	534.1	Open	
75	438.0	0.00	137	534.1	Open	
76	443.0	0.00	129	533.7	Open	PR 25 - U/S
77	443.0	28.40	88	504.9	Open	PR 25 - D/S
78	437.0	4.87	138	534.1	Open	
79	425.0	0.00	155	534.2	Open	
80	465.0	0.00	98	534.3	Open	
81	493.0	0.00	59	534.3	Open	
82	500.0	0.26	49	534.4	Open	
83	497.0	0.00	53	534.4	Open	
84	525.0	0.99	13	534.4	Open	
85	516.0	0.67	26	534.4	Open	
86	525.0	0.83	13	534.4	Open	
87	497.0	0.57	53	534.4	Open	
88	534.4	0.00	0	534.4	Open	Okanagan Lake Reservoir
89	465.0	0.43	99	534.4	Open	
90	445.0	0.00	127	534.4	Open	
91	435.0	0.23	141	534.4	Open	
92	475.0	1.24	84	534.4	Open	
93	421.0	0.16	161	534.4	Open	
94	342.0	0.00	273	534.5	Open	OK Lake Pump Station
95	471.0	0.00	202	613.1	Open	PR 8 - U/S
96	478.0	0.00	191	612.8	Open	PR 9 - U/S
97	502.0	4.10	156	612.1	Open	
98	507.0	0.70	148	611.0	Open	
99	525.0	7.97	120	609.8	Open	
100	471.0	2.93	60	513.2	Open	PR 8 - D/S
101	475.0	2.00	53	512.5	Open	
102	460.0	1.93	75	512.4	Open	
103	480.0	5.06	46	512.1	Open	
104	477.0	3.30	48	511.0	Open	
105	478.0	4.76	70	527.2	Open	PR 9 - D/S
106	478.0	6.97	69	526.6	Open	
107	481.0	1.27	54	519.3	Open	
108	485.0	0.54	48	519.1	Open	
109	486.0	1.39	47	519.1	Open	
110	481.0	2.30	54	519.0	Open	
111	477.0	0.83	59	518.8	Open	
112	455.0	2.80	90	518.4	Open	
113	472.0	5.40	143	572.6	Open	
114	479.0	9.44	135	573.8	Open	
115	491.0	2.01	122	576.5	Open	
116	500.0	5.31	110	577.1	Open	
117	497.0	8.47	113	576.7	Open	
118	492.0	2.43	120	576.6	Open	
119	487.0	1.50	127	576.6	Open	

NODE TABLE						
Node	Elevation m	Demand l/s	Pressure psi	HGL m	Status	Comments
120	504.0	6.73	103	576.4	Open	
121	498.0	2.84	111	575.8	Open	
122	493.0	5.06	118	575.8	Open	
123	502.0	4.10	104	575.4	Open	
124	495.0	0.00	114	575.2	Open	PR 21 - U/S
125	495.0	0.00	65	540.7	Open	PR 21 - D/S
126	478.0	0.54	89	540.5	Open	
127	472.0	2.87	97	540.1	Open	
128	452.0	3.86	125	539.9	Open	
129	483.0	1.39	82	540.5	Open	
130	501.0	2.93	105	575.1	Open	
131	518.0	3.90	79	573.9	Open	
132	518.0	2.30	124	605.5	Open	
133	541.0	2.66	92	606.1	Open	
134	541.0	3.50	93	606.8	Open	
135	534.5	0.93	104	607.4	Open	PR 11 - U/S
136	534.5	0.91	60	576.7	Open	PR 11 - D/S
137	518.0	5.27	82	575.8	Open	
138	495.0	2.71	114	575.1	Open	
139	495.0	0.91	114	574.9	Open	
140	498.0	3.74	109	574.7	Open	
141	499.0	3.53	106	573.9	Open	
142	466.0	2.47	154	574.4	Open	
143	451.5	0.00	174	574.3	Open	PR 19 - U/S
144	451.5	2.36	77	505.6	Open	PR 19 - D/S
145	445.0	1.46	86	505.6	Open	
146	467.0	1.93	55	505.6	Open	
147	420.0	1.09	122	505.6	Open	
148	436.0	2.63	99	505.6	Open	
149	495.0	4.73	114	574.9	Open	
150	485.0	0.00	128	574.9	Open	PR 13 - U/S
151	485.0	0.00	30	506.1	Open	PR 13 - D/S
152	457.0	1.20	70	505.9	Open	
153	423.0	1.93	118	505.7	Open	PR 20 - U/S
154	423.0	0.47	57	463.1	Open	PR 20 - D/S
155	404.5	3.94	83	463.0	Open	
156	395.0	0.83	97	463.0	Open	
157	479.0	1.90	136	574.9	Open	
158	536.0	5.94	58	576.5	Open	
159	530.0	0.37	66	576.5	Open	
160	520.0	1.17	80	576.4	Open	
161	515.0	1.93	87	576.3	Open	
162	513.0	3.08	90	576.3	Open	
163	506.0	1.74	100	576.3	Open	
164	506.0	2.77	100	576.2	Open	
165	487.0	1.33	127	576.2	Open	
166	467.0	1.33	155	575.8	Open	
167	467.0	4.57	155	575.7	Open	
168	475.5	1.68	142	575.7	Open	
169	463.0	7.97	158	574.5	Open	
170	450.0	3.15	178	575.5	Open	PR 22 - U/S
171	450.0	0.00	59	491.5	Open	PR 22 - D/S
172	404.0	7.46	124	490.9	Open	
173	391.5	5.60	139	489.6	Open	PR 23 - U/S
174	391.5	0.00	83	449.9	Open	PR 23 - D/S
175	404.5	1.69	64	449.6	Open	
176	402.5	1.74	63	446.8	Open	
177	375.0	0.00	101	446.3	Open	
178	356.0	4.10	127	445.4	Open	

NODE TABLE						
Node	**Elevation m**	**Demand l/s**	**Pressure psi**	**HGL m**	**Status**	**Comments**
179	398.0	2.03	69	446.5	Open	
180	385.5	3.30	82	443.0	Open	
181	377.5	2.20	93	442.8	Open	Hyd # 98 - McCreight Rd.
182	529.5	4.77	113	609.3	Open	
183	529.0	0.99	114	609.3	Open	
184	552.0	4.77	81	609.1	Open	Hyd # 58 - Monte Bella Rd.
185	532.5	11.67	108	608.8	Open	PR 10 - U/S
186	532.5	2.03	64	577.5	Open	PR 10 - D/S
187	541.0	6.00	95	607.9	Open	
188	548.0	8.77	86	608.7	Open	
189	564.0	1.74	64	608.7	Open	
190	553.0	0.00	79	608.7	Open	
191	588.4	0.00	29	608.7	Open	Camp Road Reservoir
192	546.5	1.02	88	608.6	Open	
193	528.0	1.07	115	608.6	Open	
194	524.5	0.00	119	608.6	Open	PR 16 - U/S
195	524.5	0.00	40	552.6	Open	PR 16 - D/S
196	492.0	3.86	86	552.6	Open	
197	537.0	0.00	102	608.6	Open	
198	550.0	2.36	83	608.5	Open	
199	554.0	4.22	77	608.5	Open	
200	557.0	2.11	73	608.5	Open	
201	529.0	3.10	112	608.0	Open	
202	518.5	4.34	125	606.4	Open	
203	498.0	5.70	153	605.6	Open	PR 18 - U/S
204	498.0	4.00	41	526.8	Open	PR 18 - D/S
205	532.0	5.10	105	606.2	Open	
206	528.0	0.00	111	606.1	Open	PR 12 - U/S
207	528.0	5.54	44	558.9	Open	PR 12 - D/S
208	530.0	1.33	108	606.1	Open	
209	548.5	3.46	83	606.7	Open	
210	547.0	6.04	84	606.4	Open	
211	555.0	2.03	73	606.4	Open	Hyd # 85 - Nygren / Cemetary
212	428.0	7.60	137	524.1	Open	PR 17 - U/S
213	428.0	0.83	79	483.5	Open	PR 17 - D/S
214	409.0	3.86	105	483.0	Open	
215	391.5	0.41	129	482.1	Open	PR 14 - U/S
216	391.5	0.99	61	434.4	Open	PR 14 - D/S
217	382.5	1.26	74	434.4	Open	
218	417.5	3.18	90	480.6	Open	
219	415.5	2.77	86	476.2	Open	
220	420.0	2.71	76	473.7	Open	
221	425.0	2.97	69	473.6	Open	
222	380.5	2.03	135	475.2	Open	PR 15 - U/S
223	380.5	0.37	58	421.3	Open	PR 15 - D/S
224	349.5	0.75	101	420.8	Open	
225	343.0	4.90	106	417.8	Open	
226	353.0	6.51	89	415.6	Open	
227	554.0	0.00	78	608.6	Open	
1000	342.0	0.00	273	534.5	Open	OK Lake Pump Station

File Name: Ex-Calibrated.xls

PUMPED SOURCES TABLE						
Node	Pumps	Op Curve	Estimate %	Actual %	Inflow l/s	Status
94	1	Pump3	0.1	0.2	-105.5	Open
1000	2	Pump1	0.5	0.0	0.0	Closed

FIXED GRADE SOURCES TABLE					
Node	Top of Water m	Estimate %	Actual %	Inflow l/s	Status
1	819.3	0.8	0.8	-428.0	Open
88	534.4	0.3	0.0	-15.1	Open
191	588.4	0.0	0.0	0.0	Closed

PRV TABLE								
Pipe	Source Node	Pressure psi	Check Valve	PRV Loss psi	Chk. Valve State	Status	PRV No.	PRV Name
2	1	59	Yes	69	Open	Open	1	
5	1	93	Yes	122	Open	Open	2	
7	1		Yes				24	Jim Bailey
15	1	98	Yes				3	Beaver
16	1	70	Yes	142	Open	Open	4	Bottom
26	88	78	Yes	31	Open	Open	26	Taiji
35	1	86	Yes				5	Kobayashi
54	1	133	Yes	59	Open	Open	6	Glenmore
56	1	61	Yes	42	Open	Open	7	Harwood
79	88	88	Yes	28	Open	Open	25	HRI
103	1	60	Yes	97	Open	Open	8	Read
108	1	70	Yes	84	Open	Open	9	Seaton
129	1	65	Yes	34	Open	Open	21	Jardine
140	1	60	Yes	30	Open	Open	11	Tepper
148	1	77	Yes	68	Open	Open	19	Robinson
155	1	30	Yes	68	Open	Open	13	Brew
159	1	57	Yes	43	Open	Open	20	Pretty / Middle
178	1	59	Yes	84	Open	Open	22	Hikichi
181	1	83	Yes	39	Open	Open	23	M^{c}Farlene
193	1	64	Yes	31	Open	Open	10	Bond / Camp
204	1	40	Yes	56	Open	Open	16	Tyndall
214	1	41	Yes	78	Open	Open	18	Davidson
217	1	44	Yes	47	Open	Open	12	Admusen
224	1	79	Yes	40	Open	Open	17	Dobson
227	1	61	Yes	48	Open	Open	14	Hare
234	1	58	Yes	53	Open	Open	15	6th

PUMP 1		PUMP 2		PUMP 3	
Flow l/s	Head m	Flow l/s	Head m	Flow l/s	Head m
0.0	292.6	0.0	292.6	0.0	260.6
126.2	237.7	126.2	237.7	15.8	244.4
189.3	216.4	189.3	216.4	31.5	232.7
220.8	201.2	220.8	201.2	47.3	223.3
252.4	179.2	252.4	179.2	63.1	218.5
283.9	154.4	283.9	154.4	78.9	211.5
315.5	126.5	315.5	126.5	94.6	202.1
				110.4	188.1
				142.0	153.4
				173.5	95.8

ANNEX 3

License Details

MINISTRY OF ENVIRONMENT, LANDS & PARKS
Water Rights Information System
Client Water Licence Summary

Client Name LAKE COUNTRY DISTRICT OF

Licence Number	Status	File Number	Purpose	Licenced Quantity	Units	Source Reference
011623	CURRENT	0093308	STORAGE	4,000.000	AF	Crooked Lake
015025	CURRENT	0143062	STORAGE	4,172.000	AF	Swalwell Lake
021807	CURRENT	0196602	STORAGE	507.000	AF	Vernon Creek
034636	CURRENT	0281970	WATERWORKS LOCAL AUTH	91,250,000.000	GY	Vernon Creek
			IRRIGATION LOCAL AUTH	1,053.250	AF	Vernon Creek
056171	CURRENT	0368284	DOMESTIC	200.000	GD	Vernon Creek
			IRRIGATION LOCAL AUTH	12.730	AF	Vernon Creek
059644	CURRENT	0365133	IRRIGATION LOCAL AUTH	500.000	AF	Vernon Creek
059645	CURRENT	0364803	WATERWORKS LOCAL AUTH	136,875,000.000	GY	Vernon Creek
108281	CURRENT	0285672	WATERWORKS LOCAL AUTH	1,934,500,000.000	GY	Okanagan Lake
006991	CURRENT	0241871	INCIDENTAL - DOMESTIC	2,000.000	GD	Swalwell Lake
			IRRIGATION LOCAL AUTH	550.000	AF	Swalwell Lake
010425	CURRENT	0066196	STORAGE	5,500.000	AF	Swalwell Lake
F010426	CURRENT	0066196	IRRIGATION LOCAL AUTH	25.000	AF	Vernon Creek
010427	CURRENT	0066196	IRRIGATION	26.500	AF	Vernon Creek
011414	CURRENT	0066196	WATERWORKS LOCAL AUTH	18,250,000.000	GY	Vernon Creek
F018936	CURRENT	0257817	IRRIGATION LOCAL AUTH	.500	AF	Vernon Creek
019809	CURRENT	0066196	WATERWORKS LOCAL AUTH	36,500,000.000	GY	Vernon Creek
			IRRIGATION LOCAL AUTH	4,151.750	AF	Vernon Creek
070848	CURRENT	0028233	INCIDENTAL - DOMESTIC	250.000	GD	Vernon Creek
			IRRIGATION LOCAL AUTH	50.000	AF	Vernon Creek
070849	CURRENT	8001600	INCIDENTAL - DOMESTIC	250.000	GD	Vernon Creek
			IRRIGATION LOCAL AUTH	14.000	AF	Vernon Creek
070850	CURRENT	8001601	DOMESTIC	250.000	GD	Vernon Creek
			IRRIGATION	26.000	AF	Vernon Creek
070851	CURRENT	8001602	INCIDENTAL - DOMESTIC	250.000	GD	Vernon Creek
			IRRIGATION LOCAL AUTH	13.000	AF	Vernon Creek
070852	CURRENT	8001603	DOMESTIC	250.000	GD	Vernon Creek
			IRRIGATION	24.000	AF	Vernon Creek
070853	CURRENT	8001604	DOMESTIC	250.000	GD	Vernon Creek
			IRRIGATION	12.500	AF	Vernon Creek
070854	CURRENT	8001605	DOMESTIC	250.000	GD	Vernon Creek
070854	CURRENT	8001605	IRRIGATION	25.000	AF	Vernon Creek
070855	CURRENT	8001606	DOMESTIC	250.000	GD	Vernon Creek
			IRRIGATION	24.250	AF	Vernon Creek
070856	CURRENT	8001607	DOMESTIC	250.000	GD	Vernon Creek
			IRRIGATION	19.500	AF	Vernon Creek
070857	CURRENT	8001608	INCIDENTAL - DOMESTIC	250.000	GD	Vernon Creek
			IRRIGATION LOCAL AUTH	10.750	AF	Vernon Creek
070858	CURRENT	8001609	DOMESTIC	250.000	GD	Vernon Creek
			IRRIGATION	58.500	AF	Vernon Creek

ANNEX 4

Water Quality Improvements
Cost Estimate

ANNEX 4
MASTER WATER SERVICING PLAN

WATER QUALITY IMPROVEMENTS - COST ESTIMATES

1. *OKANAGAN LAKE RESERVOIR GRAVITY SUPPLY*

1.1 *Phase 1 – Town Centre / Woodsdale*

.1	300 mm HDPE, 290 m @ $130/m	$ 38,000
.2	Valves & Fittings	$ 12,000
.3	PR Building, 64 m^2 @ 800m^2	$ 51,000
.4	Mechanical	$ 50,000
.5	Relocate PR's 5 & 6	$ 8,000
.6	Service Reconnections, 2 @ $500/conn.	$ 1,000
.7	Asphalt 150 m^2 @ $20/ m^2	$ 3,000
.8	Road Crossings 2 @ $6,000	$ 12,000
.9	*Sub-total*	*$ 175,000*
.10	Engineering & Contingencies @ 25%	$ 44,000
.11	District Administration @ 10%	$ 22,000
.12	**Sub-total**	**$ 241,000**

1.2 *Phase 2 – Okanagan Centre Road*

.1	400 mm HDPE, 2300 m @ $180/m	$ 414,000
.2	300 mm HDPE, 700 m @ $130/m	$ 91,000
.3	250 mm HDPE, 1,080 m @ $110/m	$ 119,000
.4	200 mm HDPE, 810 m @ $90/m	$ 73,000
.5	Air Valve Assembly, 1 @ $3,500	$ 3,500
.6	Valves & Fittings	$ 50,000
.7	Service Reconnections, 113 @ $500/conn.	$ 56,500
.9	Abandon PR's 7, 8, 9, 13 & 21	$ 20,000
.9	New PR 13	$ 45,000
.10	Relocate PR's 9 & Reconfigure PR 19	$ 16,000
.11	Asphalt 1,200 m^2 @ $20/ m^2	$ 24,000
.12	*Sub-total*	*$ 912,000*
.13	Engineering & Contingencies @ 25%	$ 228,000
.14	District Administration @ 10%	$ 114,000
.15	**Sub-total**	**$1,254,000**

1.3 *Phase 3 - Okanagan Centre & Oceola Road Interconnect*

.1	200 mm HDPE, 390 m @ $80/m	$ 31,000
.2	Valves & Fittings	$ 6,000
.3	Services, 2 @ $500	$ 1,000
.4	Asphalt, 100 m^2 @ $20/$m^2$	$ 2,000
.5	*Sub-total*	*$ 40,000*
.6	Engineering & Contingencies @ 25%	$ 10,000
.7	District Administration @ 10%	$ 5,000
.8	**Sub-total**	**$ 55,000**

1.4 *Phase 4 – PR 22 & PR 17 Interconnect*

.1	200 mm HDPE, 850 m @ $95/ m	$ 81,000
.2	Valves & Fittings	$ 7,000
.3	Air Valve Assembly, 2 @ $3,500	$ 7,000
.4	*Sub-total*	*$ 95,000*
.5	Engineering & Contingencies @ 25%	$ 23,500
.6	District Administration @ 10%	$ 11,500
.7	**Sub-total**	**$ 130,000**

1.5 **TOTAL** **$1,680,000**

2. *OKANAGAN LAKE PUMPED SUPPLY*

2.1 *Okanagan Lake Pump Station*

.1	Control Panel Upgrade & 750 hp VFD	$ 150,000
.2	Screens	$ 130,000
.3	Chlorine Injection Reconfiguration	$ 10,000
.4	Pump & Motor Servicing	$ 40,000
.5	Miscellaneous Mechanical	$ 20,000
.6	*Sub-total*	*$ 350,000*
.7	Engineering & Contingencies @ 25%	$ 87,000
.8	District Administration @ 10%	$ 43,000
.9	**Sub-total**	**$ 480,000**

2.2 *UltraViolet Disinfection Facility*

.1	Excavation & Site Prep, 200 m^3 @ $15	$ 3,000
.2	Building, 40 m^2 @ $800/$m^2$	$ 32,000
.3	Valves & Fittings	$ 40,000
.4	Pipeline, 500 mm HDPE, 300 m @ $230/m	$ 69,000
.5	Flow Meter & Recorder	$ 15,000
.6	UV Units, 3 @ $150,000	$ 450,000
.7	Chlorine Residual Analyzer & Test Kit	$ 10,000
.8	Power Supply – 3 Phase	$ 10,000
.9	Electrical Equipment	$ 45,000
.10	Backfilling & Landscaping	$ 10,000
.11	*Sub-total*	*$ 684,000*
.12	Engineering & Contingencies @ 25%	$ 171,000
.13	District Administration @ 10%	$ 85,000
.14	**Sub-total**	**$ 940,000**

2.3 *Glenmore Road Pump Station (350 hp, 200 lps)*

.1	Power Supply	$ 6,000
.2	Pumps, 2 @ $20,000	$ 40,000
.3	Electrical Equipment	$ 180,000
.4	Mechanical Equipment	$ 100,000
.5	Telemetry	$ 20,000
.6	Site Preparation & Landscaping	$ 10,000
.7	500 mm HDPE, 175 m @ $250/m	$ 44,000
.8	Mainline Valves	$ 10,000
.9	Connection to Existing Pipelines	$ 20,000
.10	Pavement, 300 m^2 @ $20/$m^2$	$ 6,000
.11	*Sub-total*	*$ 436,000*
.12	Engineering & Contingencies @ 25%	$ 109,000
.13	District Administration @ 10%	$ 55,000
.14	**Sub-total**	**$ 600,000**

2.4 *TOTAL* *$2,020,000*

3. *VERNON CREEK WATER TREATMENT FACILITY*

.1	Pilot Plant Construction, Operation and Summary Report	$ 100,000
.2	Site Excavation & Backfill	$ 60,000
.3	Front End Piping	$ 80,000
.4	Chemical Feed System	$ 170,000
.5	Flocculators	$ 220,000
.6	Floatation/Clarification	$1,400,000
.7	Filtration	$1,150,000
.8	Backwash Water Storage Reservoir	$ 150,000
.9	Electrical and Instrumentation	$ 850,000
.10	Building	$ 820,000
.11	Heating, Ventilating, and Plumbing	$ 200,000
.12	Yard Piping including Backwash Water	$ 120,000
.13	Compressed Air and Plant Service Water	$ 100,000
.14	Sludge Storage	$ 50,000
.15	Filter Backwash Water Recycling	$ 100,000
.16	Treated Water Reservoir, 5.5 Million Litre	$ 800,000
.17	Landscaping and Parking	$ 30,000
.18	*Sub-total*	*$6,400,000*
.19	Engineering & Contingencies @ 25 %	$1,600,000
.20	District Administration @ 5%	$ 400,000
.21	TOTAL	**$8,400,000**

4. WATER QUALITY IMPROVMENTS **GRAND TOTAL** **$12,100,000**

ANNEX 5

Separate Domestic System Cost Estimate

ANNEX 5
MASTER WATER SERVICING PLAN

SEPARATE DOMESTIC SYSTEM - COST ESTIMATES

1.	*OKANAGAN LAKE RESERVOIR GRAVITY SUPPLY*			
	1.4		*TOTAL*	*$1,680,000*
2.	*OKANAGAN LAKE PUMPED SUPPLY*			
	2.4		*TOTAL*	*$2,020,000*
3.	*SEPARATE DISTRIBUTION SYSTEM*			
	3.1	***Balancing Reservoir, 5.0 Million Litres***		
	.1	Excavation & Backfilling		$ 65,000
	.2	Concrete Structure		$ 600,000
	.3	Reservoir Piping & Overflow		$ 90,000
	.4	Valve Control Building		$ 52,000
	.5	Supply/Discharge Mains:		
		.1 500 mm HDPE, 700 m @ $230/m		$ 160,000
	.6	Valves & Fittings		$ 15,000
	.7	*Sub-total*		*$ 982,000*
	.8	Engineering & Contingencies @ 25%		$ 245,000
	.9	District Administration @ 10%		$ 123,000
	.10		**Sub-total**	**$1,350,000**
	3.2	***Distribution System***		
	.1	500 mm HDPE, 2,950 m @ $225/m		$ 664,000
	.2	300 mm HDPE, 1,460 m @ $135/m		$ 197,000
	.3	250 mm HDPE , 2,300 m @ $115/m		$ 265,000
	.4	200 mm HDPE , 9,740 m @ $95/m		$ 925,000
	.5	150 mm HDPE , 3,960 m @ $90/m		$ 356,000
	.6	100 mm , HDPE 1,050 m @ $70/m		$ 74,000
	.7	Valves & Fittings		$ 427,000
	.8	Service Re-connections		
		.1 Domestic, 410 @ $500		$ 205,000
		.2 Irrigation, 210 @ $750		$ 158,000
	.9	PR Stations, 7 @ $40,000		$ 315,000
	.10	Air Valves, 15 @ $3,500		$ 53,000
	.11	Hydrant Reconnections, 28 @ $2,000		$ 56,000
	.12	Traffic Control & Road Crossings		$ 300,000
	.13	Cross Connection Control Measure		$ 500,000
	.14	*Sub-total*		*$4,495,000*
	.14	Engineering & Contingencies @ 25%		$1,124,000
	.15	District Administration @ 5%		$ 281,000
	.16		**Sub-total**	**$5,900,000**
	3.3		**TOTAL**	**$7,250,000**
4.	*SEPARATE DOMESTIC SYSTEM*		*GRAND TOTAL*	*$10,950,000*

ANNEX 6

Distribution System Analysis - Phase II, Water Quality Improvements

District of Lake Country
Water Quality Improvements
Okanagan Lake Supply Area - Phase 2 @ Peak Hour Demand
December 2001

File Name: Phase1.xls

PIPE TABLE

Pipe	Up Node	Down Node	Length m	Diameter mm	Roughness C	Flow l/s	Velocity m/sec	HeadLoss m	Status	Pipe Description
54	50	51	10	150	100	91.9	5.2	56.4	Open	PR6
56	52	53	10	150	100	55.4	3.1	41.0	Open	PR7
103	95	100	10	75	100	0.0	0.0	0.0	Closed	PR8 (Removed)
104	100	101	177	400	140	106.6	0.8	0.3	Open	UPGRADED
105	101	102	334	150	130	3.2	0.2	0.1	Open	
106	101	103	176	400	140	100.1	0.8	0.2	Open	UPGRADED
107	103	104	473	400	140	91.8	0.7	0.6	Open	UPGRADED
108	96	105	10	100	100	0.0	0.0	0.0	Closed	PR9 (Removed)
109	105	106	398	200	130	13.4	0.4	0.5	Open	
110	106	107	446	100	130	4.8	0.6	2.2	Open	
111	107	108	108	150	130	-5.2	-0.3	0.1	Open	
112	108	109	186	150	130	2.3	0.1	0.0	Open	
113	108	110	97	150	130	-8.4	-0.5	0.2	Open	
114	110	111	367	150	130	-12.2	-0.7	1.4	Open	
115	111	112	258	400	140	72.8	0.6	0.2	Open	UPGRADED
116	112	113	175	400	140	68.2	0.5	0.1	Open	UPGRADED
117	113	114	188	400	140	67.7	0.5	0.1	Open	UPGRADED
118	114	115	493	400	140	66.8	0.5	0.3	Open	UPGRADED
119	115	116	461	250	130	0.0	0.0	0.0	Closed	
124	120	121	247	200	130	0.0	0.0	0.0	Closed	
125	121	122	110	300	140	-62.9	-0.9	0.3	Open	UPGRADED
126	122	115	435	300	140	-65.1	-0.9	1.1	Open	UPGRADED
127	121	123	185	300	140	62.8	0.9	0.4	Open	UPGRADED
128	123	124	97	150	130	19.9	1.1	0.9	Open	
129	124	125	10	150	130	19.9	1.1	0.1	Open	PR21 (Removed)
130	125	126	115	150	130	19.9	1.1	1.1	Open	
134	123	130	238	250	140	42.6	0.9	0.7	Open	UPGRADED
135	130	131	341	100	130	0.0	0.0	0.0	Closed	
142	137	138	236	250	130	1.5	0.0	0.0	Open	
143	138	139	122	200	140	0.0	0.0	0.0	Closed	UPGRADED
144	139	140	163	250	140	-40.6	-0.8	0.4	Open	UPGRADED
145	140	141	277	250	140	-42.1	-0.9	0.8	Open	UPGRADED
146	142	139	227	150	130	-4.0	-0.2	0.1	Open	
147	142	143	94	150	130	0.0	0.0	0.0	Open	
148	143	144	10	150	10	0.0	0.0	0.0	Open	PR19
153	138	149	112	200	140	1.5	0.0	0.0	Open	
154	149	150	125	200	140	0.0	0.0	0.0	Open	
155	150	151	10	200	100	0.0	0.0	0.0	Open	PR13
159	153	154	10	200	100	8.6	0.3	59.7	Open	PR20
162	151	157	400	150	130	10.2	0.6	1.1	Open	
300	80	100	348	400	140	129.7	1.0	0.8	Open	Proposed 400mm HDPE
301	145	129	550	200	140	-5.6	-0.2	0.1	Open	Proposed 200mm HDPE
302	141	130	138	250	140	-42.5	-0.9	0.4	Open	Proposed 250mm HDPE
303	139	151	383	200	140	35.5	1.1	2.3	Open	Proposed 200mm HDPE
304	80	57	63	200	140	9.9	0.3	0.0	Open	Proposed 200mm HDPE
305	80	36	427	300	140	44.3	0.6	35.8	Open	Prop. 300mm HDPE & PRV
306	100	105	257	250	140	18.3	0.4	0.2	Open	Proposed 250mm HDPE
1001	104	111	2	300	140	86.3	1.2	0.0	Open	
1002	1000	94	10	600	100	0.0	0.0	0.0	Open	

File Name: Phase1.xls

NODE TABLE

Node	Elevation m	Demand l/s	Pressure psi	HGL m	Status	Comments
1	819.3	0	0	819.3	Open	Vernon Creek Intake
50	460	0	213	609.9	Open	U/S PR 6
51	460	1.64	133	553.5	Open	D/S PR 6
52	467.5	0	119	551.4	Open	U/S PR 7
53	467.5	0	61	510.4	Open	D/S PR 7
95	471	0	197	609.5	Open	U/S PR 8 (Removed)
96	478	0	186	608.9	Open	U/S PR 9 (Removed)
100	471	4.82	88	532.9	Open	D/S PR 8
101	475	3.29	82	532.6	Open	
102	460	3.18	103	532.5	Open	
103	480	8.33	74	532.3	Open	
104	477	5.43	78	531.8	Open	
105	478	4.88	78	532.7	Open	D/S PR 9
106	478	8.66	77	532.2	Open	
107	481	9.98	70	530.1	Open	
108	485	0.88	64	530.1	Open	
109	486	2.3	63	530.1	Open	
110	481	3.78	70	530.3	Open	
111	477	1.37	78	531.8	Open	
112	455	4.61	109	531.6	Open	
113	472	0.5	84	531.4	Open	
114	479	0.88	74	531.3	Open	
115	491	1.71	57	531.0	Open	
116	500	8.11	110	577.2	Open	
120	504	28.55	103	576.5	Open	
121	498	0.15	45	529.6	Open	
122	493	2.17	52	529.9	Open	
123	502	0.3	39	529.1	Open	
124	495	0	47	528.2	Open	U/S PR 21 (Removed)
125	495	0	47	528.1	Open	D/S PR 21
130	501	0.15	39	528.5	Open	
131	518	16.53	39	545.6	Open	
137	518	17.69	83	576.5	Open	
138	495	0.063	116	576.5	Open	
139	495	1.06	45	526.9	Open	
140	498	1.46	42	527.3	Open	
141	499	0.36	41	528.1	Open	
142	466	4.06	86	526.8	Open	
143	451.5	0	107	526.8	Open	U/S PR 19
144	451.5	3.89	99	521.3	Open	D/S PR 19
149	495	1.47	116	576.5	Open	
150	485	0	130	576.5	Open	U/S PR 13
151	485	0	56	524.6	Open	D/S PR 13
152	457	1.97	95	523.8	Open	
153	423	3.18	142	522.8	Open	U/S PR 20
154	423	0.77	57	463.1	Open	D/S PR 20
155	404.5	6.47	83	463.0	Open	
156	395	1.37	96	462.9	Open	
157	479	10.16	63	523.5	Open	

ANNEX 7

Vernon Creek Water Quality

1. 1996 and 1997 by Summitt Environmental Consultants

2. Grab Sample Data by Ministry of Water, Land, and Air Protection

WOCID

Water Sampling   Combined

SITE 2   50° 00. 826' N, 119° 18. 942' W

Date	Time	Temperature (°C)	Colour (TCU)	pH	EC (umhos/cm)	Turbidity (NTU)	Total P (mg/L)	Total Suspended Solids (mg/L)	Total Coliform (col/ 100mL)	Fecal Coliform (col/ 100mL)
29/05/96	16:04	9.5	**52**	7.3	56	1.75	0.020	1.5	**22**	**17**
05/06/96	15:30	13.0	***54***	7.1	55	**7.20**	0.030	17.0	**29**	**3**
12/06/96	14:15	*14.0*	**48**	7.4	65	1.70	0.020	1.0	7	**1**
19/06/96	15:45	12.5	**47**	7.5	76	1.40	0.005	3.0	**75**	**5**
27/06/96	14:20	13.0	**49**	7.3	80	1.50	0.005	2.0	**69**	**8**
10/07/96	14:20	***16.0***	**42**	7.4	72	1.00	0.010	1.0	7	**5**
**18/07/96	17:25	*14.0*	**36**	*7.6*	73	1.20	0.020	2.0	**100**	**6**
24/07/96	12:50	***17.5***	**33**	7.5	70	1.00	0.020	0.5	***310***	**20**
07/08/96	11:45	*14.5*	**33**	7.4	73	0.80	0.010	1.0	**34**	**1**
21/08/96	13.05	*14.0*	**33**	7.5	67	1.00	0.010	0.5	**52**	***40***
04/09/96	13:30	13.0	**29**	7.3	71	0.75	0.010	0.5	**60**	**16**
18/09/96	11:40	10.0	**32**	7.5	81	0.95	0.020	1.0	**34**	***33***
**19/09/96	10:30	11.0	**32**	7.5	82	1.30	0.020	2.0	**48**	**22**
02/10/96	12:20	8.0	**23**	7.3	83	1.10	0.005	0.5	**43**	***41***
16/10/96	14:10	4.0	**30**	*7.6*	83	0.80	0.010	0.5	**18**	**5**
30/10/96	12:30	4 0	**42**	*7.6*	*94*	1.20	0.005	0.5	**35**	**20**
13/11/96	14:40	6.0	**32**	7.5	*95*	2.20	0.030	0.5	**24**	**2**
11/12/96	10:15	3.0	**23**	7.3	*101*	0.80	0.020	0.5	3	0
10/01/97	10:30	1.0	**27**	7 2	66	0.65	0.005	0.5	0	0
18/02/97	12:30	2.5	**28**	7.3	70	1.30	0.005	0.5	8	0
21/03/97	12:15	3.0	**28**	7 0	82	***21***	0.060	14.0	<u>6</u>	<u>2</u>
03/04/97	13:30	2.5	**30**	7.1	82	1.70	0.005	0.5	**22**	**4**
14/04/97	14:45	4.0	**33**	7.0	81	4.80	0.020	3.0	**17**	**1**
17/04/97	12:15	4.0	***60***	7.3	78	**7.90**	0.050	11.0	**31**	**20**
**21/04/1997	12:20	3.0	***65***	7.3	80	**5.20**	0.040	5.0	**12**	**6**
**23/04/1997	14:10	3.0	***65***	7.0	75	**5.70**	0.040	7.0	**19**	**4**
**28/04/1997	14:30	3.5	***60***	6.6	59	***22***	*0.120*	*69.0*	**12**	**3**
**01/05/1997	14.45	4.0	**50**	7.0	59	***29***	*0.120*	*53.0*	***120***	**4**
**21/05/1997	12:50	10	**50**			**7.2**			4	**4**
Mean		8.2	**40**	7.3	75	4.6	0.026	7.1	**42**	**10**
Standard deviation		5.1	13	0.2	11	7.1	0.030	16.0	59	12
CV%		62%	32%	3%	15%	154%	115%	225%	141%	117%
n		29	29	28	28	29	28	28	29	29
Minimum		1.0	23.0	6 6	55.0	0.7	0.0	0.5	0.0	0.0
Maximum		17.5	65.0	7 6	101.0	29.0	0.1	69.0	310.0	41.0
90th Percentile		14	60	8	86	11	0	15	80	24
Detection Limit		0.5	1	0.1	1	0.1	0.01	2	1	1
*WQC										
- Aquatic Life			50	6.5-9.0	nc	nc	nc	see (1)	nc	nc
- Drinking Water		15.0	15	6.5-8.5	700	5	nc	nc	10	see (2)
- Recreation			15	5.0-9.0	nc	see (3)	nc	nc	see (4)	see (4)

nc = no criteria

Values not within criteria shown in **bold**

Values in *italics* are > mean + 1 standard deviation

<u>Underlined</u> values are suspect: analysis conducted more than 24 hours after sample was taken

Notes

1 Increase of 10 mg/l (where background <= 100 mg/l); increase of 10% (where background > 100 mg/l)

2 Geometric mean of 5 samples over 30 d not to exceed 200 E. coli per 100 mL. Resample if over 400/100 mL

3. Not to increase >5 NTU over natural turbidity (when turbidity < 50 NTU

4 Geometric mean of 5 samples over 30 d not to exceed 200 E. coli per 100 mL. Resample if over 400/100 mL

* Approved and Working Criteria for Water Quality (MoELP,1995)

** Storm Event/High Flow

Grab Sample Water Quality Data - 1997 to 2000
Intake Pond on Vernon Creek

Site: E224185

Date	Time	Colour (TCU)	Dissolved Oxygen (mg/L)	Dissolved $NO_3 + NO_2$ (mg/L)	Suspended Solids (mg/L)	Specific Conductance (uS/cm)	Temp. (°C)	Turbidity (NTU)	pH
07/03/97	10:10	50		0.01	5	65		1.8	7.68
07/17/97	11:00	45		0.041	11	61		4.2	7.69
07/31/97	11:55	50		0.02	5	70		2.3	7.67
07/31/97	12:03		11.22			80.1	15.37	4.83	7.94
08/14/97	11:22	45		0.025	5	72		1.7	7.76
09/03/97	10:50	40		0.027	5	76		1.48	7.78
09/16/97	15:25	45		0.045	5	98		0.94	7.91
09/30/97	15:40	30		0.037	5	100		1.99	7.82
10/16/97	12:44	45		0.03	5	85		1.99	7.82
10/28/97	10:30	35		0.035	5	85		1.28	7.93
11/26/97	11:25	25		0.064	5	89		1.09	7.81
02/11/98	10:26	29		0.065	5	76	1	0.91	7.74
03/31/98	8:30	30		0.053	5	88	2.5	2.5	7.76
04/28/98	14:10	50	11.59	0.019	26	58	6.3	11.7	7.53
05/12/98	13:45	45	9.01	0.022	5	38	12.36	1.94	7.64
05/25/98	11:20	35	10.7	0.043	5	74	11	1.66	7.73
06/01/98	11:00	30	11	0.047	5	80	10.7	1.54	7.7
06/11/98	13:00	25	10.92	0.032	5	80	13.8	2.11	7.68
06/16/98	15:20	30	10.9	0.033	5	7.78	13	1.42	7.78
06/18/98	9:45	30	11.4	0.04	5	84	11	1.27	7.8
06/25/98	13:10	25	10.1	0.025	6	79	13.3	2.86	7.7
07/08/98	14:00	30	9.75	0.025	5	72	17.5	1.49	7.81
07/23/98	14:00	20	9.76	0.025	5	66	19	1.86	7.54
08/06/98	9:40	28		0.017	5	67		1.64	7.66
08/19/98	15:00	22	10.1	0.025	5	67	15.1	1.5	7.74
08/27/98	13:30	25		0.029	5	67	12	1.58	7.86
09/08/98	15:00	15		0.042	5	68	14	1.7	7.74
10/01/98	10:00	13		0.139	5	91.8	10	1.15	7.8
10/21/98	11:00	10		0.129	5	114	4.3	0.62	7.79
11/05/98	10:30	13		0.109	5	117	5.1	0.52	7.8
11/23/98	11:40	20		0.157	5	122	2.7	0.84	7.87
12/09/98	14:30	19		0.119	5	106		0.7	7.82
01/28/99	13:30	20	12.6	0.11	5	93.6	0.8	0.77	7.83
02/23/99	13:30	13		0.1	5	105	1	0.58	7.9
03/22/99	13:45	30		0.217	7	113	2.4	12.9	7.92
03/31/99	15:30	25		0.123	5	94	2	6.2	7.7
04/15/99	15:00	30	12.1	0.083	5	89	3.2	3.2	7.76
04/15/99	15:30					91		3.2	
05/11/99	14:00	35		0.034	9	61	7.2	3.6	7.61
05/19/99	14:45	50		0.022	7	60		4.3	7.59
05/25/99	16:00	40		0.013	8	56	9.8	3.2	7.56
06/03/99	12:00	35		0.018	6	61	10.7	2.2	7.62
06/07/99	15:15	30	7.6	0.015	5	63	10.65	1.8	7.57
06/24/99	15:00	30	10.6	0.031	5	75	12.2	2.9	7.84
07/13/99	13:00	30	9.5	0.028	5	70	14.3	2	7.76
07/27/99	12:45	25	9.7	0.03	5	66	14.87	1.5	7.43
07/29/99	15:08					68		1.6	
08/10/99	13:15	25	10.65	0.032	5	69	16.54	1.7	7.85
08/26/99	14:30	25		0.037	5	67	16.7	1.75	7.8
09/09/99	14:45	25		0.053	5	75	11.5	1.5	7.78
09/13/99	16:09					76		1.6	

Date	Time	Colour (TCU)	Dissolved Oxygen (mg/L)	Dissolved $NO_3 + NO_2$ (mg/L)	Suspended Solids (mg/L)	Specific Conductance (uS/cm)	Temp. (°C)	Turbidity (NTU)	pH
09/23/99	15:00	20		0.042	5	72	12	1.8	7.78
10/07/99	14:05	20	11	0.053	5	81	8.7	1.1	7.6
10/21/99	13:30	20	11.57	0.059	5	89	4.9	0.35	7.94
11/29/99	11:00	25		0.074	5	91	1.7	0.81	7.24
11/29/99	11:50					92		1.1	
12/09/99	14:00	20		0.086	5	89	1.2	0.94	7.86
03/14/00	11:30	20		0.049	5	75		2	7.85
03/21/00	10:00	20		0.044	5	69		1.6	7.71
03/30/00	13:27	20		0.039	5	65	2.6	1	7.78
04/05/00	15:45	25		0.044	5	68	3.9	1.7	7.74
04/11/00	16:45	50		0.038	6	65	4.7	3.8	7.94
04/13/00	15:10					66		5.1	
04/19/00	12:00	60		0.036	7	61	3.2	4.3	7.43
04/27/00	14:45	40		0.03	12	53	6.2	3.4	7.52
05/02/00	15:00	50		0.031	6	56	7	2.74	7.39
05/02/00	16:00					56		2.12	
05/04/00	12:45					59		1.37	
05/16/00	13:13					56		2.8	
05/16/00	13:45	45	11.2	0.018	7	55	9.6	2.1	7.09
05/30/00	12:00	25	10.4	0.03	5	58	9.9	2.08	7.64
05/31/00	13:25					65		1.44	
06/14/00	11:00	45		0.018	5	70	10.2	1.91	7.79
06/14/00	11:45					71	5.9	2.2	
06/29/00	10:30	25	10	0.03	5	70	13.6	1.25	7.84
07/11/00	14:15	30	10	0.034	5	68	14.5	1.2	7.77
07/11/00	14:40					69		2.2	
08/03/00	15:15	25	9.6	0.037	5	63	18.7	1.7	7.7
08/03/00	15:38					64		0.15	
08/30/00	13:45	22	9.8	0.027	5	62	12.8	1.39	7.75
08/31/00	11:28					64		1.26	
09/07/00	10:30	25		0.036	5	68	10.7	1.3	7.84
09/21/00	14:15	22		0.03	5	68	9.7	1.52	7.68
10/10/00	12:15	22	10.9	0.033	5	72	7.9	0.1	7.68
10/10/00	13:26					74		0.52	
10/24/00	11:39	20		0.053	5	72		0.1	6.88
11/01/00	1:13					84	4.69	0.51	
11/07/00	3:05	22	12.22	0.08	5	84	3.06	0.09	7.33
11/22/00	10:07	18	14.76	0.107	5	86	0.04	0.85	7.47
12/07/00	12:12	17.5	13.7	0.101	5	87	0.52	0.53	7.56
02/12/01	11:30	19		0.07	5	74	0.7	0.52	7.85
03/20/01	11:30	22.5		0.053	5	82	2.4	0.63	7.86
Minimum		**10**	**7.6**	**0.01**	**5**	**7.78**	**0.04**	**0.09**	**6.88**
Mean		**29**	**10.8**	**0.05**	**6**	**74**	**8**	**2.0**	**7.71**
Maximum		**60**	**14.76**	**0.217**	**26**	**122**	**19**	**12.9**	**7.94**

ANNEX 8

Correspondence from Okanagan Similkameen Health Region

Okanagan Similkameen
Health Region

COPY
CAN BE DESTROYED

July 31, 1998

W - WOCID

Michael Mercer, Administrator
District of Lake Country - Winfield Okanagan Centre Water System
10591 Okanagan Centre Rd E
Winfield BC V4V 1K3

Dear Sir:

Re: **Water Treatment**

This letter will confirm our conversation during the visit to your facility by myself and Guy Osachoff on July 28, 1998.

In the last few months there have been positive coliform counts from samples of your system. This has resulted in a boil advisory being imposed. As we went through your records it was noted that your chlorine injection system is operating at maximum capacity. At the same time, there have been instances where the chlorine residual in your system has been inadequate. This indicates that your chlorination system is unable to provide the amount of chlorine required for the quantity and quality of water you are using.

It is recommended that your chlorine injection capacity be increased.

As soon as the chlorine injection problem is resolved, it would be advisable to test for chlorine throughout the system to determine that a chlorine residual can indeed be maintained. You may also wish to budget for coliform testing at certain critical points in your system, say, three samples per week. You may wish to investigate presence/absence testing equipment which could be used by your own staff for all of your water systems. This testing equipment and the staff to operate it would enhance your ability to provide safe drinking water for your customers.

If you have any questions, please contact me at the South Okanagan Health Unit in Penticton at (250)770-3523.

Yours truly,

ORIGINAL SIGNED BY
R.H. JOHNSTON, P.Eng.

R.H. Johnston, P. Eng.
Public Health Engineer/Okanagan Region

RHJ:cq

c.c. Guy Osachoff, PHI, SOHU, 1340 Ellis St, Kelowna BC V1Y 9N1
Dr W P Moorehead, MHO, OSHR, 2180 Ethel St, Kelowna BC V1Y 3A1

Okanagan Similkameen Health Region

May 25, 1998

File: 32900-20
Winfield & Okanagan
Centre Irrigation District

Mr. Michael Mercer, Administrator
Winfield & Okanagan Centre Irrigation District
10591 Okanagan Centre Road East
Lake Country, B. C. V4V 1K3

Dear Mr. Mercer:

Re: Boil Water Advisory – May 21, 1998

Further to phone conversations and a meeting May 21, 1998 with this office, this is to confirm that a Boil Water Advisory is effective May 21, 1998 for the Vernon Creek source of the Winfield and Okanagan Centre Irrigation District Waterworks System. The advisory is in response to the lack of a free chlorine residual at some end points in the waterworks system and the continued detection of total coliforms.

The above advisory will remain in place until two consecutive sets of samples taken from the community, each set on a different day, show no presence of coliform organisms.

If you require further information, please call me at 862-4300 local 4219.

Sincerely,

for Dr. William P. Moorehead
MB,ChB,MSc,FRCP(C)
Medical Health Officer & Director

WPM:mh

c.c. Mr. Ron White, Chief P.H.I.

Ken Cooper, D/C, P.H.I.

Mr. Guy Osachoff, P.H.I.

Okanagan Similkameen Health Region
Community Health Programs
2nd Floor, 1340 Ellis Street
Kelowna, B.C. V1Y 1Z8
Telephone: (250)868-7700
Fax: 1st Floor: (250)868-7809
2nd Floor: (250)868-7760

S :em : WINFIELD OKANAGAN CENTRE WATER SYSTEM
O rator: MICHAEL MERCER, MGR
Address : WINFIELD OK CENTRE WATER SYSTE
: 10591 OKANAGAN CENTRE ROAD E
: WINFIELD BC
: V4V 1K3
System
Type : Community Water System-301+ connections

For Further Enquires Contact:
OKANAGAN SIMILKAMEEN HLTH REG
2ND FLOOR
1340 ELLIS STREET
KELOWNA BC
V1Y 9N1
Telephone: **868-7834**

Water Sites	Date Collected	Positive Results	Total Coliform	Faecal Coliform	Over-Grown	Site type	Site Source	Site Status
OKANAGAN LAKE	2000.11.30	[N]	-	-	[N]	Dist.System	Lake(s)	A
	2000.10.31	[N]	-	-	[N]			
	2000.09.26	[N]	-	-	[N]			
	2000.08.25	[N]	-	-	[N]			
	2000.08.22	[N]	-	-	[N]			
	2000.07.25	[N]	-	-	[N]			
	2000.06.28	[N]	-	-	[N]			
	2000.06.22	[N]	-	-	[N]			
	2000.06.22	[N]	-	-	[N]			
	2000.05.10	[N]	-	-	[N]			
	2000.05.01	[N]	-	-	[N]			
	2000.03.09	[N]	-	-	[N]			
	2000.02.29	[N]	-	-	[N]			
	2000.02.10	[N]	-	-	[N]			
	2000.01.27	[N]	-	-	[N]			
	1999.12.08	[N]	-	-	[N]			
	1999.11.04	[N]	-	-	[N]			
	1999.10.13	[N]	-	-	[N]			
	1999.09.08	[N]	-	-	[N]			
	1999.08.31	[N]	-	-	[N]			
	1999.08.11	[N]	-	-	[N]			
	1999.07.13	[N]	-	-	[N]			
	1999.06.14	[N]	-	-	[N]			
	1999.05.26	[N]	-	-	[N]			
	1999.05.07	[N]	-	-	[N]			
	1999.05.07	[N]	-	-	[N]			
	1999.04.19	[N]	-	-	[N]			
	1999.03.23	[N]	-	-	[N]			
	1999.02.04	[N]	-	-	[N]			
	1998.12.22	[N]	-	-	[N]			
	1998.10.14	[N]	-	-	[N]			
	1998.09.14	[N]	-	-	[N]			
	1998.08.11	[N]	-	-	[N]			
	1998.07.08	[N]	-	-	[N]			
	1998.06.23	[N]	-	-	[N]			
	1998.05.26	[N]	-	-	[N]			
	1998.05.25	[Y]*	3	-	[N]			
	1998.05.21	[N]	-	-	[N]			
	1998.05.21	[Y]*	1	-	[N]			
	1998.05.19	[N]	-	-	[N]			
	1998.05.11	[Y]*	42	-	[N]			
	1998.05.11	[N]	-	-	[N]			
	1998.05.08	[N]		-	[Y]			
	1990.01.13	[N]	-	-	[N]			
VERNON CREEK SOURCE	2000.11.30	[N]	-	-	[N]	Dist.System	Lake(s)	A
	2000.11.24	[N]	-	-	[N]			
	2000.11.24	[N]	-	-	[N]			
	2000.10.31	[N]	-	-	[N]			
	2000.10.13	[N]	0	0	[N]			
	2000.10.13	[N]	0	0	[N]			
	2000.10.13	[N]	0	0	[N]			
	2000.09.26	[N]	-	-	[N]			
	2000.08.25	[N]	-	-	[N]			
	2000.08.01	[Y]*	.2	.3	[N]			
	2000.07.25	[N]	-	-	[N]			
	2000.07.12	[N]	-	-	[N]			
	2000.07.11	[N]	-	-	[N]			
	2000.07.11	[N]	-	-	[N]			
	2000.06.28	[N]	-	-	[N]			
	2000.06.28	[N]	-	-	[N]			
	2000.06.28	[N]	-	-	[N]			
	2000.06.22	[N]	-	-	[N]			
	2000.06.07	[N]	-	-	[N]			
	2000.06.07	[N]	-	-	[N]			
	2000.06.07	[N]	-	-	[N]			
	2000.06.07	[N]	-	-	[N]			

Water Sites	Date Collected	Positive Results	Total Coliform	Faecal Coliform	Over-Grown	Site type	Site Source	Site Status
VERNON CREEK SOURCE	2000.05.10	[N]	-	-	[N]	D	L	A
	2000.05.01	[N]	-	-	[N]			
	2000.03.09	[N]	-	-	[N]			
	2000.02.10	[N]	-	-	[N]			
	2000.01.27	[Y]*	E 1	-	[N]			
	1999.12.08	[N]	-	-	[N]			
	1999.11.04	[N]	-	-	[N]			
	1999.10.13	[N]	-	-	[N]			
	1999.08.31	[N]	-	-	[N]			
	1999.08.25	[N]	-	-	[N]			
	1999.08.25	[N]	-	-	[N]			
	1999.08.24	[N]	-	-	[N]			
	1999.07.14	[N]	-	-	[N]			
	1999.06.14	[N]	-	-	[N]			
	1999.06.04	[N]	-	-	[N]			
	1999.06.03	[N]	-	-	[N]			
	1999.06.03	[N]	-	-	[N]			
	1999.05.27	[N]	-	-	[N]			
	1999.05.14	[N]	0	0	[N]			
	1999.05.14	[N]	0	0	[N]			
	1999.05.07	[N]	-	-	[N]			
	1999.04.19	[N]	-	-	[N]			
	1999.03.23	[N]	-	-	[N]			
	1999.02.04	[N]	-	-	[N]			
	1999.01.27	[N]	-	-	[N]			
	1999.01.25	[N]	-	-	[N]			
	1999.01.11	[N]	-	-	[N]			
	1998.12.21	[N]	-	-	[N]			
	1998.11.24	[N]	-	-	[N]			
	1998.11.16	[N]	-	-	[N]			
	1998.11.16	[N]	-	-	[N]			
	1998.10.15	[N]	-	-	[N]			
	1998.09.14	[N]	-	-	[N]			
	1998.08.27	[N]	0	0	[N]			
	1998.08.20	[N]	0	0	[N]			
	1998.08.14	[N]	-	-	[N]			
	1998.08.14	[N]	-	-	[N]			
	1998.08.12	[N]	-	-	[N]			
	1998.08.12	[N]	-	-	[N]			
	1998.08.12	[N]	-	-	[N]			
	1998.08.11	[N]	-	-	[N]			
	1998.07.28	[N]	-	-	[N]			
	1998.07.10	[N]	-	-	[N]			
	1998.07.10	[N]	-	-	[N]			
	1998.07.10	[N]	-	-	[N]			
	1998.07.10	[N]	-	-	[N]			
	1998.07.08	[N]	-	-	[N]			
	1998.06.22	[N]	0	0	[N]			
	1998.06.09	[N]	-	-	[N]			
	1998.06.09	[N]	-	-	[N]			
	1998.06.09	[N]	-	-	[N]			
	1998.06.08	[Y]*	E 10	9	[Y]			
	1998.06.08	[Y]*	8	-	[N]			
	1998.06.08	[N]	-	-	[N]			
	1998.05.28	[Y]*	27	-	[N]			
	1998.05.28	[N]	-	-	[N]			
	1998.05.28	[N]	-	-	[N]			
	1998.05.28	[N]	-	-	[N]			
	1998.05.28	[N]	-	-	[N]			
	1998.05.28	[N]	-	-	[N]			
	1998.05.26	[N]	-	-	[N]			
	1998.05.26	[N]	-	-	[N]			
	1998.05.26	[N]	-	-	[N]			
	1998.05.26	[N]	-	-	[N]			
	1998.05.25	[N]	-	-	[N]			
	1998.05.25	[N]	-	-	[N]			
	1998.05.25	[N]	-	-	[N]			
	1998.05.25	[N]	-	-	[N]			
	1998.05.25	[N]	-	-	[N]			
	1998.05.25	[N]	-	-	[N]			
	1998.05.25	[Y]*	1	-	[N]			
	1998.05.21	[Y]*	1	-	[N]			
	1998.05.21	[Y]*	4	-	[N]			
	1998.05.21	[Y]*	6	-	[N]			
	1998.05.21	[Y]*	125	-	[N]			
	1998.05.21	[N]	-	-	[N]			
	1998.05.19	[Y]*	E 2	-	[Y]			
	1998.05.19	[Y]*	105	-	[N]			
	1998.05.19	[Y]*	15	-	[N]			
	1998.05.19	[N]	-	-	[N]			

Wat.. Sites	Date Collected	Positive Results	Total Coliform	Faecal Coliform	Over-Grown	Site type	Site Source	Site Status
VERNON CREEK SOURCE	1998.05.12	[N]	-	-	[N]	D	L	A
	1998.05.12	[N]	-	-	[N]			
	1998.05.11	[N]	-	-	[N]			
	1998.05.11	[N]	-	-	[N]			
	1998.05.11	[Y]*	4	-	[N]			
	1998.05.11	[N]	-	-	[N]			
	1998.05.08	[N]	-	-	[N]			
	1998.05.08	[N]	-	-	[N]			
	1998.05.08	[Y]*	18	7	[N]			
	1998.05.08	[Y]*	3	-	[N]			
	1998.05.05	[Y]*	19	-	[N]			
	1990.01.13	[N]	-	-	[N]			
WINFIELD ELEMENTARY SCHOOL	1997.03.03	[N]	-	-	[N]	Dist.System	Flowing Supply(s)	A
	1996.12.20	[N]	-	-	[N]			
	1996.12.20	[N]	-	-	[N]			
	1996.12.20	[N]	-	-	[N]			
WINFIELD/O.K. CENTRE IRR. DIST	1998.07.10	[N]	-	-	[N]	Dist.System	Flowing Supply(s)	A
	1998.04.21	[N]	-	-	[N]			
	1998.03.23	[N]	-	-	[N]			
	1998.02.17	[N]	-	-	[N]			
	1998.01.28	[N]	-	-	[N]			
	1997.11.06	[N]	-	-	[N]			
	1997.10.29	[N]	-	-	[N]			
	1997.09.30	[N]	-	-	[N]			
	1997.08.26	[N]	-	-	[N]			
	1997.07.30	[N]	-	-	[N]			
	1997.07.28	[N]	-	-	[N]			
	1997.07.25	[N]	-	-	[N]			
	1997.07.25	[Y]*	46	-	[N]			
	1997.07.25	[N]	-	-	[N]			
	1997.07.21	[N]	-	-	[N]			
	1997.07.21	[N]	-	-	[N]			
	1997.07.18	[N]	-	-	[N]			
	1997.07.18	[N]	-	-	[N]			
	1997.07.18	[N]	-	-	[N]			
	1997.07.02	[N]	-	-	[N]			
	1997.06.04	[N]	-	-	[N]			
	1997.05.23	[N]	-	-	[N]			
	1997.05.23	[N]	-	-	[N]			
	1997.05.23	[N]	-	-	[N]			
	1997.05.07	[N]	-	-	[N]			
	1997.04.24	[N]	-	-	[N]			
	1997.03.03	[N]	-	-	[N]			
	1997.03.03	[N]	-	-	[N]			
	1997.02.05	[N]	-	-	[N]			
	1997.02.05	[N]	-	-	[N]			
	1997.02.05	[N]	-	-	[N]			
	1997.02.05	[N]	-	-	[N]			
	1997.01.09	[N]	-	-	[N]			
	1997.01.09	[N]	-	-	[N]			
	1997.01.08	[N]	-	-	[N]			
	1996.12.20	[N]	-	-	[N]			
	1996.12.20	[N]	-	-	[N]			
	1996.12.12	[N]	-	-	[N]			
	1996.12.12	[N]	-	-	[N]			
	1996.12.12	[N]	-	-	[N]			
	1996.11.25	[N]	-	-	[N]			
	1996.11.25	[N]	-	-	[N]			
	1996.11.25	[N]	-	-	[N]			
	1996.10.02	[N]	-	-	[N]			
	1996.10.01	[N]	-	-	[N]			
	1996.10.01	[N]	-	-	[N]			
	1996.10.01	[N]	-	-	[N]			
	1996.09.04	[N]	-	-	[N]			
	1996.09.04	[N]	-	-	[N]			
	1996.09.04	[N]	-	-	[N]			
	1996.08.26	[N]	-	-	[N]			
	1996.08.21	[N]	-	-	[N]			
	1996.07.17	[N]	-	-	[N]			
	1996.06.25	[N]	-	-	[N]			
	1996.06.18	[N]	-	-	[N]			
	1996.06.18	[N]	-	-	[N]			
	1996.06.18	[Y]*	1	-	[N]			
	1996.04.29	[N]	-	-	[N]			
	1996.04.29	[N]	-	-	[N]			
	1996.04.29	[N]	-	-	[N]			
	1996.03.26	[N]	-	-	[N]			
	1996.03.26	[N]	-	-	[N]			

Water Sites	Date Collected	Positive Results	Total Coliform	Faecal Coliform	Over-Grown	Site type	Site Source	Site Status
WINFIELD/O.K. CENTRE IRR. DIST	1996.03.26	[N]	-	-	[N]	D	F	A
	1996.02.13	[N]	-	-	[N]			
	1996.02.13	[N]	-	-	[N]			
	1996.02.13	[N]	-	-	[N]			
	1996.02.13	[N]	-	-	[N]			
	1996.01.08	[N]	-	-	[N]			
	1995.12.21	[N]	-	-	[N]			
	1995.11.08	[N]	-	-	[N]			
	1995.11.08	[N]	-	-	[N]			
	1995.11.08	[N]	-	-	[N]			
	1995.10.04	[N]	-	-	[N]			
	1995.10.04	[N]	-	-	[N]			
	1995.10.04	[N]	-	-	[N]			
	1995.09.13	[N]	-	-	[N]			
	1995.09.13	[N]	-	-	[N]			
	1995.09.12	[N]	-	-	[N]			
	1995.09.12	[N]	-	-	[N]			
	1995.09.12	[N]	-	-	[N]			
	1995.07.05	[N]	-	-	[N]			
	1995.06.07	[N]	-	-	[N]			
	1995.06.06	[N]	-	-	[N]			
	1995.06.06	[N]	-	-	[N]			
	1995.05.08	[N]	-	-	[N]			
	1995.05.08	[N]	-	-	[N]			
	1995.05.04	[N]	-	-	[N]			
	1995.03.30	[N]	-	-	[N]			
	1995.03.30	[N]	-	-	[N]			
	1995.03.14	[N]	-	-	[N]			
	1995.02.23	[N]	-	-	[N]			
	1995.02.23	[N]	-	-	[N]			
	1995.02.09	[N]	-	-	[N]			
	1995.02.09	[N]	-	-	[N]			
	1995.02.09	[N]	-	-	[N]			
	1995.02.09	[N]	-	-	[N]			
	1995.01.09	[N]	-	-	[N]			
	1995.01.09	[N]	-	-	[N]			
	1994.12.13	[N]	-	-	[N]			
	1994.12.13	[N]	-	-	[N]			
	1994.12.13	[N]	-	-	[N]			
	1994.11.23	[N]	-	-	[N]			
	1994.11.14	[N]	-	-	[N]			
	1994.11.14	[N]	-	-	[N]			
	1994.11.14	[N]	-	-	[N]			
	1994.09.27	[N]	-	-	[N]			
	1994.09.27	[N]	-	-	[N]			
	1994.08.17	[N]	-	-	[N]			
	1994.07.28	[N]	-	-	[N]			
	1994.06.14	[N]	-	-	[N]			
	1994.06.14	[N]	-	-	[N]			
	1994.06.14	[N]	-	-	[N]			
	1994.05.19	[N]	-	-	[N]			
	1994.05.19	[N]	-	-	[N]			
	1994.05.19	[N]	-	-	[N]			
	1994.05.19	[N]	-	-	[N]			
	1994.05.04	[N]	-	-	[N]			
	1994.04.21	[N]	-	-	[N]			
	1994.04.20	[N]	-	-	[N]			
	1994.04.18	[N]	-	-	[N]			
	1994.04.13	[N]	-	-	[N]			
	1994.03.10	[N]	-	-	[N]			
	1994.03.09	[N]	-	-	[N]			
	1994.03.08	[N]	-	-	[N]			
	1994.03.08	[N]	-	-	[N]			
	1994.03.08	[N]	-	-	[N]			
	1994.03.08	[N]	-	-	[N]			
	1994.03.07	[N]	-	-	[N]			
	1994.03.07	[N]	-	-	[N]			
	1994.02.24	[Y]*	4	-	[N]			
	1994.02.17	[N]	-	-	[N]			
	1994.02.17	[N]	-	-	[N]			
	1994.01.14	[N]	-	-	[N]			

Note: * means EXCEEDS Canadian Drinking Water Guidelines, Site Status: I-Inactive Site, A-Active Site

Wa	Sites	Date Collected	Positive Results	Total Coliform	Faecal Coliform	Over-Grown	Site type	Site Source	Site Status

Total Positive Coliform Samples = 23
Total Samples Taken = 295
Percentage of Positive Coliforms = 7.8%

Evaluation of Samples:

- Number of samples that contain faecal coliform = 3
- Number of samples that contain total coliform = 23
- Number of samples that contain more than 10 total coliform per 100 mL = 8
- Occurrence of consecutive samples from the same site showing presence of coliform = 9
- Based on a minimum of ten samples, percentage that contain coliform = 7.8%
- Number of samples taken on the same day that shows presence of coliform = 7

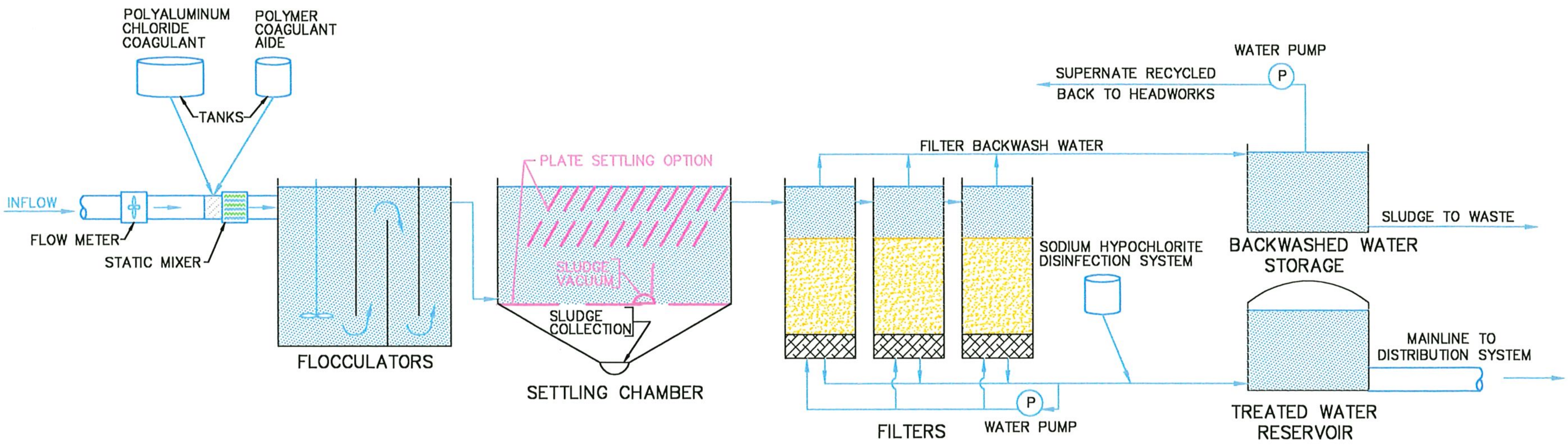
[ ] Satisfactory [ ] Needs Improvement [ ] Unsatisfactory [ ] Boil Advisory

Comments :

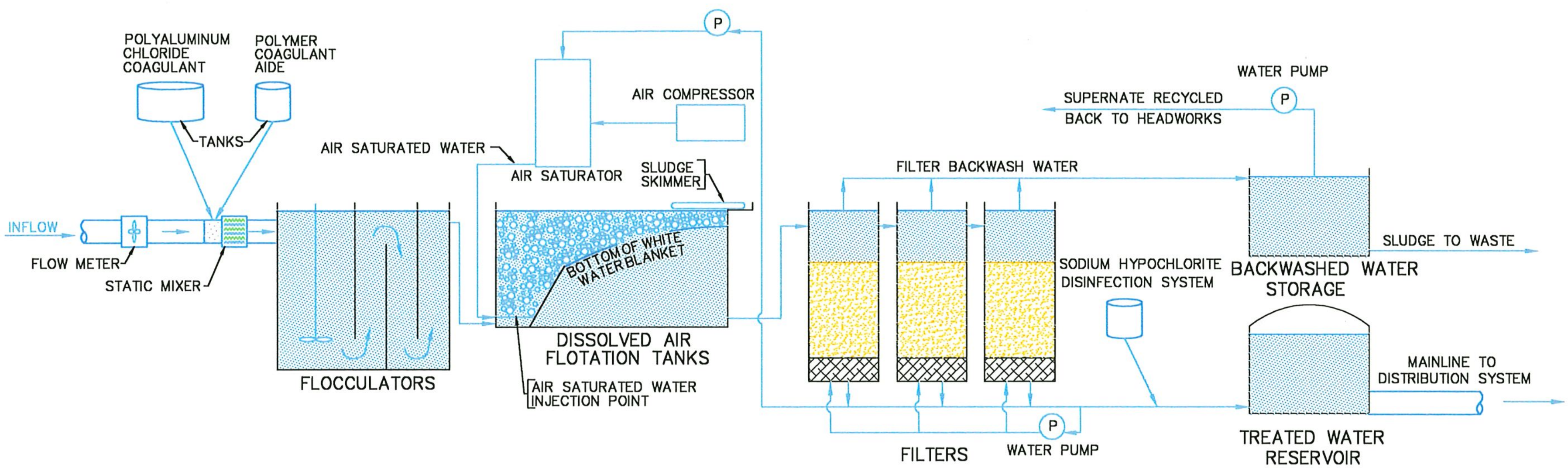
Environmental Health Officer

ANNEX 9

Schematic of Water Treatment Facility



SCHEMATIC OF SETTLING TREATMENT PROCESS

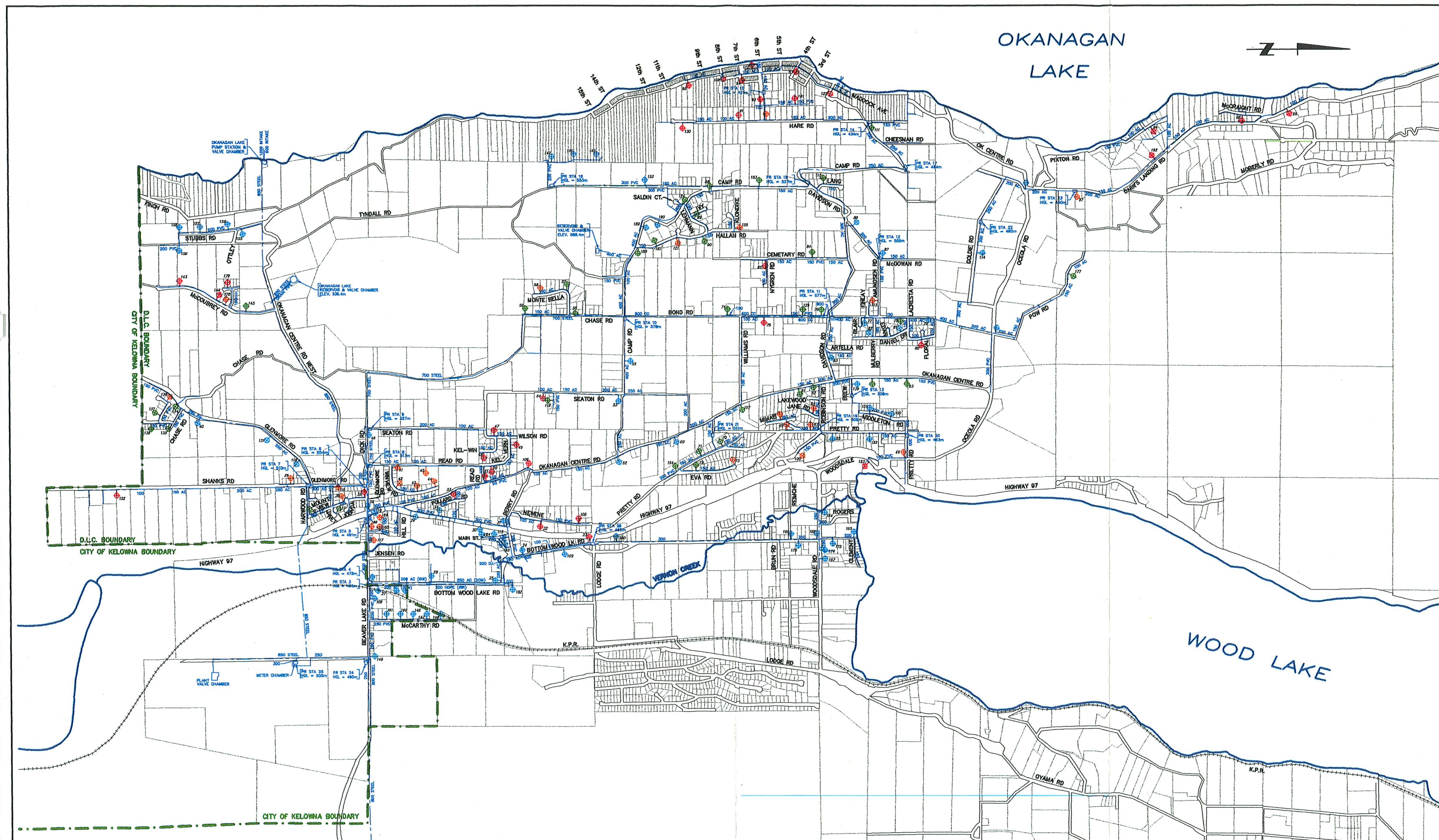


SCHEMATIC OF DISSOLVED-AIR FLOTATION TREATMENT PROCESS

ANNEX 10

Drawings

1.	Fire Hydrant Flow Capacities	DLC-105
2.	Existing System Improvements	DLC-107
3.	Computer Model Schematic	DLC-108
4.	Water Quality Improvements	DLC-109



LEGEND

WATERMAIN	
DISTRICT OF LAKE COUNTRY BOUNDARY	
< 32 lps (< 500 US gpm)	
< 60 lps (< 950 US gpm)	
60 – 95 lps (950 – 1500 US gpm)	
> 95 lps (1500 US gpm)	
HYDRANT	

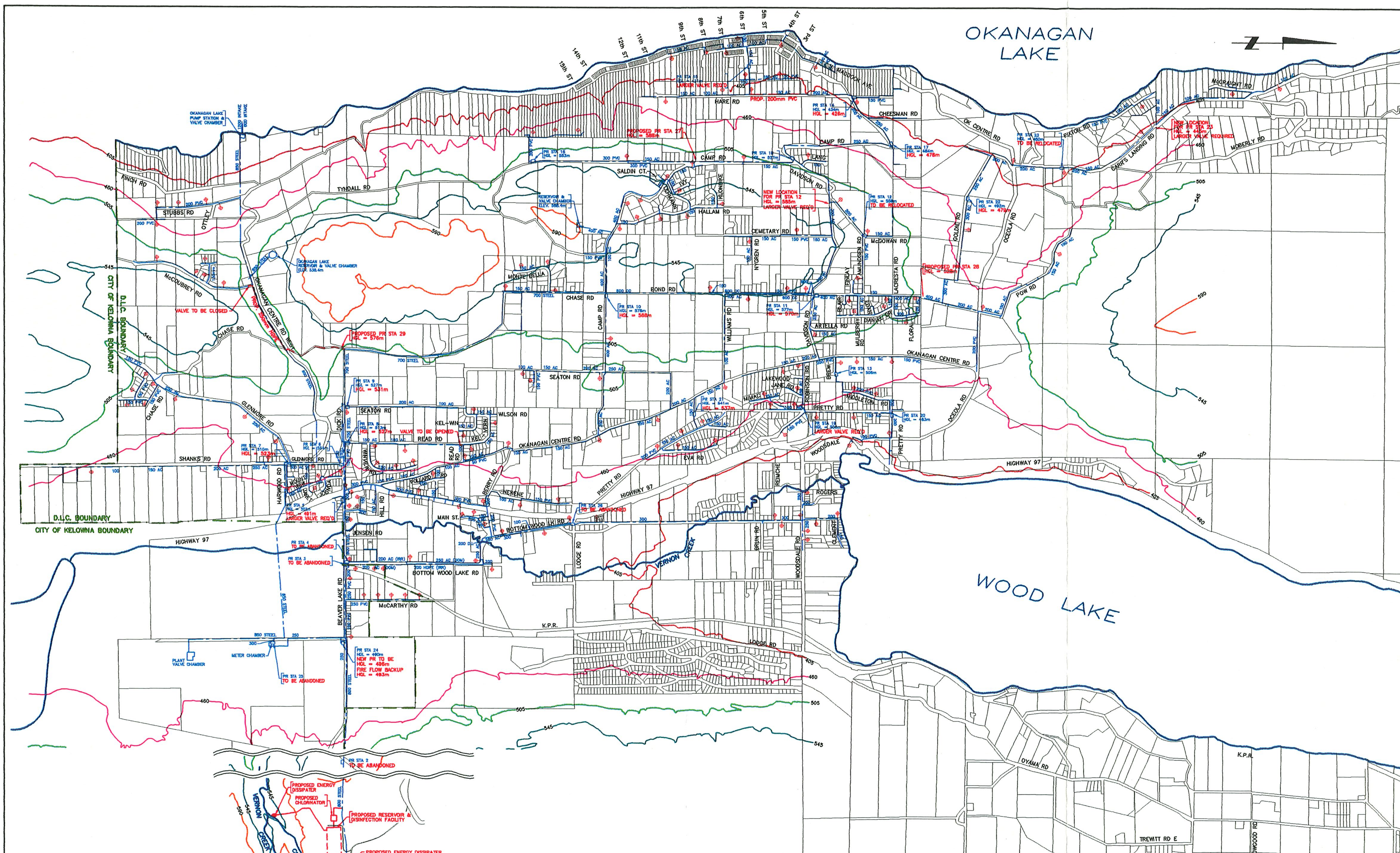
Mould Engineering
206 – 437 Glenmore Road, Kelowna, B.C. V1V 1Y5
Telephone 868-2072

DRAWN	R.J.
DESIGN	
APPROVED	
DATE	FEB. 2002
SCALE	1:25,000

DISTRICT OF LAKE COUNTRY

WINFIELD OKANAGAN CENTRE WATER SYSTEM
FIRE HYDRANT FLOW CAPACITIES

DRAWING NO. DLC–105
REV. NO.



LEGEND

WATERMAIN

PROPOSED WORKS

DISTRICT OF LAKE COUNTRY BOUNDARY

HYDRANT

Mould Engineering

206 – 437 Glenmore Road, Kelowna, B.C. V1V 1Y5 Telephone 868-2072

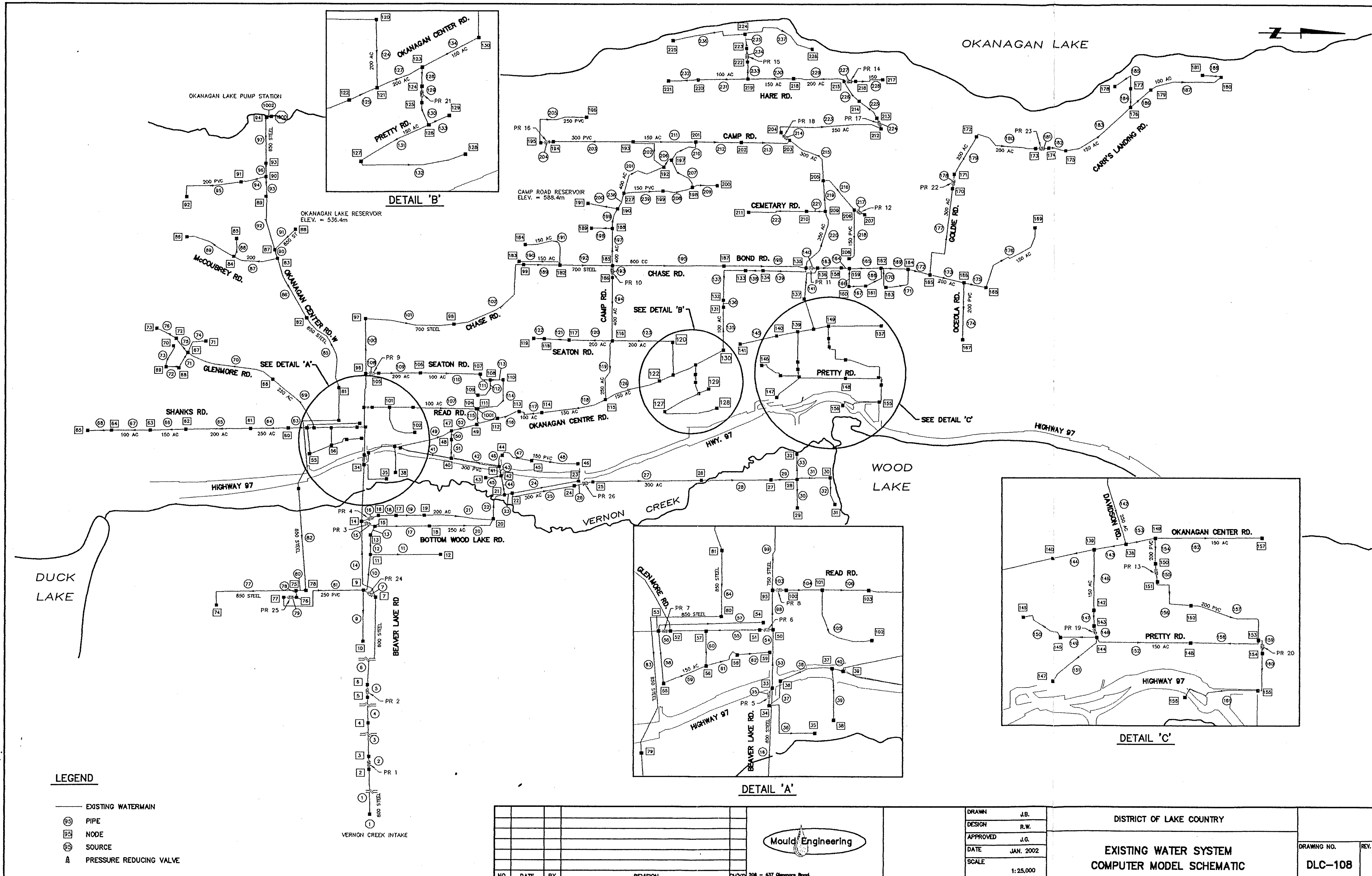
DRAWN	J.B.
DESIGN	J.G.
APPROVED	
DATE	FEB. 2002
SCALE	1:25,000

DISTRICT OF LAKE COUNTRY

WINFIELD OKANAGAN CENTRE WATER SYSTEM
EXISTING SYSTEM IMPROVEMENTS

DRAWING NO. DLC–107

REV. NO.


OKANAGAN LAKE
OKANAGAN LAKE PUMP STATION
OKANAGAN LAKE RESERVOIR
ELEV. = 536.4m
CAMP ROAD RESERVOIR
ELEV. = 588.4m
McCOUBREY RD.
OKANAGAN CENTER RD.W
GLENMORE RD.
SHANKS RD.
SEE DETAIL 'A'
SEE DETAIL 'B'
SEE DETAIL 'C'
READ RD.
SEATON RD.
CHASE RD.
CAMP RD.
BOND RD.
CEMETARY RD.
HARE RD.
CARR'S LANDING RD.
GOLDIE RD.
OCEOLA RD.
PRETTY RD.
OKANAGAN CENTRE RD.
HIGHWAY 97
HWY. 97
WOOD LAKE
VERNON CREEK
DUCK LAKE
BOTTOM WOOD LAKE RD.
BEAVER LAKE RD
VERNON CREEK INTAKE
DETAIL 'A'
DETAIL 'B'
DETAIL 'C'
DAVIDSON RD.
OKANAGAN CENTER RD.
LEGEND
EXISTING WATERMAIN
PIPE
NODE
SOURCE
PRESSURE REDUCING VALVE
NO.
DATE
BY
REVISION
CH'KD
Mould Engineering
208 - 437 Glenmore Road, Kelowna, B.C. V1V 1Y5
Telephone 868-2072
DRAWN J.B.
DESIGN R.W.
APPROVED J.G.
DATE JAN. 2002
SCALE 1:25,000
DISTRICT OF LAKE COUNTRY
EXISTING WATER SYSTEM
COMPUTER MODEL SCHEMATIC
DRAWING NO.
DLC-108
REV. NO.

REC'D SEPT 4/02 (E)

4.0 INFRASTRUCTURE FOR NEW DEVELOPMENT

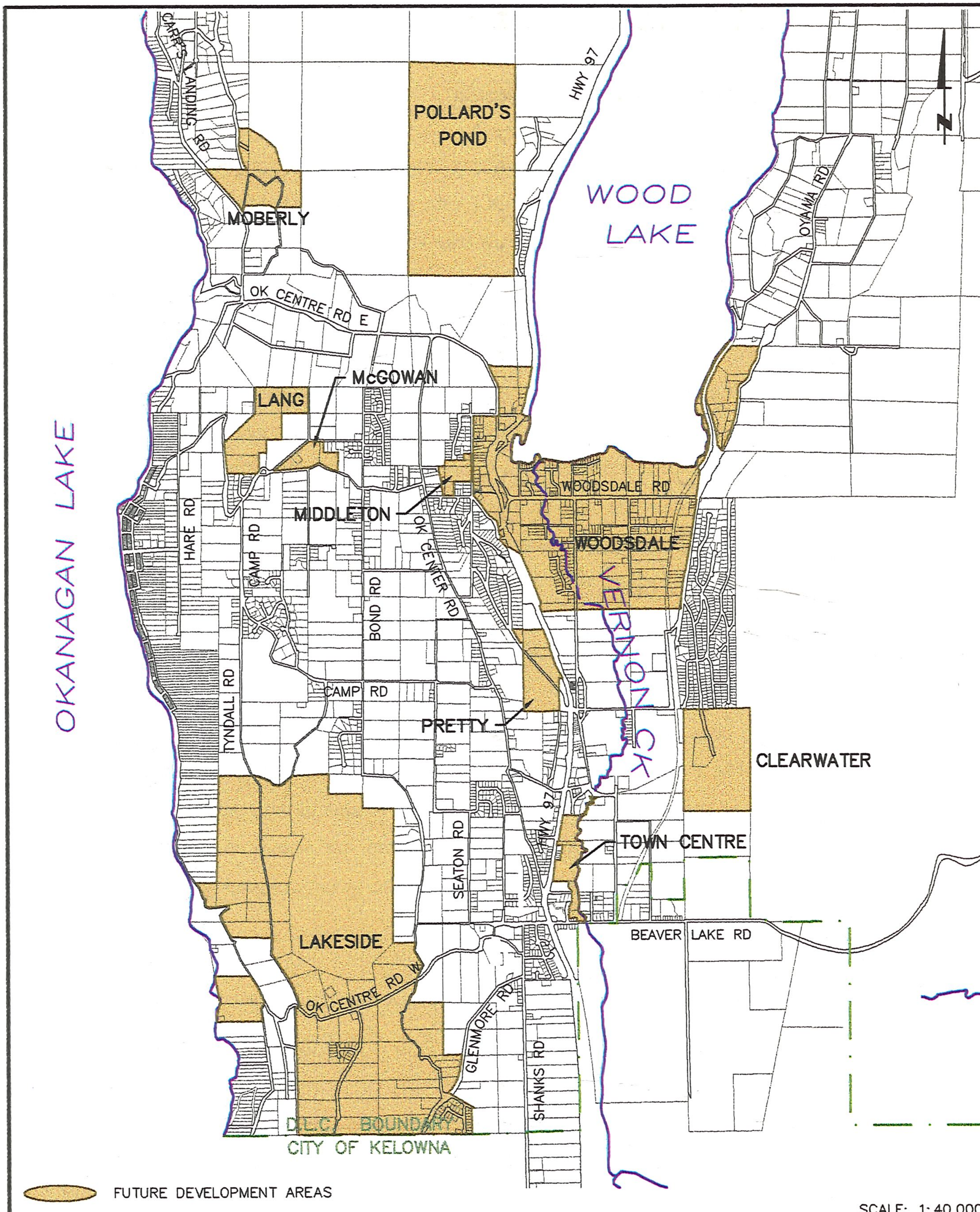
The District of Lake Country has seen significant, consistent growth for many years and according to the Official Community Plan (OCP), the trend is expected to continue. The area is desirable with numerous lakes and many lake-view properties.

This section outlines the expected growth and the effect of increasing water demands on the capacity of the WOCWS until Year 2020. The existing service area is primarily within the Agricultural Land Reserve, which results in the majority of growth being located beyond the existing infrastructure. Growth is dependent on the economy and land use policies, two variables that are difficult to predict, therefore the timing of required works is somewhat uncertain and the plan must be flexible. Two objectives are: to ensure the existing users are not negatively impacted by growth, and to outline a phased plan to supply the new developments with superior water quality in a timely manner. Infrastructure for new development and their associated costs have been estimated and form the basis for a new Development Cost Charge (DCC).

Two options have been reviewed for increasing the supply of superior water quality to service growth. The first option investigated is to increase the Okanagan Lake pump station capacity, and the second option is to increase the volume of the proposed Vernon Creek water treatment facility. The distribution system has also been analyzed to determine the impact of the increased water demand and to outline proposed pipeline sizes.

Also outlined are the water supply and distribution system requirements needed to service growth from a separate distribution system should it be chosen over the recommended Vernon Creek water treatment facility option.

This section of the Master Water Servicing Plan is not eligible for Federal / Provincial Infrastructure funding and must be solely funded by DCC's levied on new development.



Mould Engineering

FIGURE 10

DISTRICT OF LAKE COUNTRY
DEVELOPMENT AREAS
JULY 2002

4.1 *Population Growth*

According to the most recent OCP, dated February 19th, 2002, the average growth rate in the area over the past 25 years has been 3% with only a slight decline in the last two years. Most of the Neighbourhood Plans are based on 3% growth and the District also expects its overall population to increase by at least 3% in the next five years, therefore, this figure has been used as the basis for calculating future water demands. The OCP estimates the population of the District in 2001 was 9,844 and with an increase of 3% annually, the population in 2020 is estimated at 17,260. The District further estimates approximately 4,200 new housing units will be built by 2020. As outlined in the OCP, growth is expected in pockets throughout the District of Lake Country and this plan is based on 70% of new development (2,940 housing units) being serviced from the WOCWS. The majority of the remaining growth will be supplied by the Oyama and Wood Lake water systems, which are not included in the Master Water Servicing Plan at this time. Currently, the OCP does not indicate an increase in agricultural water demand or an increase over the existing commitments to the City of Kelowna industrial park.

The OCP and Figure 10, opposite, outlines the growth areas to be developed and serviced by 2020. Infill of the Woodsdale and Town Centre areas is particularly encouraged. It is expected growth will occur first in Town Centre and Woodsdale as these areas are nearest to water and sewer services. Table 7, opposite page 48, lists the estimated number and type of units each development will have by Year 2020 and under Full Build-Out conditions. Also listed are Single Family Equivalent (SFE) units for each development which the water demands have been based on. Using SFE units to project water demands gives the plan flexibility by allowing the number and type of units in each development to vary from the OCP's 90% single and 10% multi-family split without affecting the overall estimated demand. Table 7 also shows the estimated development start date for the purposes of determining the number of units within each development by Year 2020.

Table 7
Projected Growth

Area / (Development Start Date)	Projected Growth Year 2020		Full Build-Out	
	Units	Total (SFE)	Units	Total (SFE)
Town Centre / (2002)				
Multi-Family (MF) Commercial, Industrial & Institutional	50 10 ha	48	50 20 ha	69
Woodsdale / (2002)				
Single Family (SFR) Multi-Family Commercial, Industrial & Institutional	883 126 6 ha	963	883 126 30 ha	1,014
Clearwater Extension / (2004)				
Single Family Multi-Family Commercial, Industrial & Institutional	69 191 3 ha	176	80 220 3 ha	202
Middleton Road / (2004)				
Single Family Multi-Family	121 17	130	140 20	150
Pretty Road / (2004)				
Single Family Multi-Family	161 23	173	186 27	200
Moberly Road / (2004)				
Single Family	22	22	25	25
Lakeside Properties / (2008)				
Single Family Multi-Family	534 76	574	1,581 226	1,700
Pollard's Pond / (2008)				
Single Family Multi-Family	534 76	574	931 133	1,000
Lang Road / (2016)				
Single Family	39	39	150	150
McGowan Road / (2016)				
Single Family	18	18	70	70
TOTAL	**2,940 19 ha**	**2,717**	**4,848 53 ha**	**4,580**

4.2 *WATER DEMAND PROJECTIONS*

Water demand projections have been made for the Year 2002, as well as full build-out conditions. Full build-out projections are included as an 18 year horizon can be a short time frame for planning large capital expenditures on works which are expected to last at least 40 years.

.1 *Peak Day Use*

Peak Day figures are used to determine the required size of major supply works. The resulting facilities will be utilized to near capacity daily throughout the summer months.

The number and type of new dwellings as well as the use per connection, are important factors in projecting future water demands. Table 7, opposite, outlines the housing distribution estimates for the development areas. Water demand for the various types of development are outlined in Table 1, Page 9. These are present water demands and do not take into consideration possible water conservation options, which may later be included in the Master Plan. The following table shows the current and projected peak day demands in relation to the existing supply capabilities of the WOCWS.

Table 8
Peak Day Demand Versus Supply

Demand Scenario	Present Demand (lps)	Projected Demand (lps)	Vernon Creek Gravity Supply (lps)	OK Lake Pumped Supply (lps)	Surplus / (Deficit) (lps)
Year 2020	760	315	837	464	**226**
Full Build-Out	760	535	837	464	**6**

NOTES: Year 2020 projected demand has been reduced by 11 lps as a portion of the growth is expected to occurred on irrigated land.

Vernon Creek gravity supply is 1,004 lps (2.0 m/s in the mainline) divided by 1.2 factor to achieve peak day in the existing system.

Table 9
Projected Annual Water Requirements – Year 2020

Vernon Creek Source		
1.	*Irrigation*	
	.1 Grade 'A' Land Serviced, 813 ha @ *7.3 da m^3/ha	5,935 da m^3
2.	*Domestic*	
	.1 Rural Residential, 1741 conn. @ 0.25 da m^3	435 da m^3
	.2 Multi-family & Stratas, 126 Units @ 0.17 da m^3	21 da m^3
3.	*Total Annual Use from Vernon Creek*	***6,391 da m^3***
Okanagan Lake Source		
4.	*Irrigation*	
	.1 Grade 'A' Land Serviced, 137 ha @ *7.3 da m^3/ha	1,000 da m^3
5.	*Domestic*	
	.1 Rural Residential, 2411 conn. @ 0.25 da m^3	603 da m^3
	.2 Multi-family & Stratas, 533 Units @ 0.17 da m^3	91 da m^3
	.3 Commercial, Industrial & Institutional, 19 ha @ 7.3 da m^3 plus 60 Conn. @ 0.17 da m^3	149 da m^3
6.	*Glenmore Road Booster Station*	
	.1 95 lps for 2 months	509 da m^3
7.	*City of Kelowna*	
	.1 Industrial Area, 80 ha @ 7.3 da m^3/ha	584 da m^3
8.	*Total Annual Use from Okanagan Lake*	***2,936 da m^3***
9.	*TOTAL*	***9,327 da m^3***

NOTES: * Estimated annual irrigation requirements are from the *Irrigation Design Manual* prepared by the British Columbia Ministry of Agriculture.

The Grade 'A' land serviced area included the irrigated areas within the Rural Residential, Multi-Family & Stratas, and Commercial, Industrial & Institutional developments.

The table indicates WOCWS has enough capacity to supply the District's water needs for many years, without the addition of another source. However, it should be noted that following implementation of the water quality recommendations, only 440 lps of the total water available at Vernon Creek will be treated to meet the GCDWQ for the present users. Therefore, additional water to supply growth is available, but treatment is required. Reservoir upgrades are also required to ensure peak hour commitments are met.

By Year 2020, the domestic component will represent approximately 55% of the peak day demand, in comparison to the irrigation flow at 45%.

.2 *Annual Use*

The annual water requirements, considering a drought year, from Okanagan Lake and Vernon Creek have been calculated for the Year 2020 and are shown in table 9, opposite. The quantity from each source assumes the recommended water quality improvements in Section 3.4 have been completed.

As shown, annual water requirements for Vernon Creek are 6,391 da m^3 (5,181 ac-ft), which are well under the total water licenses of 8,213 da m^3 (6,661 ac-ft). The annual water requirements from Okanagan Lake are 2,936 da m^3 (2,380 ac-ft). As indicated in Section 2.3, Water Consumption, additional licenses in the amount of 2,200 da m^3 have been applied for on Okanagan Lake for a total of 3,079 da m^3 (2,497 ac-ft). When the application is approved, the District of Lake Country will have sufficient licenses on Okanagan Lake to meet Year 2020 requirements.

It will be noted in point 6 of the table that water supply to the Glenmore Road booster station will have decreased to 95 lps by year 2020 if growth proceeds as expected.

4.3 *WATER QUALITY IMPROVEMENTS FOR DEVELOPMENT*

Two options are presented in order to increase the supply of superior water quality for growth. Table 8 shows that an additional peak day demand of 315 lps is required by Year 2020. The first option reviewed is the possibility of increasing the capacity of the Okanagan Lake pump station. The second option is to expand the proposed water treatment facility on Vernon Creek, as additional water is available but requires treatment to meet GCDWQ.

If the preferred option to improve water quality is a separate domestic system, as outlined in Section 3.5, an additional source is required and the implications are discussed in Section 4.5.

.1 *Okanagan Lake Pump Station and Ancillary Works*

The pump system design and operating conditions were reviewed in some detail to determine whether the pumping rate could be increased over the original design flow of 464 lps (7350 USgpm). The pump station is very well built and there was some thought the pumping rate could be increased at a relatively low cost. In particular, using all three 750 hp pumps simultaneously was an obvious area worth investigation even though it was realized that the third pump would not be sufficient to supply the Year 2020 growth.

Although the analysis indicates the pump station design is very conservative and most components are capable of an increased pumping rate, there are several areas of concern.

1. The pump station and other facilities along the mainline are susceptible to water hammers, or pressure surges, and the higher the pumping rate the more severe the surges. The worst case scenario occurs during a power failure, causing the pumps to stop suddenly, rather than slowly powering down. The calculated pressure surge with three pumps running is 1,700

kPa (250 psi) and (1,200 kPa) 180 psi with two pumps in operation. The pressure surge is over and above the normal operating pressure. Some protection is provided by surge relief valves in the pump station, but these valves are not completely reliable and take some time to open. It is difficult to predict the degree of damage with any surety, but a 1,700 kPa (250 psi) pressure surge has the potential to cause very serious damage to the pump station and other facilities. It is possible to dampen surges by adding a surge tank(s), however, the cost of a surge tank(s) for a facility of this size would be high.

.2 The electrical equipment is specifically designed to allow only two pumps to operate at the same time. Upgrading of the electrical system is needed in order to operate the three pumps simultaneously. In addition, transformers on the power supply, which are owned by the District, are only large enough for the operation of two pumps and would have to be upsized. Because the equipment is nearly 30 years old, upgrading the electrical system would be quite expensive.

.3 The current Ministry of Water, Land and Air Protection's specifications for fish screens on water intakes call for a screening area of 35.7 m^2/cms. The existing screen area is 11.8 m^2, equalling 25 m^2/cms with two pumps running, or 17 m^2/cms with three pumps in operation. The cost of upgrading the existing screens to allow three pumps to operate must be considered.

.4 Increasing the pumping rate by using all three pumps reduces the reliability of the pump station and the facility would not meet fire protection standards. The Fire Underwriter's Guidelines for reliability of pumping capacity states "the system must be able to meet peak day demands with the largest pump out of service". The pump station cannot easily be expanded to accommodate a standby pump, and 2,600 m^3 of extra reservoir capacity would be required to compensate for the lack of pumping redundancy.

.5 Another important factor against increasing the pump station capacity is its location at the south end of the District. A large portion of the new developments to be supplied with water are at the north end of the service area. Future distribution system costs would be less if the source of supply were closer to the areas of use.

In our opinion, the costs required to increase the pumping rate are better spent at a water treatment facility on Vernon Creek or at another pumping facility on Okanagan Lake. The Okanagan Lake pump station should remain at the design pumping rate of 464 lps (7,350 USgpm).

.2 *Vernon Creek Water Treatment Facility Expansion*

The recommended option to increase the quantity of superior water quality for growth is to expand the proposed water treatment facility on Vernon Creek. Vernon Creek water typically contains high colour derived from organics in the soils upstream and experiences times of high turbidity as described in Section 3.1. The facility expansion will be designed to supply 315 lps, which will result in a total treated water supply of 755 lps. Treatment will involve the same flocculation, clarification, and filtration process that is determined to be the most suitable during the pilot testing completed for the water quality improvements. Section 3.4.3 describes the proposed treatment facility that is recommended to improve water quality for existing users.

Additional reservoir balancing capacity will be required to supply the peak hour component of the increased demand. The majority of the growth will occur in the Woodsdale and Lakeside areas, therefore, the additional reservoir capacity will be required at the Okanagan Lake reservoir. A proposed reservoir size of 2.5 million litres will be situated at the same elevation as the existing structure.

Annex 10 includes a detailed cost estimate of the treatment expansion as well as the Okanagan Lake reservoir expansion.

Estimated Cost: $5,720,000

4.4 *DISTRIBUTION SYSTEM IMPROVEMENTS*

Waterworks for AutoCAD R14 was used extensively to investigate supply options for new development. Two key design parameters were maintaining the existing standard of water service for existing users, and adhering to the water system design parameters outlined in Table 1. The proposed distribution system works have been designed to supply peak hour demands. Drawing number DLC-111 is a schematic of the computer model showing pipes and nodes and the corresponding computer printout is enclosed in Annex 12. Drawing number DLC-110 shows the proposed infrastructure required to supply new development and identifies Developer versus DCC funded projects.

The proposed works described below expect the Existing System Improvements (Section 2.5) and Water Quality Improvements (Section 3.4) will be implemented by the year 2020. Each development will be analyzed on an individual basis but the following provides a general outline of the service possibilities. The cost estimates include DCC eligible works only, and do not include the expansion to the Vernon Creek water treatment facility or Okanagan Lake reservoir. These works are accounted for in Section 4.3.2.

.1 *Town Centre and Woodsdale Areas*

Several new pipelines and pipeline upgrades are required to ensure this area does not exceed maximum pipeline velocities and maintains sufficient pressure to all users. Amongst these upgrades, PR 5 will be relocated to a new location on Glenmore Road as outlined in the Water Quality Section. Dead-end watermains will be looped when possible, to minimize the extent of existing watermain upsizing.

Estimated Cost: $1,560,000

.2 *Clearwater Development*

A simple pipeline extension from the Okanagan Lake pumped supply main on Jim Bailey Road is required to service the Clearwater development. The proposed works will loop to a proposed pipeline on Lodge Road via a PR station to eliminate the long dead-end pipeline associated with servicing. All works to be installed will be developer funded.

.3 *Moberly, Pretty and Middleton Roads Developments*

Servicing the **Moberly Road** development with high quality water within the time frame of their expected development is very costly. Therefore, it is proposed to primarily service the development from the existing Vernon Creek source, and expect that the expansion to the Vernon Creek water treatment facility or other water quality improvements are implemented.

The **Pretty Road** development has the advantage of partially being within the Town Centre / Woodsdale pressures zones and nearby existing watermains that service this area. It is possible to service a portion of the development with Okanagan Lake water and the remaining portion with Vernon Creek water until the Okanagan Centre Road works are completed.

The **Middleton Road** development lies predominantly in an intermediate pressure zone above the Town Centre / Woodsdale pressure zone, best serviced by existing infrastructure with Vernon Creek water. A small portion of the development could be serviced by an even higher-pressure zone. The long term supply for this development will be Okanagan Lake water via the Okanagan Centre Road works.

.4 *Pollard's Pond*

Pollard's Pond development is proposed to receive Vernon Creek water via a dedicated pipeline from upstream of PR 10. This configuration permits a considerable portion of the development to be serviced without the need for a pump station or reservoir. Several on-site PR stations will be required to reduce pressures in the lower sections of the development. Another option to supply the first stage or two with Okanagan Lake water would be to install a booster station and dedicated pipeline on Oceola Road. The pump station would receive water via a new pipeline from Woodsdale to the downstream pressure zone of PR 20. However, the pump station would have to be decommissioned, or maintained for backup and fire flow purposes by about Year 2017, as demand in the Town Centre / Woodsdale areas increased. The Vernon Creek water treatment facility should be in operation by this time. The booster station and associated works would be solely developer funded and are not included in the cost estimates. The only DCC eligible work is upgrading the existing 100 mm watermain on Oceola Road to accommodate the new development.

.5 *Lakeside Properties*

This development has the advantage of being situated beside the Okanagan Lake reservoir. It is primarily located north and above the balancing reservoir and will be serviced via a booster pump station supplied from the Okanagan Lake reservoir. The booster station would then feed another higher reservoir within the development for on-site growth. All the required works would be developer-funded.

.6 *McCoubrey Road*

Significant development is slated to occur in the McCoubrey Road area, and although existing users receive low pressures from the Okanagan Lake pumped supply, this will not be permitted for future development. It is therefore recommended that a pipeline from the Vernon Creek mainline, including a PR station, be extended over to this area to ensure adequate pressure, especially during a fire.

Estimated Cost: $275,000

Table 10
DCC Eligible Capital Expenditures

DCC Eligible Capital Expenditures	YEAR 2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	TOTAL
Town Centre - New Watermains & Upgrades											
Jim Bailey Road - Okanagan Lake Mainline to Beaver Lake Road		145,000									145,000
Beaver Lake Road - Jim Bailey Road to McCarthy Road			145,000								145,000
McCarthy Road - Bottom Wood Lake Road - 500 m South on McCarthy				185,000							185,000
Berry Road - Grant Road to Bottom Wood Lake Road						105,000					105,000
Main Street - South of Grant Road Intersection						60,000					60,000
Woodsdale - New Watermains & Upgrades											
McCarthy Rd. to Lodge Rd. - Along Konshuh Rd. to Meadow Rd.							290,000				290,000
Lodge Road - Highway 97 to Sherman Road							245,000	240,000			485,000
Oceola Road - Highway 97 to Pretty Road					145,000						145,000
Additional Works											
Okanagan Lake Reservoir Expansion, 2.5 Million Litre				200,000	520,000						720,000
Vernon Creek Water Treatment Facility Expansion								1,000,000	2,000,000	2,000,000	5,000,000
McCoubrey Road Supply Main - Dick Road - 970 m South					275,000						275,000
Miscellaneous Pipelines	20,000	20,000	10,000	10,000	20,000	20,000	20,000	20,000	20,000	20,000	180,000
Okanagan Lake Pump Station Debt	71,000	284,000	284,000	76,000							715,000
Planning and Engineering	5,000	20,000	20,000	20,000	20,000	25,000	30,000	100,000	5,000	5,000	250,000
TOTAL	96,000	469,000	459,000	491,000	980,000	210,000	585,000	1,360,000	2,025,000	2,025,000	8,700,000

.7 *Lang and McGowan Roads*

Although these relatively small developments are close together and near existing watermains, it is expected they will occur late in the twenty year plan, as they will be costly due to the lack of nearby sewer. By the time these developments are slated to occur, the Vernon Creek water treatment facility should be operational. The associated cost to supply these developments, therefore, lies in the cost of expanding the water treatment plant.

.8 *Miscellaneous Pipelines*

As development occurs, the District may have to upgrade various pipelines to meet the water demands. It is recommended the District set aside the following contingency value to account for minor pipe upgrades not accounted for in this plan.

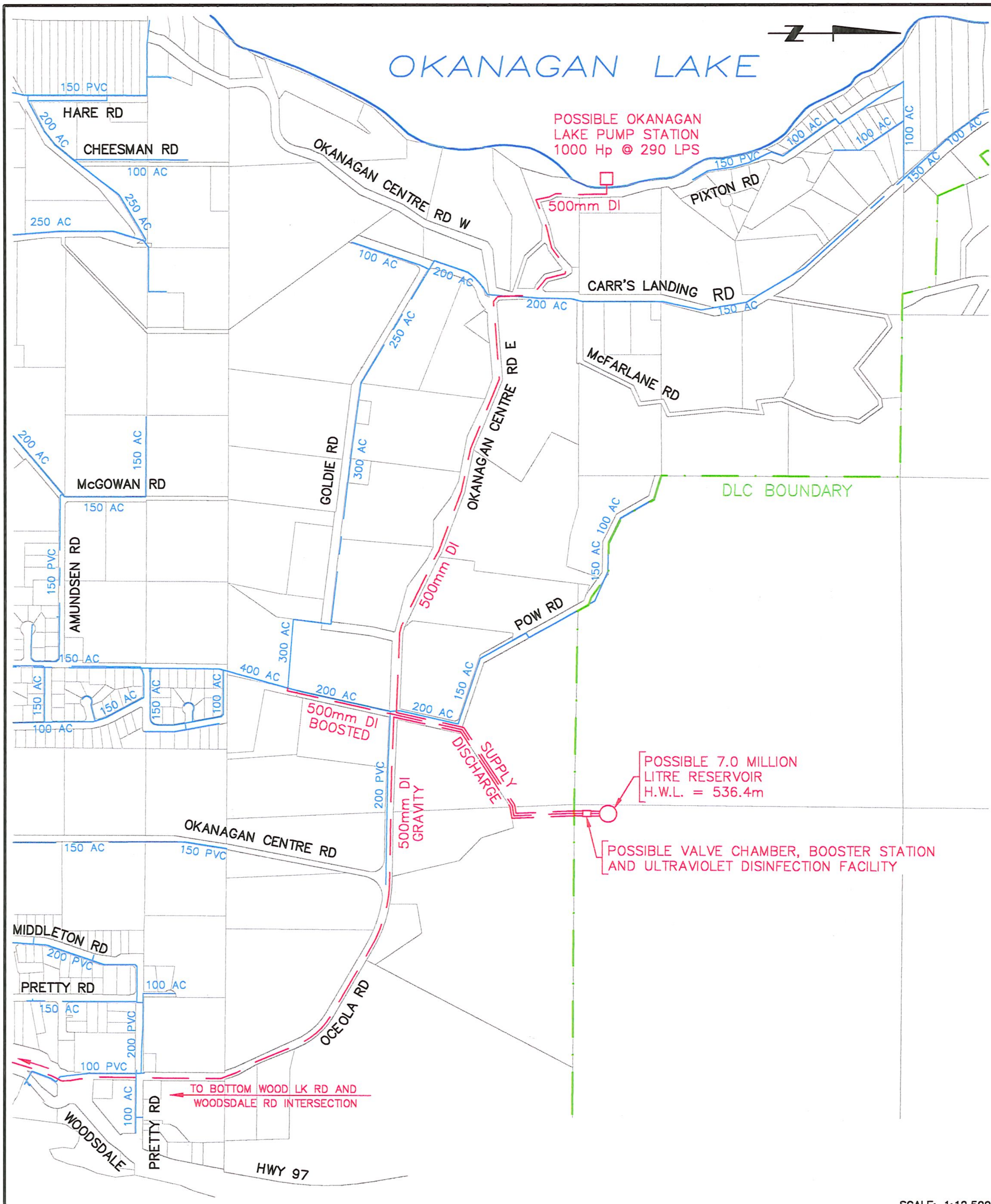
Estimated Cost: $180,000

.9 *Planning and Engineering*

An amount is included for miscellaneous planning and engineering that may be required for review of small development applications. This is a preventative measure that helps keep problems from compounding and creating deficiencies that cost large sums of money to solve. As well, an amount is included for updating and expanding the Master Water Servicing Plan to include additional sections.

Estimated Cost: $250,000

The above works are meant to be phased as development occurs. It should be noted that predicting the where and when of new development is not an exact science, and there are several supply options depending on the extent, location and timing of development. For planning purposes, Table 10 opposite, breaks down the above work into an estimated time frame for construction.



Mould Engineering

FIGURE 11

DISTRICT OF LAKE COUNTRY

POSSIBLE SEPARATE DOMESTIC SYSTEM ADDITIONAL SUPPLY

JULY 2002

4.5 SEPARATE DOMESTIC SYSTEM – WORKS REQUIRED FOR GROWTH TO YEAR 2020

As discussed in Section 3.5, a separate domestic system is an option to supply superior water quality to existing users. There is approximately 35 lps surplus capacity at the Okanagan Lake pumping station after supplying the current domestic users. Therefore additional infrastructure will be required by the year 2004 to supply the anticipated growth. The plans to increase the water supply will involve the construction of another source on Okanagan Lake. The major components required to service growth to year 2020 are shown on Figure 11 opposite and described below:

- An Okanagan Lake pump station (1000 Hp, 290 lps) and disinfection facility to be constructed on Pixton Road;
- A 7.0 million litre balancing reservoir constructed in the Southwest corner of the Pollard's Pond future development area;
- A valve chamber/high pressure-zone booster station (350 Hp, 200 lps) to be constructed at the reservoir site;
- A ultraviolet disinfection facility to be constructed at the reservoir site;
- Approximately 4.4 kilometre's of 500mm transmission mainlines.

A new Okanagan Lake pump station could be constructed on the Pixton Road right-of-way. This location is favorable for several reasons, the first being it may negate the need for land acquisition. Secondly, this location places an Okanagan Lake domestic source at virtually each end of the WOCWS, thereby helping to balance the system hydraulically.

A 7.0 million litre balancing reservoir, is required with a hydraulic grade line equal to the existing Okanagan Lake balancing reservoir. By situating the reservoir at this elevation, the two reservoirs combined will share the volume required for both fire and peak day balancing storage. Also, either reservoir will be able to act independently to service the same pressure zone in the event that the other reservoir requires off-line maintenance or repairs.

A booster station will be constructed at the reservoir site to boost water into the upper pressure zone. This station will match the capacity of the proposed Glenmore Road booster station and supply to the proposed Dick Road reservoir. Peak day demands would be shared equally between the two booster stations; and each station will act as a temporary back up to the other. The station will house the required valves for the reservoir plus an ultraviolet disinfection facility. The water quality provided by this facility will be equal with the quality proposed for the existing Okanagan Lake system.

Incorporation of these works into the separate domestic system would yield the same advantages and disadvantages as outlined in Section 3.5. The estimated cost of another Okanagan Lake source is **$ 6,530,000** for which details are included in Annex 11.

4.6 Cost Estimate Summary

The estimated cost of the works required to supply growth to the Year 2020 is summarized below. Details of the estimates are contained in Annex 10. The cost estimates do not include land acquisition or subsurface materials, such as bedrock or groundwater that may be encountered during construction. The cost estimates should be considered preliminary as they are based on limited design and fieldwork.

Infrastructure for New Development

1.	Vernon Creek Water Treatment Facility	$5,000,000
2.	Okanagan Lake Reservoir Expansion, 2.5 Million Litre	$ 720,000
3.	Distribution System Improvements	
	3.1 McCoubrey Road	$ 275,000
	3.2 Town Centre and Woodsdale Area	$1,560,000
4.	Miscellaneous Pipelines	$ 180,000
5.	Existing Debt Repayment	
	5.1 Okanagan Lake Pump Station	$ 715,000
6.	Planning and Engineering	$ 250,000
7.	TOTAL	**$8,700,000**

4.7 *DEVELOPMENT COST CHARGES*

The calculation of Development Cost Charges (DCC's) for all service provided by the District of Lake Country (ie: roads, parks, sewer, etc.) are being completed by another Consultant. A complete list of the water related projects for the WOCWS, and their capital costs, will be submitted to the Consultant for the calculation of new DCC rates. Although the District maintains and operates numerous water systems, only the costs from the WOCWS will be used to form the new rates levied on developments serviced from the WOCWS. It is expected that rates will be set for the types of use shown in the following table. When the new rates are available, they will be included in the table.

Table 11

Recommended Development Cost Charges

1. Residential Irrigated land to Residential – Single Family - Multi-Family Dryland to Residential - Single Family - Multi-Family	 per unit per unit per unit per unit
2. Irrigation	per unit
3. Commercial, Institutional & Industrial (dependent on building floor area) Basic First 250 m^2 (minimum Charge) Over 250 m^2 Building with approved sprinkler system First 250 m^2 (minimum Charge) Over 250 m^2	 per unit per m^2 per unit per m^2

4.8 *Conclusions and Recommendations*

These conclusions and recommendations are made following an analysis of the water system infrastructure required to service new development within the WOCWS service area.

1. The findings in this section are based on water quality improvements being implemented for existing users with new development expected to continue to provide water of similar quality.

2. The District of Lake Country OCP indicates there may be 2,717 single-family equivalent units developed by Year 2020, which will increase peak day demand increase by 315 lps. The existing water sources can meet this demand and still have a surplus of approximately 226 lps. By Year 2020, the domestic component will represent approximately 55% of the peak day demand, with the irrigation component at 45% compared to 35% for domestic and 65% for irrigation at present.

3. The plan to supply new development is complicated as the characteristics of the Vernon Creek and Okanagan Lake sources are very different from both a quality and hydraulic point of view. The general concept to supply new development is to service the lower lands from the Okanagan Lake source and service the upper lands from the Vernon Creek source. Two critical items that must be understood when utilizing the Vernon Creek source are:

   .1 Superior water quality will not be available in the interim, however, improvement plans are being implemented.

   .2 A minimum quantity of water equal to the proposed development demand must be transferred from the Vernon Creek mainline to the Okanagan Lake mainline.

This being said, each development has a different effect on the system and funds in addition to the DCC contributions may be necessary to facilitate growth in order to not negatively impact existing users. Each application for water servicing must be assessed in detail before approval can be given.

4. The recommended improvements include a Vernon Creek water treatment facility expansion, an Okanagan Lake reservoir expansion, and numerous distribution system installations for a total estimated cost of $8.7 million.

5. The existing Okanagan Lake pump station cannot be upgraded to allow all three pumps to run due to hydraulic limitations.

6. It is recommended that new Development Cost Charges be calculated and a 2002 DCC Bylaw be authorized for the expenditures to be incurred in 2002 as outlined in the Master Plan.

ANNEX 10

Infrastructure for New Development

Cost Estimates

MASTER WATER SERVICING PLAN

INFRASTRUCTURE FOR NEW DEVELOPMENT - COST ESTIMATES

1. *VERNON CREEK WATER TREATMENT FACILITY EXPANSION*

.1	Land Acquisition	$ 200,000
.2	Pilot Plant Construction, Operation and Summary Report	$ 100,000
.3	Site Excavation and Backfill	$ 35,000
.4	Front End Piping	$ 80,000
.5	Chemical Feed System	$ 150,000
.6	Flocculators	$ 200,000
.7	Floatation/Clarification	$1,300,000
.8	Filtration	$ 700,000
.9	Electrical and Instrumentation	$ 400,000
.10	Building	$ 300,000
.11	Heating, Ventilating, and Plumbing	$ 120,000
.12	Yard Piping including Backwash Water	$ 50,000
.13	Compressed Air and Plant Service Water	$ 60,000
.14	Sludge Storage	$ 35,000
.15	Filter Backwash Water Recycling	$ 60,000
.16	Landscaping and Parking	$ 20,000
.17	*Sub-total*	*$3,810,000*
.18	Engineering and Contingencies @ 25%	$ 950,000
.19	District Administration @ 5%	$ 240,000
.20	**Sub-total**	**$5,000,000**

2. *OKANAGAN LAKE RESERVOIR EXPANSION, 2.5 MILLION LITRE*

.1	Excavation and Backfilling	$ 45,000
.2	Concrete Structure	$ 330,000
.3	Reservoir Piping and Overflow	$ 50,000
.4	Valve Control Building	$ 50,000
.5	Supply/Discharge Tie-in to Existing Main	
	.1 500 mm D.I., 100 m @ $300/m	$ 30,000
.6	Tie-in Fittings	$ 20,000
.7	*Sub-total*	*$ 525,000*
.8	Engineering and Contingencies @ 25%	$ 130,000
.9	District Administration @ 10%	$ 65,000
.10	**Sub-total**	**$ 720,000**

3. *DISTRIBUTION SYSTEM IMPROVEMENTS*

3.1 McCoubrey Road – Dick Road – 970 m South

.1	300 mm PVC, 420 m @ 140/m	$ 59,000
.2	250 mm PVC, 550 m @ $130/m	$ 71,000
.3	Valves and Fittings	$ 18,000
.4	PR Station	$ 45,000
.5	Service Reconnections	
	.1 Domestic, 2 @ $500	$ 1,000
	.2 Irrigation, 3 @ $750	$ 2,500
.6	Air Valve Assembly, 1 @ 3,500	$ 3,500
.7	*Sub-total*	*$ 200,000*
.8	Engineering and Contingencies @ 25%	$ 50,000
.9	District Administration @ 10%	$ 25,000
.10	**Sub-total**	**$ 275,000**

3.2 Jim Bailey Road –Okanagan Lake Mainline to Beaver Lake Road

.1	500 mm D.I. 460 m @ $185/m	$ 85,000
.2	Valves and Fittings	$ 16,000
.3	Beaver Lake Road Crossing	$ 5,000
.4	*Sub-total*	*$ 106,000*
.5	Engineering and Contingencies @ 25%	$ 26,000
.6	District Administration @ 10%	$ 13,000
.7	**Sub-total**	**$ 145,000**

3.3 Beaver Lake Road - Jim Bailey Road to McCarthy Road

.1	400 mm D.I., 280 m @ $200/m	$ 56,000
.2	Valves and Fittings	$ 21,500
.3	Service Reconnections, 11 @ $500/conn.	$ 5,500
.4	Asphalt, 1120 m^2 @ 20/m^2	$ 22,500
.5	*Sub-total*	*$ 105,500*
.6	Engineering and Contingencies @ 25%	$ 26,500
.7	District Administration @ 10%	$ 13,000
.8	**Sub-total**	**$ 145,000**

3.4 McCarthy Road – Bottom Wood Lake Road – 500m South on McCarthy

.1	250 mm PVC, 500 m @ $160/m	$ 80,000
.2	Valves and Fittings	$ 19,000
.3	Railway Crossing	$ 25,000
.4	Asphalt, 500 m^2 @ 20/m^2	$ 10,000
.5	*Sub-total*	*$ 134,000*
.6	Engineering and Contingencies @ 25%	$ 34,000
.7	District Administration @ 10%	$ 17,000
.8	**Sub-total**	**$ 185,000**

3.5 McCarthy Road to Lodge Road – Along Konshuh Road to Meadow Road

.1	350 mm D.I., 910 m @ $165/m	$ 150,000
.2	Valves and Fittings	$ 40,500
.3	Service Reconnections	
	.1 Domestic, 1@ $500/conn.	$ 500
.4	Asphalt, 1000 m^2 @ 20/m^2	$ 20,000
.5	*Sub-total*	*$ 211,000*
.6	Engineering and Contingencies @ 25%	$ 53,000
.7	District Administration @ 10%	$ 26,000
.8	**Sub-total**	**$ 290,000**

3.6 Main Street South of Grant Road Intersection

.1	300 mm PVC, 130 m @ $185/m	$ 24,000
.2	Valves and Fittings	$ 7,000
.3	Service Reconnections, 2 @ $1,000/conn.	$ 2,000
.4	Asphalt, 520 m^2 @ 20/m^2	$ 10,500
.5	*Sub-total*	*$ 43,500*
.6	Engineering and Contingencies @ 25%	$ 11,000
.7	District Administration @ 10%	$ 5,500
.8	**Sub-total**	**$ 60,000**

3.7 *Berry Road – Grant Road to Bottom Wood Lake Road*

.1	300 mm PVC, 200 m @ $185/m	$ 37,000
.2	Valves and Fittings	$ 16,000
.3	Service Reconnections, 7 @ $1,000/conn.	$ 7,000
.4	Asphalt, 800 m^2 @ 20/m^2	$ 16,000
.5	*Sub-total*	*$ 76,000*
.6	Engineering and Contingencies @ 25%	$ 19,000
.7	District Administration @ 10%	$ 10,000
.8	**Sub-total**	**$ 105,000**

3.8 *Lodge Road – Highway 97 to Sherman Road*

.1	Pipe	
	.1 350 mm D.I., 300 m @ $160 /m	$ 48,000
	.2 300 mm PVC, 870 m @ $185/m	$ 160,000
	.3 200 mm PVC, 410 m @ $135/m	$ 55,000
.2	Valve & Fittings	$ 21,500
.3	Air Valves, 1 @ $3,500	$ 3,500
.4	Asphalt, 1580 m^2 @ $20/$m^2$	$ 32,000
.5	Railway Crossing	$ 25,000
.6	Creek Crossing	$ 8,000
.7	*Sub-Total*	*$ 353,000*
.8	Engineering & Contingencies @ 25%	$ 88,000
.9	District Administration @ 10%	$ 44,000
.10	***Sub-total***	***$ 485,000***

3.9 *Oceola Road – Highway 97 to Pretty Road*

.1	250 mm PVC, 280 m @ $170/m	$ 47,500
.2	Valves and Fittings	$ 14,000
.3	Service Reconnections	
	.1 Domestic, 3 @ $500/conn.	$ 1,500
.4	Highway Crossing	$ 20,000
.5	Asphalt, 1120m^2 @ 20/m^2	$ 22,500
.6	*Sub-total*	*$ 105,500*
.7	Engineering and Contingencies @ 25%	$ 26,500
.8	District Administration @ 10%	$ 13,000
.9	**Sub-total**	**$ 145,000**

3.10	TOTAL	**$ 1,835,000**
4.	*MISCELLANEOUS PIPELINES AND UPSIZING*	*$ 180,000*
5.	*EXISTING DEBT REPAYMENT*	*$ 715,000*
6.	*PLANNING AND ENGINEERING*	*$ 250,000*
7.	*INFRASTRUCTURE FOR NEW DEVELOPMENT* — *GRAND TOTAL*	*$8,700,000*

ANNEX 11

Separate Domestic System
Additional Supply for Growth
Cost Estimates

Annex 11
Master Water Servicing Plan

Separate Domestic System
Additional Supply For Growth - Cost Estimates

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1. ***Okanagan Lake Pumped Supply***

1.1 ***Okanagan Lake Pump Station (1000 hp, 290 lps)***

.1	Access Road to Station		$ 20,000
.2	Intake Pipe and Screening Structure		$ 275,000
.3	Wet Well		$ 150,000
.4	Superstructure		$ 140,000
.5	Valves, Piping, Flow Meter, etc.		$ 120,000
.6	Pumps, 2 @ 500 Hp		$ 250,000
.7	Electrical & Telemetry		$ 275,000
.8	Chlorination System		$ 55,000
.9	Powerline and Transformers		$ 80,000
.10	*Sub-total*		*$ 1,365,000*
.10	Engineering and Contingencies @ 25%		$ 340,000
.11	District Administration @ 10%		$ 170,000
.12		**Sub-total**	**$ 1,875,000**

1.2 ***Balancing Reservoir, 7.0 Million Litres***

.1	Access Road to Reservoir		$ 50,000
.2	Excavation and Backfilling		$ 78,000
.3	Concrete Structure		$ 700,000
.4	Reservoir Piping and Overflow		$ 125,000
.6	Telemetry		$ 25,000
.7	Valves and Fittings		$ 80,000
.8	Powerline		$ 25,000
.9	*Sub-total*		*$1,083,000*
.10	Engineering & Contingencies @ 25%		$ 271,000
.11	District Administration @ 10%		$ 136,000
.12		**Sub-total**	**$ 1,490,000**

1.3 ***Pump Station At Reservoir Site (350hp, 200 lps)***

.1	Building, 62 m^2 @ $800/$m^2$		$ 50,000
.2	Power Supply		$ 25,000
.3	Pumps, 2 @ 20,000		$ 40,000
.4	Electrical Equipment		$ 180,000
.5	Mechanical Equipment		$ 145,000
.6	Telemetry		$ 20,000
.7	Site Preparation & Landscaping		$ 10,000
.8	*Sub-total*		*$ 470,000*
.9	Engineering and Contingencies @ 25%		$ 120,000
.10	District Administration @ 10%		$ 60,000
.11		**Sub-total**	**$ 650,000**

1.4 UltraViolet Disinfection Facility

.1	Excavation & Site Prep, 200 m^3 @ $15	$ 3,000
.2	Building, 40 m^2 @ $800/$m^2$	$ 32,000
.3	Valves & Fittings	$ 40,000
.4	Flow Meter & Recorder	$ 15,000
.5	UV Units, 3 @ $120,000	$ 360,000
.6	Chlorine Residual Analyzer & Test Kit	$ 10,000
.7	Electrical Equipment	$ 36,000
.8	Backfilling & Landscaping	$ 10,000
.9	*Sub-total*	*$ 506,000*
.10	Engineering & Contingencies @ 25%	$ 126,000
.11	District Administration @ 10%	$ 63,000
.12	**Sub-total**	**$ 695,000**

1.5 Transmission Mainlines

.1	Res. Supply Main, 500 mm D.I., 2280 m @ $300/m	$ 685,000
.2	Boosted Res. Dis. Main, 500 mm D.I., 980 m @ $240/m	$ 235,000
.3	Gravity Res. Dis. Main, 500 mm D.I., 1150 m @ $240/m	$ 275,000
.4	Asphalt, 4500 m^2 @ $20/$m^2$	$ 90,000
.5	Traffic Control	$ 15,000
.6	Road Crossings	$ 25,000
.7	*Sub-total*	*$1,325,000*
.8	Engineering & Contingencies @ 25%	$ 330,000
.9	District Administration @ 10%	$ 165,000
.10	**Sub-total**	**$ 1,820,000**

2. *SEPARATE DOMESTIC ADDITIONAL SUPPLY* **GRAND TOTAL** **$6,530,000**

ANNEX 12

Proposed System for Year 2020 –

75% of Theoretical Peak Hour Demand

District of Lake Country
Proposed System for Year 2020
Modeled at 75% of Theoretical Peak Hour
July 2002

PIPE TABLE

Pipe	Up Node	Down Node	Length m	Diameter mm	Roughness C	Flow l/s	Velocity m/sec	HeadLoss m	Status	Pipe Description
1	1	2	2182	800	90	714.40	1.42	9.04	Open	
2	2	3	10	300	80	714.40	10.11	66.28	Open	PR1
3	3	4	1044	800	100	714.40	1.42	3.56	Open	
4	4	5	537	800	100	714.40	1.42	1.83	Open	
5	5	6	10	300	80	714.40	10.11	121.50	Open	PR2
6	6	7	1615	800	100	714.40	1.42	5.51	Open	
7	78	305	400	500	140	128.30	0.65	0.30	Open	PR24
9	9	10	389	250	140	8.25	0.17	0.05	Open	
10	305	11	292	400	140	102.30	0.81	40.50	Open	
11	11	12	524	250	140	60.93	1.24	2.90	Open	
12	11	13	147	250	140	40.06	0.82	0.37	Open	
13	13	15	104	200	140	39.70	1.26	0.77	Open	
14	7	14	562	800	100	714.40	1.42	1.92	Open	
16	14	16	10	150	100	6.47	0.37	137.50	Open	PR4
17	15	18	495	200	130	37.45	1.19	3.78	Open	
18	16	19	495	200	130	6.47	0.21	0.15	Open	
20	18	20	585	350	140	86.65	0.90	1.21	Open	
22	20	21	236	250	130	5.92	0.12	0.02	Open	
23	21	22	60	300	140	88.66	1.25	0.27	Open	
24	22	23	507	100	130	3.81	0.49	1.64	Open	
25	22	25	523	300	140	78.89	1.12	1.92	Open	
27	25	26	922	300	140	88.06	1.25	4.15	Open	
28	26	27	528	300	140	68.34	0.97	1.48	Open	
29	27	28	197	300	140	46.16	0.65	0.27	Open	
30	28	29	214	250	140	-42.25	-0.86	0.60	Open	
31	28	30	253	200	140	41.04	1.31	1.99	Open	
32	30	31	207	150	140	20.13	1.14	1.78	Open	
33	28	32	198	250	140	27.79	0.57	0.26	Open	
34	14	33	465	800	100	707.90	1.41	1.56	Open	
36	34	228	120	300	140	40.30	0.57	0.13	Open	
37	34	36	119	300	120	-43.94	-0.62	0.20	Open	
38	36	37	221	300	140	83.21	1.18	0.90	Open	
39	37	35	195	150	130	8.56	0.48	0.39	Open	
40	37	39	44	300	140	70.80	1.00	0.13	Open	
41	39	40	391	300	140	65.29	0.92	1.01	Open	
42	40	41	365	300	140	58.00	0.82	0.76	Open	
43	41	42	71	250	140	38.77	0.79	0.17	Open	
44	42	21	145	300	140	82.74	1.17	0.58	Open	
45	42	43	240	250	140	-43.98	-0.90	0.73	Open	
46	41	44	104	200	140	12.72	0.40	0.09	Open	
47	44	45	255	150	140	12.72	0.72	0.93	Open	
48	45	46	356	150	140	10.86	0.61	0.97	Open	
49	39	47	414	100	130	3.26	0.42	1.01	Open	
50	47	48	68	100	130	1.09	0.14	0.02	Open	
51	48	40	139	150	140	-1.99	-0.11	0.02	Open	
52	47	49	195	100	130	2.17	0.28	0.22	Open	
53	33	50	238	800	100	707.90	1.41	0.80	Open	
54	50	51	10	150	100	95.57	5.41	53.80	Open	PR6
55	51	52	388	300	130	94.04	1.33	2.26	Open	
56	52	53	10	150	100	61.29	3.47	27.50	Open	PR7
57	53	54	392	65	100	0.26	0.08	0.12	Open	
58	53	55	197	150	130	6.65	0.38	0.25	Open	
59	55	56	174	150	130	4.04	0.23	0.09	Open	
60	56	57	130	150	130	1.19	0.07	0.01	Open	
61	56	58	145	100	130	2.02	0.26	0.14	Open	
62	58	59	122	150	130	0.83	0.05	0.00	Open	
63	53	60	163	250	130	51.96	1.06	0.77	Open	
64	60	61	280	250	130	45.27	0.92	1.03	Open	
65	61	62	484	200	130	30.47	0.97	2.52	Open	
66	62	63	266	150	130	18.18	1.03	2.16	Open	
67	63	64	290	100	130	8.47	1.08	4.13	Open	
68	64	65	180	100	130	2.00	0.25	0.18	Open	

PIPE TABLE

Pipe	Up Node	Down Node	Length m	Diameter mm	Roughness C	Flow l/s	Velocity m/sec	HeadLoss m	Status	Pipe Description
69	52	66	475	250	130	32.75	0.67	0.95	Open	
70	66	67	681	250	130	20.50	0.42	0.57	Open	
71	67	68	134	150	140	6.02	0.34	0.12	Open	
72	68	69	96	150	140	5.55	0.31	0.08	Open	
73	69	70	178	150	140	1.69	0.10	0.02	Open	
74	67	71	186	50	140	2.42	1.23	6.65	Open	
75	67	72	138	150	130	1.78	0.10	0.02	Open	
76	72	73	165	150	140	0.89	0.05	0.00	Open	
77	78	74	766	850	100	34.50	0.06	0.01	Open	
78	78	77	10	200	100	47.20	1.50	0.19	Open	
81	77	9	674	250	140	15.75	0.32	0.30	Open	
82	78	79	766	850	100	-217.50	-0.38	0.22	Open	
83	79	80	737	850	100	-217.50	-0.38	0.21	Open	
84	80	81	286	850	100	-479.00	-0.84	0.35	Open	
85	81	82	614	850	100	-479.00	-0.84	0.74	Open	
86	82	87	566	850	100	-479.40	-0.84	0.69	Open	
87	83	84	342	200	130	3.85	0.12	0.04	Open	
88	84	85	146	150	140	1.04	0.06	0.01	Open	
89	84	86	388	200	130	1.28	0.04	0.01	Open	
91	87	88	214	850	100	-332.30	-0.59	0.13	Open	
92	87	89	409	850	100	-230.00	-0.41	0.13	Open	
93	89	90	149	850	100	-230.60	-0.41	0.05	Open	
94	90	91	196	200	140	2.27	0.07	0.01	Open	
95	91	92	492	200	140	1.91	0.06	0.01	Open	
96	90	93	99	850	100	-232.90	-0.41	0.03	Open	
97	93	94	343	850	100	-233.20	-0.41	0.11	Open	
98	50	95	148	750	100	612.40	1.39	0.52	Open	
99	95	96	258	750	100	612.40	1.39	0.91	Open	
100	96	97	411	700	100	612.40	1.59	2.02	Open	
101	97	98	664	700	100	602.20	1.57	3.16	Open	
102	98	99	801	700	100	591.70	1.54	3.69	Open	
104	100	101	177	400	140	105.20	0.84	0.27	Open	
105	101	102	334	150	130	2.99	0.17	0.10	Open	
106	101	103	176	400	140	99.18	0.79	0.24	Open	
107	103	104	473	400	140	91.38	0.73	0.56	Open	
109	105	106	398	200	130	15.98	0.51	0.63	Open	
110	106	107	446	100	130	5.24	0.67	2.61	Open	
111	107	108	108	150	130	3.29	0.19	0.04	Open	
112	108	109	186	150	130	2.15	0.12	0.03	Open	
113	108	110	97	150	130	0.30	0.02	0.00	Open	
114	110	111	367	150	130	-3.25	-0.18	0.12	Open	
115	111	112	258	400	140	81.76	0.65	0.25	Open	
117	113	114	188	100	130	-7.86	-1.00	2.34	Open	
118	114	115	493	150	130	-21.58	-1.22	5.51	Open	
119	115	116	462	250	130	-37.16	-0.76	1.17	Open	
120	116	117	329	200	130	19.11	0.61	0.72	Open	
121	117	118	184	150	130	6.05	0.34	0.19	Open	
122	118	119	82	100	130	2.31	0.29	0.11	Open	
123	116	120	462	250	130	31.53	0.64	0.87	Open	
124	120	121	247	200	130	21.16	0.67	0.65	Open	
125	121	122	110	150	130	0.55	0.03	0.00	Open	
126	122	115	436	150	130	-5.22	-0.30	0.35	Open	
127	121	123	185	200	130	16.38	0.52	0.31	Open	
130	125	126	115	150	130	35.46	2.01	3.21	Open	
131	126	127	290	150	130	26.39	1.49	4.70	Open	
132	127	128	406	150	130	5.96	0.34	0.42	Open	
133	126	129	87	150	130	8.24	0.47	0.16	Open	
134	123	130	238	150	130	10.34	0.59	0.68	Open	
135	130	131	341	100	130	5.96	0.76	2.53	Open	
137	132	133	431	100	130	-3.55	-0.45	1.23	Open	
138	133	134	130	100	130	-7.66	-0.98	1.54	Open	
139	134	135	340	150	140	-13.05	-0.74	1.30	Open	
140	135	136	10	200	100	171.00	5.44	19.39	Open	PR11
141	136	137	278	250	130	44.45	0.91	0.98	Open	
142	137	138	236	250	130	36.33	0.74	0.57	Open	
143	138	139	122	200	130	9.98	0.32	0.08	Open	
144	139	140	163	150	130	9.56	0.54	0.40	Open	
145	140	141	277	100	130	5.17	0.66	1.58	Open	

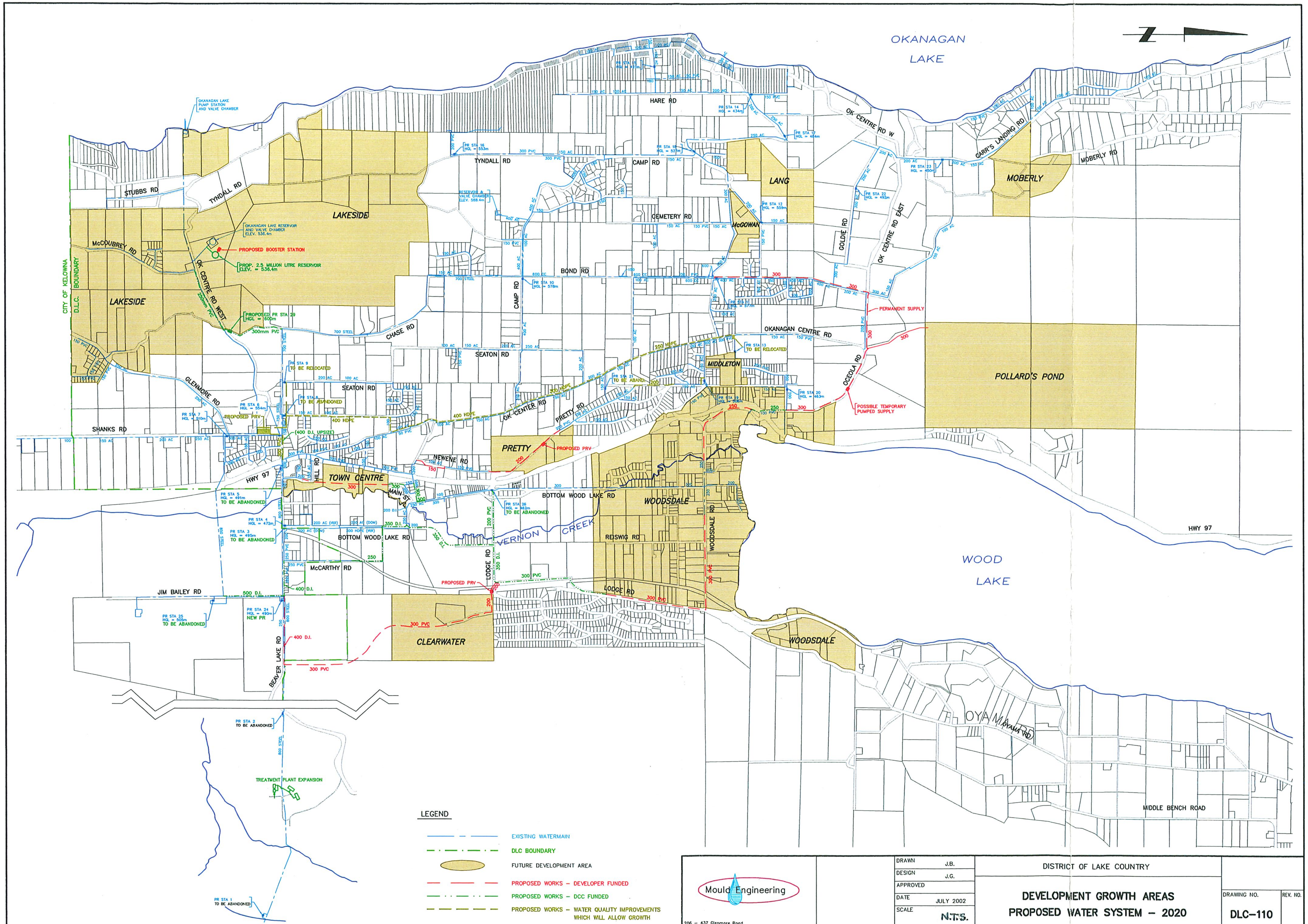
PIPE TABLE										
Pipe	Up Node	Down Node	Length m	Diameter mm	Roughness C	Flow l/s	Velocity m/sec	HeadLoss m	Status	Pipe Description
146	401	142	227	150	130	14.85	0.84	1.27	Open	
147	142	143	95	150	130	11.04	0.63	0.31	Open	
148	143	144	10	75	100	11.89	2.69	16.07	Open	PR19
149	143	145	140	150	130	-0.85	-0.05	0.00	Open	
150	145	146	182	150	130	2.99	0.17	0.05	Open	
151	144	147	243	150	140	3.19	0.18	0.07	Open	
152	144	148	361	150	130	5.06	0.29	0.27	Open	
153	138	149	112	200	140	22.51	0.72	0.29	Open	
155	150	151	10	100	100	17.34	2.21	17.02	Open	PR13
156	151	152	246	200	140	17.34	0.55	0.39	Open	
157	152	153	341	200	140	10.98	0.35	0.23	Open	
158	153	148	270	150	130	3.49	0.20	0.10	Open	
159	153	154	10	100	100	0.00	0.00	0.00	Open	PR20
160	154	155	179	200	140	-0.72	-0.02	0.00	Open	
161	155	156	306	250	140	-6.79	-0.14	0.03	Open	
162	149	157	400	150	130	11.51	0.65	1.40	Open	
163	136	158	260	400	130	125.10	1.00	0.63	Open	
164	158	159	60	400	130	116.00	0.92	0.13	Open	
165	159	162	240	400	130	107.50	0.86	0.44	Open	
166	159	160	135	150	130	7.96	0.45	0.24	Open	
167	160	161	127	150	130	6.15	0.35	0.14	Open	
168	161	162	209	150	130	3.16	0.18	0.07	Open	
169	162	164	200	400	130	101.40	0.81	0.33	Open	
170	162	163	168	150	130	4.51	0.26	0.10	Open	
171	163	164	277	100	130	1.82	0.23	0.23	Open	
172	164	165	164	400	130	98.92	0.79	0.26	Open	
173	165	166	259	200	130	26.48	0.84	1.04	Open	
174	166	167	427	200	140	7.04	0.22	0.13	Open	
175	166	168	169	200	130	17.38	0.55	0.31	Open	
176	168	169	655	150	130	12.29	0.70	2.58	Open	
177	165	170	830	300	130	67.92	0.96	2.65	Open	
178	170	171	10	150	100	49.37	2.79	87.09	Open	PR22
179	171	172	352	250	130	49.37	1.01	1.51	Open	
180	172	173	548	200	130	37.86	1.21	4.27	Open	
181	173	174	10	100	100	29.23	3.72	22.49	Open	PR23
182	174	175	177	200	130	29.23	0.93	0.85	Open	
183	175	176	601	150	130	26.62	1.51	9.89	Open	
184	176	177	141	100	130	6.32	0.80	1.16	Open	
185	177	178	240	100	130	6.32	0.80	1.99	Open	
186	176	179	201	150	130	11.61	0.66	0.71	Open	
187	179	180	549	100	130	8.49	1.08	7.85	Open	
188	180	181	142	100	130	3.40	0.43	0.37	Open	
189	99	182	273	700	100	579.40	1.51	1.21	Open	
190	182	183	324	150	130	1.53	0.09	0.03	Open	
191	182	184	428	150	130	7.35	0.42	0.65	Open	
192	182	185	395	700	100	563.10	1.46	1.66	Open	
193	185	186	10	200	100	99.10	3.16	22.27	Open	PR10
194	186	116	553	400	130	95.98	0.76	0.82	Open	
195	185	187	844	600	110	377.10	1.33	3.00	Open	
196	187	135	617	600	110	367.90	1.30	2.10	Open	
197	185	188	279	400	130	68.94	0.55	0.23	Open	
198	188	189	160	150	140	2.69	0.15	0.03	Open	
199	188	190	159	400	130	52.73	0.42	0.08	Open	
200	190	191	237	400	130	0.00	0.00	0.00	Open	
201	227	192	420	400	130	43.67	0.35	0.15	Open	
202	192	193	381	400	140	19.22	0.15	0.03	Open	
203	193	194	671	300	140	5.96	0.08	0.02	Open	
204	194	195	10	100	100	5.96	0.76	40.96	Open	PR16
205	195	196	553	200	140	5.96	0.19	0.12	Open	
206	192	197	92	400	130	20.33	0.16	0.01	Open	
207	198	197	275	150	130	-4.34	-0.25	0.16	Open	
208	198	199	225	150	130	-2.55	-0.14	0.05	Open	
209	198	200	195	150	130	3.25	0.18	0.07	Open	
210	197	201	261	150	130	15.99	0.91	1.67	Open	
211	193	201	467	150	130	11.61	0.66	1.65	Open	
212	201	202	346	150	130	22.84	1.29	4.30	Open	
213	202	203	377	150	130	16.15	0.91	2.46	Open	
214	203	204	10	150	100	72.15	4.08	58.37	Open	PR18

PIPE TABLE										
Pipe	Up Node	Down Node	Length m	Diameter mm	Roughness C	Flow l/s	Velocity m/sec	HeadLoss m	Status	Pipe Description
215	203	205	444	300	130	-64.28	-0.91	1.28	Open	
216	205	206	353	200	130	11.10	0.35	0.28	Open	
217	206	207	10	100	100	8.04	1.02	27.25	Open	PR12
218	206	208	472	150	140	2.06	0.12	0.06	Open	
219	205	209	233	300	130	-82.74	-1.17	1.07	Open	
220	209	135	484	350	130	-100.40	-1.04	1.50	Open	
221	209	210	146	150	140	11.30	0.64	0.43	Open	
222	210	211	442	150	130	2.00	0.11	0.06	Open	
223	204	212	895	250	130	65.98	1.34	6.57	Open	
224	212	213	10	150	100	54.77	3.10	43.04	Open	PR17
225	213	214	256	250	130	53.49	1.09	1.28	Open	
226	214	215	191	200	130	47.53	1.51	2.26	Open	
227	215	216	10	100	100	3.47	0.44	47.02	Open	PR14
228	216	217	296	150	140	1.94	0.11	0.03	Open	
229	215	218	396	200	130	40.35	1.29	3.47	Open	
230	218	219	346	150	130	35.45	2.01	9.68	Open	
231	219	220	375	100	130	8.75	1.11	5.67	Open	
232	220	221	228	150	130	4.58	0.26	0.14	Open	
233	219	222	191	150	130	22.43	1.27	2.29	Open	
234	222	223	10	100	100	19.31	2.46	36.96	Open	PR15
235	223	224	137	150	130	18.75	1.06	1.18	Open	
236	224	225	576	100	130	7.55	0.96	6.63	Open	
237	224	226	589	100	130	10.04	1.28	11.49	Open	
238	190	227	130	400	130	52.73	0.42	0.06	Open	
239	199	227	135	150	140	-9.06	-0.51	0.26	Open	
240	228	35	127	200	140	40.30	1.28	0.97	Open	
300	80	300	10	300	100	128.40	1.82	42.89	Open	
301	300	36	417	400	140	128.40	1.02	0.93	Open	
302	35	43	680	300	140	46.89	0.66	0.95	Open	
303	12	18	480	250	140	52.60	1.07	2.02	Open	
304	305	301	450	400	140	26.00	0.21	0.05	Open	
305	301	302	1876	300	140	0.00	0.00	0.00	Open	
306	302	303	10	200	100	0.00	0.00	0.00	Open	
307	25	303	400	200	140	-12.35	-0.39	0.34	Open	
308	46	304	750	200	140	0.00	0.00	0.00	Open	
309	127	304	10	100	100	0.00	0.00	0.00	Open	
310	303	29	2389	300	140	62.18	0.88	5.64	Open	
311	32	156	675	250	140	8.07	0.16	0.09	Open	
312	145	129	575	200	140	-6.09	-0.19	0.13	Open	
313	20	303	1200	350	140	74.53	0.77	1.87	Open	
314	135	306	2400	300	140	82.00	1.16	9.46	Open	
315	97	307	442	300	140	3.85	0.05	32.15	Open	PR29
316	307	83	564	250	140	3.85	0.08	0.0	Open	
400	80	100	341	400	140	133.10	1.06	0.8	Open	
401	100	105	257	400	140	23.32	0.19	0.0	Open	
402	112	400	842	400	140	76.14	0.61	0.7	Open	
403	400	125	715	300	140	74.06	1.05	2.333	Open	
404	125	401	930	250	140	35.96	0.73	1.937	Open	
405	401	150	282	250	140	18.47	0.38	0.2	Open	
1001	104	111	2	100	130	86.29	10.99	2.1	Open	
1002	1000	94	10	600	100	233.20	0.82	0.0	Open	

ANNEX 13

Drawings

1.	Fire Hydrant Flow Capacities	DLC-105
2.	Existing System Improvements	DLC-107
3.	Computer Model Schematic	DLC-108
4.	Water Quality Improvements	DLC-109
5.	Development Growth Areas Proposed Water System	DLC-110
6.	Proposed Water System for Year 2020 Computer Model Schematic	DLC-111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MIDDLETON
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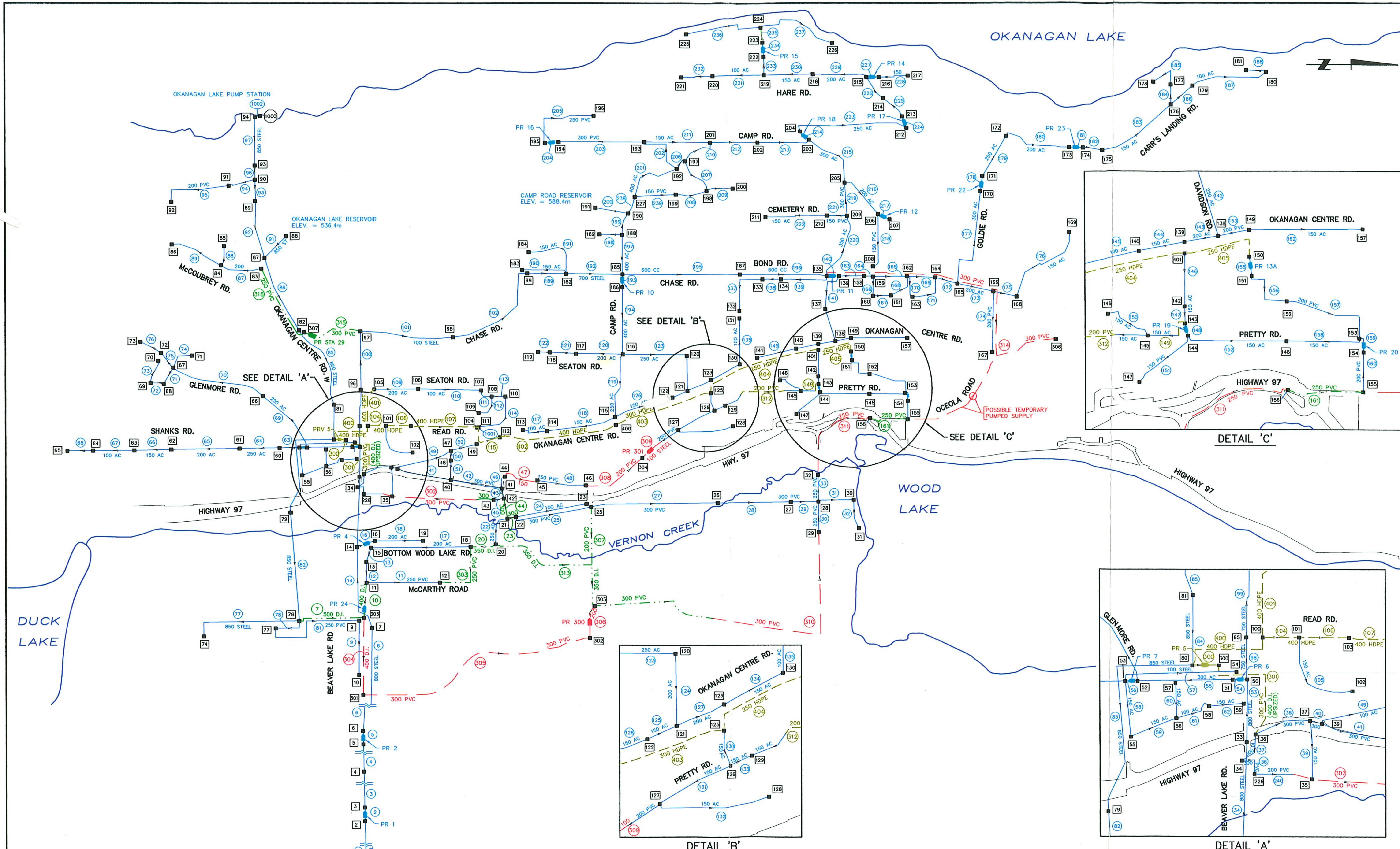
WOODSDALE
CLEARWATER
OYAMA
TYNDALL RD
STUBBS RD
McCOUBREY RD
OK CENTRE RD WEST
CAMP RD
HARE RD
CEMETERY RD
BOND RD
CHASE RD
SEATON RD
GLENMORE RD
SHANKS RD
HWY 97
HILL RD
MAIN ST
NEWENE RD
BOTTOM WOOD LAKE RD
VERNON CREEK
REISWIG RD
WOODSDALE RD
LODGE RD
McCARTHY RD
JIM BAILEY RD
BEAVER LAKE RD
OKANAGAN CENTRE RD
OK CENTRE RD W
OK CENTRE RD EAST
GOLDIE RD
CARR'S LANDING RD
MOBERLY RD
OCEOLA RD
PRETTY RD
OK CENTER RD
MIDDLE BENCH ROAD
CITY OF KELOWNA
D.L.C. BOUNDARY
PROPOSED BOOSTER STATION
PROP. 2.5 MILLION LITRE RESERVOIR ELEV. = 536.4m
PERMANENT SUPPLY
POSSIBLE TEMPORARY PUMPED SUPPLY
PROPOSED PRV
TREATMENT PLANT EXPANSION
LEGEND
EXISTING WATERMAIN
DLC BOUNDARY
FUTURE DEVELOPMENT AREA
PROPOSED WORKS – DEVELOPER FUNDED
PROPOSED WORKS – DCC FUNDED
PROPOSED WORKS – WATER QUALITY IMPROVEMENTS WHICH WILL ALLOW GROWTH
Mould Engineering
206 – 437 Glenmore Road, Kelowna, B.C. V1V 1Y5
Telephone 868-2072
DRAWN J.B.
DESIGN J.G.
APPROVED
DATE JULY 2002
SCALE N.T.S.
DISTRICT OF LAKE COUNTRY
DEVELOPMENT GROWTH AREAS
PROPOSED WATER SYSTEM – 2020
DRAWING NO.
DLC-110
REV. NO.



LEGEND

- EXISTING WATERMAIN
- PIPE
- NODE
- SOURCE
- PRESSURE REDUCING VALVE
- PROPOSED WORKS – DEVELOPER FUNDED
- PROPOSED WORKS – DCC FUNDED
- PROPOSED WORKS – WATER QUALITY IMPROVEMENTS WHICH WILL ALLOW GROWTH

NO.	DATE	BY	REVISION	CH'KD

Mould Engineering
206 – 437 Glenmore Road, Kelowna, B.C. V1V 1Y5
Telephone 868-2072

DRAWN	R.J.
DESIGN	J.G.
APPROVED	
DATE	JULY 2002
SCALE	1:25,000

DISTRICT OF LAKE COUNTRY

PROPOSED WATER SYSTEM FOR YEAR 2020
COMPUTER MODEL SCHEMATIC

DRAWING NO. DLC–111

REV. NO.

Attachment D – 2003 Master Water Servicing Plan Peer Review

District of Lake Country
Winfield & Okanagan Centre Water System
Master Water Servicing Plan

Peer Review

February 2003

D. Mitchell, P.Eng.
M. Nolan, P.Eng.
P. Gigliotti, P.Eng.

March 19, 2003

Mr. Michael Mercer, P.Eng.
District of Lake Country
10150 Bottom Wood Lake Road
Lake Country, BC V4V 2M1

Dear Mr. Mercer

RE: District of Lake Country Master Water Servicing Plan
Peer Review – Final Report

We are pleased to present herewith, ten (10) copies of the final report on our review of the District's Master Water Servicing Plan. The Peer Review Team appreciated the opportunity to carry out this review on the District's behalf.

The report is generally supportive of the findings and recommendations of the Master Water Servicing Plan, however additional work is required to address questions raised by the Peer Review Team. On the primary issue regarding purchasing property to facilitate construction of a reservoir and future water treatment plant, the Peer Review Team is supportive.

The concept of using an "open-to-atmosphere" hydraulic control structure to replace PR2 is supported; however using the site specifically to facilitate water quality improvements requires further detailed analysis prior to acceptance. Implications of interconnecting the Vernon Creek and Okanagan Lake supplies should be carefully examined prior to committing to this option.

Should the District require any clarifications or further assistance in developing the water planning process further, please do not hesitate to contact us.

Sincerely,
Peer Review Team

Dennis Mitchell, P.Eng. Mike Nolan, P.Eng. Peter Gigliotti, P.Eng.

District of Lake Country Master Water Servicing Plan Peer Review

Table of Contents

EXECUTIVE SUMMARY

The Water Service Advisory Commission of the District of Lake Country commissioned this Peer Review of the Master Water Servicing Plan prepared by Mould Engineering, dated February 2002. The Peer Review Team consisted of Mr. Mike Nolan, P.Eng., Mr. Peter Gigliotti, P.Eng. and Mr. Dennis Mitchell, P.Eng.

The document presents the Peer Review Team's responses to specific questions that the District of Lake Country and the Water Services Commission had of the Master Water Servicing Plan. It also addresses questions and concerns that were raised through the Peer review process by stakeholders and the Peer Review Team.

Peer Review Process

The Water Service Advisory Commission raised specific concerns for the Peer Review Team to address. The Peer Review Team subsequently raised additional questions based upon their assessment of the Plan and perceived District needs. Through a process of document review, facilities inspections and stakeholder interviews, the Team developed responses to all questions.

The issues presented by the Commission and the Peer Review Team are summarized as follows:

- Land purchase for construction of sedimentation pond and possible future filtration plant.
- New screening works on Vernon Creek.
- Replacement of pressure reducing stations 1 and 2 with a storage/balancing reservoir.
- Removal of a number of pressure reducing stations.
- Replacement 7 km of small diameter pipe.
- Installation of a pipeline along Okanagan Centre Road.
- Upgrading the Okanagan Lake pump station.
- A booster pump/pressure reducing station on Glenmore Road.
- Construction of water treatment facility on Vernon Creek.
- What role will agriculture play in the District?
- What level of treated water quality will the District achieve?
- Water rates to deliver the quality and quantity of water.
- Public input regarding quality, quantity, growth, costs and societal aspects of water.
- Groundwater as a Possible Source for the Winfield and Okanagan Centre Water System.
- Dual Distribution System for the Winfield and Okanagan Centre System.

Peer Review Team Responses

The questions raised by the Peer Review Team were fairly broad in context, and as such were addressed prior to the Commission's concerns. The questions raised and summaries of the Peer Review Team's responses are as follows:

What Role will Agriculture Play in the District?

Agriculture is a key contributor to the economic and social fabric of the Community. Residential users accept the primary right agriculture has to water and are likely willing to pay a premium through their water rates to help sustain the industry.

Agricultural ratepayers recognize that residential and commercial users contribute a significant portion of total water revenues, and without the residential revenues, agricultural rates would be much higher. Residential water revenues are critical to agricultural viability, and as such the agricultural sector supports increased development outside of agricultural areas and the need to improve water quality to meet the domestic needs.

What Level of Treated Water Quality Will the District Achieve?

The Peer Review Team and Provincial Health Authorities recognize that a potential health risk exists with the high turbidity water from Vernon Creek. Provincial standards will be changing to specifically regulate the turbidity in the delivered water. Water treatment improvements should enable the District to meet the anticipated regulations.

The recommendation of the Master Water Servicing Plan is to construct a reservoir to store Vernon Creek water when turbidity is low, and release this water during high turbidity events. To meet regulatory water quality standards, a water treatment plant would ultimately treat the stored water. Okanagan Lake water would supplement this source by interconnecting the two supplies through the new Glenmore Road pump station.

The Peer Review Team believes that the range and duration of Vernon Creek raw water colour and turbidity must be better understood, and the range of colour and turbidity reduction that can be expected for water in the reservoir must be confirmed. The treated water quality objectives must also be clearly defined prior to preliminary and detailed design. These assessments will be critical to evaluate or design the water treatment component of this strategy.

The Peer Review Team recommends the District complete a more detailed analysis of retaining the existing Vernon Creek system as an irrigation and fire protection system and developing the Okanagan Lake system as a strictly potable water system.

What are the Water Rates to Deliver the Desired Quality and Quantity of Water?

The Master Water Servicing Plan has identified upgrading required to address current operational concerns, and changes to major system components at a fundamental level. Further analysis of alternatives for long term supply and treatment is deemed necessary prior to committing to a long-term plan. This planning should include further analysis of rates for the various user sectors, irrigation system separation and phasing alternatives.

All sectors must recognize that agriculture is a cornerstone industry in the area. Water rates will be critical to maintaining the rural character the community desires and achieving the high quality water users demand.

Water rate financial analyses should include Net Present Value (NPV) cost calculations. This exercise will ensure current and future capital and operating costs are included in examining all options and rate structures.

Public Input Regarding Quality, Quantity, Growth, Costs and Societal Aspects of Water

The Peer Review Team solicited a limited amount of public input into the Master Water Servicing Plan, and discovered the public is very interested in this service. The issues of agricultural value to the community, water quality, quantity and rates are important to users. The Team's assessment was that the public is prepared to accept a premium to maintain the rural nature of the community and receive high quality water. The District must confirm this.

The Public should be:

- Provided with a forum to voice their concerns regarding water;
- Advised on the health issues and the alternatives available to address concerns;
- Solicited about their views on agriculture and the value they place on the rural character;
- Made aware of the impacts on water rates their issues will impose.

Water Service Advisory Commission Questions

The Commission's questions were more specific in nature, and the Peer Review Team attempted to address them in terms of the broader context issues. The questions raised and summaries of the Peer Review Team's responses are as follows:

Land Purchase for Construction of Sedimentation Pond

The site proposed for the Vernon Creek reservoir is well situated to provide operational benefits to the District, and as a future water treatment plant site

In the short term, the proposed reservoir will mitigate the most severe water quality events being experienced; additional water treatment will be required in the long term to achieve domestic water quality standards. Additional study is required to:

- Verify the raw water quality of Vernon Creek;
- Confirm the likely reduction in turbidity that the proposed reservoir concept will provide, considering the actual turbidity of Vernon Creek;
- Identify additional levels of treatment required to achieve anticipated water quality standards;
- Identify capital and O&M costs associated with treating full irrigation flows to standards achievable by the reservoir concept and additional treatment to meet anticipated water quality standards;
- Compare the costs and benefits of maintaining the existing water system as the District's irrigation and fire protection system to a domestic system sourced from Okanagan Lake.

The Peer Review Team does not support the purchase of the reservoir property on the basis of water quality/treatment improvements at this time as we feel that these concepts need further development. It is important to keep in mind however, the site's long-term potential to the community for water treatment purposes. We support acquiring the property for hydraulic control improvements and as a future water treatment plant location should the Vernon Creek treatment option prove viable. Further analysis is required to size the facility for hydraulic purposes.

New Screening Works on Vernon Creek

The Peer Review Team endorses construction of new screening works on Vernon Creek.

Replacement of PR Stations PR1 and PR2 with a Storage/Balancing Reservoir

The proposed Vernon Creek reservoir would eliminate PR2, however, it will not eliminate the need for PR1 or a similar control facility. The concept of using an "open-to-atmosphere" hydraulic control structure to maintain system pressure in lieu of PR2 is supported. Pressure reduction upstream of the structure by generating electrical power should be investigated.

The Peer Review Team does support the purchase of property for a hydraulic control structure to replace PR2. Further analysis is required to size the facility for hydraulic purposes.

Removal of a Number of Pressure Reducing Stations

The Peer Review Team accepts the report's conclusions that operational refinements and cost savings could be realized by implementing the identified modifications. A long-term systematic approach to implementing the recommended changes is required, considering capital and operational cost savings.

Replacement 7 km of Small Diameter Pipe

This recommendation is supported to ensure adequate fire flows are available to the identified areas.

Installation of a Pipeline along Okanagan Centre Road

The Peer Review Team supports this recommendation in the context of a dual distribution system.

Upgrading the Okanagan Lake Pump Station

The District acquired a significant resource in the Okanagan Lake pump station, and use and optimization of this facility is recommended. The Peer Review Team believes that a domestic water system sourced from Lake Okanagan serving a dual distribution system will prove effective in addressing the District's long-term water quality objectives.

Examination of expansion of this facility in the context of a dual distribution system is recommended.

A Booster Pump/Pressure Reducing Station on Glenmore Road

Expanding the area served by the Okanagan Lake pump station and providing additional residents with Okanagan Lake water is desirable. Installation of these facilities should be carried out in the context of examining a dual distribution system sourcing from Okanagan Lake.

Construction of Water Treatment Facility on Vernon Creek

Limited information was presented to allow the Peer Review Team to assess the proposed treatment facility. The Peer Review Team is of the opinion that a treatment facility to treat *all* Vernon Creek flows may prove to be prohibitive in terms of capital and operating costs, especially for the agricultural sector. Justification for this scheme should be analysed further and compared to costs and benefits associated with a dual distribution system with the domestic component sourced from Okanagan Lake.

Groundwater as a Possible Source for the Winfield and Okanagan Centre Water System

Minimal information is available on groundwater in the Ellison Valley. Indications are that significant quantities of groundwater are available, however the quality is questionable. Comparison of costs to pump and treat groundwater in comparison to other available options will likely show this option to be non-viable. Study issues are provided should the District wish to pursue this option further, however we suggest groundwater not be included in the ultimate water supply program.

Dual Distribution System Winfield and Okanagan Centre

The Peer Review Team supports the concept of a dual distribution system for this area. The scheme envisioned would use the existing Vernon Creek water system for irrigation and fire protection while domestic water would be sourced from Okanagan Lake via the Okanagan Lake pump station. Development centres within the District would be serviced with dual systems and Point of Entry treatment considered for remote residences.

Additional engineering and financial analyses are required to determine the viability of treating Vernon Creek to meet water quality demands compared to pumping and distribution costs associated with a supply from Okanagan Lake.

Peer Review Team Overall Conclusion

The Master Water Servicing Plan produced by Mould Engineering was a document originally generated to serve as a platform to identify specific operational improvements required for the Winfield and Okanagan Centre Water System. The document subsequently evolved into a Master Water Servicing Plan. The document as originally intended, adequately met its intended purpose.

The Peer Review Team suggests that a Master Water Servicing Plan is a document that serves as a visionary instrument and provides direction to residents and staff on critical issues. Similar to the Official Community Plan, the Master Water Servicing Plan should express the District's intent and decisions with respect to quality, quantity, future development and growth of the water system. The Plan must integrate with the District's financial planning process.

Additional public discussion is required to facilitate the broad conceptual framework that this planning document requires, particularly given the different objectives of the agricultural and domestic sectors. Issues with wide ranging impacts on the Plan's outcome must be explored prior to adoption. Solutions presented in the Master Water Servicing Plan can serve as a starting point to initiate discussions, however additional detail is required to facilitate these discussions.

Fundamental to this discussion are the concepts of agricultural financial stability and the residents' view on this resource; water quality and the residents' perceptions; and the issues of water rates and how all the inter-related variables affect the required revenues. These issues should be explored.

The overall concept of a dual distribution system is to supply the domestic and agricultural sectors with the required quantity and appropriate quality of water, at the most reasonable cost for each sector. The District is well situated for this approach, with an existing high quality water sourced from Okanagan Lake, and inexpensive gravity-fed water from Vernon Creek. The District has an unparalleled resource in the Okanagan Lake pump station as a means to deliver high quality water for a relatively minor initial capital cost investment. This source should be fully utilized.

The Peer Review Team suggests that the overall concept of a dual distribution system be explored further prior to approving major capital expenditures related to water quality improvements associated with the Vernon Creek reservoir. Operational/safety changes associated with developing an "open-to-atmosphere" hydraulic control structure should proceed to the preliminary design stage, and the design should be optimized.

To resolve the issue of improving water quality for residential consumers, the options of mixing and treating Vernon Creek and Okanagan Lake waters should be compared to supplying all domestic water from Okanagan Lake. The alternatives should be reviewed to determine if various components from each can be integrated into an overall solution, and a Master Water Plan.

The purchase of property for the Vernon Creek reservoir and water treatment plant will likely fall into this category of combining ideas from all options to develop an overall plan. The District is advised to proceed with property acquisition, with the understanding that the ultimate use will be developed as detailed water quality engineering proceeds.

Finally, the issues, concepts and costs should be presented to the public to obtain their input and approval prior to implementation.

1.0 INTRODUCTION

1.1 Preamble

The District of Lake Country requested this "peer review" of the "District of Lake Country Master Water Servicing Plan" in September 2002. Mould Engineering prepared the Master Water Servicing Plan in February 2002. The District of Lake Country issued the Terms of Reference for the peer review on September 23, 2002.

1.2 Reasons for Peer Review

The Master Water Servicing Plan was prepared by Mould Engineering and chiefly dealt with the former Winfield and Okanagan Centre Water System (WOCWS). The draft Master Water Servicing Plan was presented to the Water Service Advisory Commission in early 2002. The Water Service Advisory Commission was established upon dissolution of the Improvement and Irrigation Districts as part of the incorporation of Lake Country. The Commission's mandate is to represent the interests of water users in the community (agricultural, residential, commercial and industrial) and provide timely and constructive advice to the District of Lake Country Council.

The Commission's initial review of the Master Water Servicing Plan led to diverging opinions and it was decided to solicit a third party "peer review" of the document. The selected peer review team consists of Dennis Mitchell, P.Eng., Mike Nolan, P.Eng. and Peter Gigliotti, P.Eng.

The Commission members held the initial interview with the peer review group on June 27, 2002. The Terms of Reference and authorization for the review were subsequently issued on September 23, 2002.

1.3 Scope of Review

1.3.1 Water Service Advisory Commission Questions

The review is limited to the Winfield-Okanagan Centre Water System and does not deal with other water systems within the District of Lake Country. Specifically, the Terms of Reference request a review of the following recommendations in the Master Water Servicing Plan:

- Land purchase for construction of sedimentation pond and possible future filtration plant.
- New screening works on Vernon Creek to lower operating costs.
- Replacement of pressure reducing stations 1 and 2 with a storage/balancing reservoir to resolve mainline pressure instabilities and reduce operating costs.
- Removal of a number of pressure reducing stations to simplify the system, improve pressure instabilities, and decrease capital and operating costs.
- Replacement 7 km of small diameter pipe to improve fire flow capabilities.
- Installation of a pipeline along Okanagan Centre Road to increase the gravity supply area from Okanagan Lake reservoir.
- Upgrading the Okanagan Lake pump station to utilize its full capacity.
- A booster pump/pressure reducing station on Glenmore Road to convey additional Okanagan Lake water into the system.
- Construction of a water treatment facility on the Vernon Creek to supply the remaining water demand.

In its latest meeting of September 18, 2002, the Water Service Advisory Commission added the following items:

- Groundwater be evaluated as a possible source for the Winfield and Okanagan Centre water system; was this source considered by Mould in their original evaluation; could the Peer Review Team again review groundwater as a viable long-term source for this system.
- The Commission recognizes the lower cost of delivery for the Vernon Creek source and its water quality implications.
- The Commission also recognizes the higher cost of delivery for the Okanagan Lake source and its higher water quality value.
- In consideration of the above observation by the Commission, the Commission requests the Peer Review Team to review Mould's conclusions on the optimization of these two sources, in particular the cost and benefits of providing a dual distribution system in the long-term for the Winfield and Okanagan Centre system.

1.3.2 Peer Review Team Questions

In discussions with District Operations staff and Mould Engineering, the Peer Review Team determined that The Master Water Servicing Plan evolved from an analysis of the Winfield and Okanagan Centre system to address servicing and operational issues. In this context, the plan appeared to address immediate concerns, however the Peer Review Team felt that an examination of broader issues in addition to those examined by Mould were warranted.

In order for the District of Lake Country to adequately assess the recommendations in the Master Water Servicing Plan, the Peer Review Team was of the opinion that direction and input from the various stakeholders was warranted on the following issues:

- What role will agriculture play in the future development of the District and what value does the community place on agriculture to local society?
- The level of treated water quality to which the District will strive is paramount to future decisions regarding the water system. Health and aesthetic concerns for domestic users must be balanced against quantity and cost issues for commercial and agricultural users.
- Water rates to deliver the quality and quantity of water required for the different users should reflect each groups priorities, needs and ability to pay.
- Public input regarding quality, quantity, growth, costs and societal aspects of water is key to the District's acceptance of the Master Water Servicing Plan. A public process of soliciting input and disseminating the Plan's results is warranted.

We recognized that these issues were beyond the scope of the Master Water Servicing Plan as prepared by Mould Engineering, and as such have been addressed in this report. The Peer Review Team either gathered information from existing sources to obtain direction and make recommendations or has suggested further study.

1.4 Peer Review Approach

In order to assess the Master Water Servicing Plan and incorporate the issues the Team identified, as part of that assessment, the following tasks were carried out:

- Reviewed the Master Water Servicing plan and supporting documentation prepared by Mould Engineering and the District of Lake Country. (Appendix A)
- Toured the District Water system from Vernon Creek to the Hiram Walker pump station
- Conducted interviews with representatives of the agricultural and residential users; District Administrative staff; Mould Engineering and District Operations staff. (Appendix C)
- Met independently to review information, statements, positions and data. Prepared statements and this report.

1.5 Contextual Background

The Winfield-Okanagan Centre Water System was originally constructed by and for area agriculturalists to provide water chiefly for irrigation. Vernon Creek was a reliable source of supply and the quality of the water with respect to microbial populations, colour and turbidity was not of great concern since the inception of the system and until recently.

Okanagan Lake water was subsequently added to the system when the District purchased the Hiram Walker, Okanagan Lake pump station and reservoir. Okanagan Lake water is not subject to the type of quality upsets Vernon Creek experiences, and therefore provides a consistently high quality source.

Over the years the system has been expanded to serve residential users as well as agricultural irrigation. The Master Water Services Plan provides an expanded history of the system and its evolution. The Plan provides the following current split in total annual consumption:

Current Water Consumption

USER	QUANTITY	%
Irrigation (928 Ha)	6,775 ML/year	86.6
Domestic and Commercial (1910 Connections)	465 ML/year	5.9
Industrial	585 ML/year	7.5
Total Annual Consumption	7,825 ML/year	100.0

It is noted that the 928 Ha referred to above is not strictly agricultural irrigation but includes rural residential lawn sprinkling. Nevertheless, it is evident that the greatest proportion of water use is for outside irrigation.

Agricultural users interviewed in the course of the peer review largely felt that the system met their needs and saw no compelling reason to make any major capital expenditures.

Residential users expressed serious concern over the safety of the water for consumption. Frequent spikes of muddy turbid water at the tap and rusty brownish colour, and routine "boil-water advisories" have all contributed to reduce consumer confidence.

Operating staff expressed concerns over the safety of their daily routines with pressure reducing stations operating at high pressures, confined space entry into underground valve chambers, and numerous other elements incurring risk to personal safety.

2.0 GOALS AND OBJECTIVES

2.1 The Current Master Water Servicing Plan

The current plan states its objectives to be (pg i, Executive Summary[14]):

- System operation guidelines.
- Outline of capital works required to improve the existing system.
- Recommendations for water quality improvements.
- Concept plans for infrastructure required to service new developments.
- Watershed management plans.
- Water conservation options.
- Outline of possibilities for interconnection of the numerous water systems.
- Financial implications of constructing the recommended works.
- Charges to be attributed to existing and future users.
- Basis for establishing development cost charge bylaws and annual water rates.

2.2 Guiding Principles for Peer Review

Discussions with the Commission as a whole, and interviews with individual members (or groups) as well as Lake Country staff revealed some differences over the broad goals and objectives of the Peer Review process. Nevertheless, some common ground was found in the attempt to articulate a fundamental broad objective and this can be briefly stated as:

TO PROVIDE SAFE WATER TO CONSUMERS, AT A REASONABLE COST

Achieving this objective is complicated by lack of clear definition of safe water and what is a reasonable cost. In order to simplify the exercise, the team decided to adopt some guiding principles for the review. These can be briefly summarized as follows:

1. ***"Safe" water should, to the extent practical, minimize the risk of disease.***
2. ***Quantity of source water should be sufficient to meet the community's long-term needs.***
3. ***Recognize that agricultural users depend on water for their livelihood and their costs for water should be kept affordable.***
4. ***Worker safety should not be compromised.***

3.0 PEER REVIEW

The Peer Review was conducted in a two-step process. As presented under Item 1.3, the Peer Review Team identified four "broad context" issues for resolution prior to addressing the Commission's concerns.

A Master Water Servicing Plan is a document that serves as a visionary instrument and provides direction to residents and staff on critical issues. Similar to the Official Community Plan, the Master Water Servicing Plan should express the District's intent and decisions with respect to quality, quantity, future development and growth of the water system.

The Plan as reviewed did not, in the opinion of the Team, meet all of these criteria. In order to assist the District with the questions they raised as well as provide a Master Water Servicing Plan that will meet the District's needs for years to come, we expanded the review to issues beyond the original scope.

The following discussion presents the analysis and observations of the Peer Review Team in addressing the overall issue of providing a comprehensive planning document. Section 3.1 discusses the Peer Review Team issues; Section 3.2 discusses the Commission's issues.

3.1 Peer Review Team Questions

3.1.1 Role of Agriculture

Early on in the Peer Review process, it became apparent that a difference of opinion existed between agricultural and residential users of the water system, regarding the following issues:

- Availability of water for irrigation and source water rights.
- Water quality standards for agriculture compared to standards for domestic consumption.
  - The current quality of the water delivered to agriculture is adequate for irrigation purposes, however this quality is unacceptable to residential consumers.
- Value of the water quality improvements to agriculture.
  - The strategy to improve water quality as proposed in the Plan will provide minimal benefits for agriculture.
- Costs associated with achieving water quality standards for domestic use and how they would be paid for.
- Costs associated with upgrading the irrigation system components as they reach their design life expectancy, and how they would be paid for.

The Peer Review Team concluded that, as they were not part of the original Terms of Reference for the Plan, the Master Water Servicing Plan did not address these issues. In the Peer Review Team's opinion, documenting and recognizing agricultural rights is fundamental to the development of a sound Plan.

The Peer Review Team conducted a cursory review of the agricultural circumstances, by carrying out the following:

- Reviewed the District's Official Community Plan.
- Interviewed representatives of the agricultural sector and domestic users.
- Reviewed plans and the history of the Winfield & Okanagan Centre Irrigation District.

The Peer Review Team did identify some issues that the District and Consultant should explore further. Of prime importance was the recognition domestic users had of the high value the agricultural industry contributes to Lake Country. Of particular note were the following points:

- Agriculture contributes a significant proportion of the economic base to the community.
- In addition to the economic value, there is an associated "aesthetic" value that the agricultural sector provides the community. Residential landowners recognize this "rural character" adds to their quality of life in Lake Country, and they want to protect it.
- As water rights were historically assigned to agricultural land within the District, they are recognized as precedent to other uses.
- Costs associated with providing consistently safe quality water to meet domestic needs would be shared between the agricultural and residential users. The agricultural proportion would be based on an orchardist's domestic use, not irrigation use.
- Costs for upgrading and maintaining the water system would be borne by all users. It was recognized that non-agricultural users might pay a higher proportion of these costs, however that expense was recognized as part of maintaining the rural character urban residents value.

The preceding resolutions represent the Peer Review Team's interpretation of the research they conducted, and should be verified by the District through a more public process.

3.1.2 Water Quality

Most stakeholders were in agreement that water quality was the highest priority for the District to resolve. The exception being the agricultural users, who were of the opinion that the quality is acceptable for irrigation purposes and was therefore a low priority.

Quality issues for the residential users were aesthetic based as well as health related. The District experiences seasonal high turbidity and colour events, which residential users find unacceptable, and the Medical Health Officer (MHO) regularly deems "unsafe". The Peer Review Team examined this issue from the safety perspective (Appendix A) and concur with the MHO that the high turbidity events represent a health risk.

Appendix B, details the Peer Review Team's fact base for this issue, and the reader is encouraged to review those details to supplement this discussion. To assist in the development of our position on water quality, the following presents the key water quality facts as summarized from the Master Water Servicing Plan:

- Turbidity in Vernon Creek averages 2 NTU.
- The highest recorded turbidity reading in April was 5 NTU.
- Turbidity has been measured at 29 NTU.
- Spring flooding and summer rainfall events can spike turbidity up to 600 NTU. Boil advisories are associated with these spikes, and are typically 1 to 2 weeks duration.
- Colour averages 35 TCU peaking in April to 65 TCU.
- Without filtration, primary disinfection must achieve a minimum of 3-log (99.9%) Giardia removal. Conventional filtration provides 2.5-log Giardia removal.

The Master Water Servicing Plan addresses the water quality issue by recommending the following strategy:

- "*Constructing the Vernon Creek Reservoir and Disinfection Facility*"[14] between the intake on Vernon Creek and the community. The facility

  > "*will allow high turbidity events in Vernon Creek to be circumvented...by installing a turbidity meter at the intake...that will close the gate to the mainline should turbidity exceed a set threshold*"[14]

  > "*There will also be a colour reduction, as a result of chlorination as it enters the reservoir*"[14]

- Providing a conventional filtration plant to treat the water leaving the reservoir.
- Interconnecting the Vernon Creek and Okanagan Lake water supplies through the Glenmore Road pump station to supplement Vernon Creek flows during periods of high turbidity.
- Disinfection of Vernon Creek and Okanagan Lake waters by chlorination, ozonation or ultra-violet (UV) light.

The recommendation of the Master Water Servicing Plan is for the construction of a reservoir to store Vernon Creek water, which would subsequently be used during high turbidity events. A water treatment plant would ultimately be constructed on the reservoir site to treat the impounded water to meet regulatory water quality standards. Okanagan Lake water would be used to supplement this source by interconnecting the two supplies through the new Glenmore Road pump station. The pump station would raise the Okanagan Lake supplied water to the same operating head as the Vernon Creek system. Concurrent with this Peer Review, the District is proceeding with securing a site for the Vernon Creek reservoir.

Based upon the information provided the Peer Review Team and a tour of the site, the Team reviewed the recommendation and questions some of the tenets of the scheme. We suggest that further study is warranted prior to the District accepting this recommendation. In particular the District should conduct a more detailed investigation of the effect the reservoir will have on turbidity levels of delivered water.

The Province of British Columbia is legislating improvements to water quality, which will bring Provincial Standards in line with jurisdictions throughout North America (see Appendix B). The anticipated standards if based on the Canadian Drinking Water Guidelines will be quite stringent and will require diligence to achieve. The ability of the proposed reservoir strategy to achieve the anticipated standards, raised the following questions and concerns with the Peer Review Team:

What range and duration of raw water colour and turbidity does Vernon Creek experience?

- Raw water quality data provided for Vernon Creek does not provide a sufficient baseline of information to quantify the degree of colour and turbidity the creek experiences annually, or the duration of the high turbidity events.
- The District should carry out further sampling to characterize the raw water quality.
- The program should extend at least one year, provide for on-line turbidity sampling and increase in intensity during freshet periods and instances of high colour and turbidity.

What range of colour and turbidity can be expected for water in the reservoir?

- Mould Engineering made no predictions on the levels of colour and turbidity reduction the proposed scheme would be able to attain relative to the raw water conditions and the anticipated water quality standards.
- High turbidity events during the irrigation season may not be attenuated by the reservoir, which in turn may result in high turbidity water entering the system. An analysis of the duration of existing events compared to irrigation flow requirements should be carried out.
- Performance of similar facilities suggests water quality improvements can be expected; however additional operating issues and costs can be expected.
- Operations & Maintenance costs associated with the proposed facility were not considered, and could prove substantial.
- A modeling study of the proposed facility should be carried out to substantiate the recommendation, confirm the facility size and assess the overall viability of the proposal.
    - Pilot testing of the proposed reservoir scheme should be carried out prior to accepting this recommendation for water quality purposes.
    - A detailed predesign with O&M and capital costs should be completed.

Current water quality of Vernon Creek meets the requirements of the agriculturalists, while the quality of Okanagan Lake meets the requirements of the residential consumers. With this basic assumption, the Peer Review Team suggests that concepts be explored to develop the Okanagan Lake system into a strictly residential system and maintain the Vernon Creek system as a strictly agricultural system. Advantages to this concept are:

- The Okanagan Lake pump station can supply high quality water to meet residential needs with minimal treatment;
- The Vernon Creek system can supply sufficient quantities of acceptable quality water to meet agricultural needs.
- Substantial costs will be incurred in providing high quality water to the residential consumers, regardless of the method of delivery or the source;
- Agriculturalists are reluctant to support water quality improvements for the Vernon Creek system with minimal benefit for agriculture
- Residential consumers will support water quality improvements. A dedicated residential system sourcing from Okanagan Lake will meet their needs and not require significant water treatment.

3.1.3 Water Rates

The original systems built for the Winfield and Okanagan Centre Irrigation District (WOCID) and the Hiram Walker Distillery were constructed through the late 1960's and early 1970's, and consist of:

- Vernon Creek intake works;
- Two balancing reservoirs;
- 26 pressure reducing stations;
- Approximately 70km of pipe and 150 fire hydrants;
- Okanagan Lake Pump Station.

The Master Water Servicing Plan details design, operation and maintenance issues associated with portions of the system, which are subsequently elaborated on in the Plan. In addition to these, the Peer Review Team suggests consideration be given to the upgrading of original systems in light of their age and usage.

Although the Plan does not specifically detail condition issues for all of the components of the existing system, the Peer Review Team suggests that the age of the system warrants the District identify critical works for upgrading or replacement.

Key to this analysis will be the identification of costs associated with the future upgrading and the subsequent inclusion of these costs in any water rate calculations.

The health of the utility depends not only on the quality of the infrastructure but also on its ability to generate sufficient revenue for capital and operating expenses. A financial analysis is warranted for each option being considered and the impact on water rates.

Water rates should recognize the community's support of the agricultural sector and not compromise that sector's ability to compete in the marketplace. Appropriate allocation policies will be key to a successful rate structure.

3.1.4 Public Input

The Peer Review Team solicited a limited amount of public input into the issues and alternatives being considered for the long-term water supply. Representatives of the agricultural and residential sectors were interviewed, as were individual ratepayers. In all instances, there was great interest in water quality, quantity and rates. Of particular note was the high value agriculture was assigned in most presentations.

The issues raised by the Peer Review Team go much further than the scope of the Master Water Servicing Plan. As such it is strongly recommended that the District solicit public input into the questions raised by the Commission and evaluated by the Peer Review Team.

We believe the Master Water Servicing Plan will benefit from public input into such issues as:

- The value agriculture brings to local society, and what premium domestic users are willing to pay to maintain that character.
- Water quality and the public's perception on the quality of water they would like to receive.
- Provincial regulatory direction and comments from the Medical Health Officer.
- Alternatives to Vernon Creek as the source of domestic water and what premium domestic users may be willing to spend to receive Okanagan Lake Water.
- Developing a dual distribution system in conjunction with the existing irrigation based system and any associated concerns the concept raises.

3.2 Water Service Advisory Commission Questions

Under the context that the Peer review Teams questions would be addressed as previously detailed, the Team then reviewed the Commission's original concerns as laid out in the initial and subsequent Terms of Reference. For continuity, each of the issues is presented and addressed below in the order they were listed originally.

3.2.1 Land Purchase for Construction of Sedimentation Pond and Future Filtration Plant

The Peer Review Team must qualify the response to this question in light of the information we have been presented with and the questions we raised ourselves. The purchase must also be examined in the context of using the reservoir as an operational tool to stabilize system hydraulics in addition water quality reasons.

We concur with Mould Engineering that the reservoir scheme will mitigate some turbidity spikes inherent with the Vernon Creek source. The resultant water quality improvement is still in question however, and should be addressed by analysis of continuous turbidity monitoring records. Quantification of the water quality benefits resulting from the proposed reservoir may help gain support from the agricultural and domestic users for this improvement.

Considering the Peer Review Team's concerns about the degree of treatment the reservoir alone can achieve, and that a potentially viable alternate source exists from Okanagan Lake, the Team concluded that acquisition of the site *for water treatment purposes alone* is not supported.

To summarize the thought process the Team went through in arriving at this conclusion, we restate the concerns and suggestions reached:

- The proposed water quality improvements will provide limited benefit for agriculture. While reduction in sediment entering the water system will be a positive improvement for irrigation users i.e. equipment maintenance, however this benefit must be weighed against the additional capital and operating costs for the proposed reservoir.
- Provincial water quality regulations will be changing in the future, requiring water purveyors and utilities to achieve stringent treated water quality standards. This may require a broad review of treatment facilities on the Vernon Creek source, and the reservoir, as proposed, may or may not fit into the future treatment scheme.
- Indications of the raw water quality for Vernon Creek suggest the water will be challenging to treat in achieving the impending standards. Additional and on-going raw water testing and monitoring is recommended to provide a sound basis for future treatment facility design.
- The Consultant has not identified the required amount of storage to offset high turbidity events or the levels of colour and turbidity reduction the facility will achieve.
- Capital and O&M costs associated with the reservoir and future treatment facility on Vernon Creek may prove prohibitive when treating irrigation flows. A financial analysis is required to verify this.
- Okanagan Lake is a viable, high quality water source available to the District. This source will require minimal treatment to achieve anticipated standards.
- Construction of a dual distribution system to deliver Okanagan Lake water may be a viable alternative to treating Vernon Creek water. Further engineering work is required to determine a concept plan and the associated costs.

- Long term O&M costs associated with treating Okanagan Lake water will be less than treating Vernon Creek water to the same standard. A financial analysis comparing the capital and O&M costs of treating and delivering Vernon Creek water to Okanagan Lake water must be carried out.

Vernon Creek will continue to serve as a major source of supply for the Winfield and Okanagan Centre water system. Regardless of the ultimate make-up of the entire water system, operating improvements for the Vernon Creek supply will be of benefit to the system.

Mould Engineering has presented an operating scheme that utilizes the reservoir as the means of maintaining the system operating head. Water from Vernon Creek would be delivered to the site and pressure reduced to accommodate an open-to-atmosphere reservoir. The established static water level in the reservoir would then set the operating head (pressure) for the downstream components of the distribution system. Currently this control is maintained by pressure reducing station PR2. This scheme would eliminate PR2.

Regardless of the method selected to maintain system pressure, the Vernon Creek supply main will still require pressure reduction prior to establishing the operating head. The Peer Review Team suggests that the District further examine the option of generating electrical power as the primary means of pressure reduction. A backup means of pressure reduction may also be required for times when the electrical system is offline.

On the basis of operational considerations, the Peer Review Team concurs with Mould Engineering that acquisition of property for the development of a hydraulic control structure is prudent.

We suggest that consideration be given to initially constructing a facility sized for system pressure control rather than water quality improvements. In the opinion of the Peer Review Team, this approach has the following benefits:

- A smaller, covered facility will be less susceptible to water degradation resulting from climatic conditions;
- With a smaller facility, less land would be required, potentially allowing the District a wider range of sites to choose from;
- An enclosed concrete structure would facilitate annual cleaning and subsequent disinfection of supplied water by chlorination.

3.2.2 New Screening Works on Vernon Creek

No specific cost analysis was presented in the Master Water Servicing Plan to substantiate the reduced operating costs this change would afford. The Peer Review Team interviewed the Operator and witnessed the procedure to clean the screens. Based on those assessments, we endorse this recommendation. In addition to the operating cost savings, operator safety while cleaning the screens will be greatly improved.

3.2.3 Replacement of Pressure Reducing Stations PR1 and PR2

This recommendation requires an open reservoir or similar "open-to-atmosphere" hydraulic structure to control system-operating pressures downstream of the facility. We are in agreement that the reservoir concept would eliminate pressure reducing station PR2, however pressure reduction will still be required upstream of the hydraulic structure.

An alternative to conventional pressure reduction technology the Commission may consider to replace PR1 is Pelton Wheel Power Generation equipment. With this type of equipment, excess pressure head is converted to electricity and subsequently sold to the local power authority to offset operating costs. Many implementation models are available to develop this type of program, including a Public Private Partnership (P3) with firms experienced in the design, construction, operation and sale of electricity. The Peer Review Team recommends the District explore the option of power generation in lieu of pressure reduction, and the various models available to implement such a scheme.

3.2.4 Removal of PR Stations Within the Distribution System

Mould Engineering conducted a detailed examination of the water distribution system and recommended a series of modifications be undertaken to optimize system operation, reduce the number of pressure-reducing stations and reduce operating costs. The Peer Review Team did not examine Mould Engineering's detailed hydraulic calculations used to arrive at these conclusions, as we were confident the analysis was adequate. Based on our tour of the system and observation of many of the stations, we generally concur that refinements could be made.

In discussions with Mould Engineering and the operators, we understood that although the changes were not critical to the operation of the system, operating and capital cost savings could be realized by making the recommended changes. A long-term, planned refinement of the distribution system to reduce capital and operating costs supported with detailed financial justification for each change is recommended.

3.2.5 Replacement 7 km of Small Diameter Pipe

This recommendation would improve fire-flows within the distribution system. Although the Peer Review Team did not review the detailed hydraulic analyses Mould used to arrive at this conclusion, the Team supports this recommendation.

Insufficient fire flows within a distribution system can have significant liability implications for the District in the event of a fire loss. Mitigating this liability by ensuring adequate fire flows are available throughout the District is highly recommended. Installation of adequately sized mains to provide these flows is recommended.

3.2.6 Pipeline Installation Along Okanagan Centre Road

This recommendation will increase the gravity supply area from the Okanagan Lake system. In light of the Peer Review Team's position on the District increasing the use of Okanagan Lake water as the primary source of supply for domestic use, the Team generally supports this recommendation.

Should further detailed financial analysis show that a dual distribution domestic water system, sourced from Okanagan Lake, serve as a superior alternative to Vernon Creek, many additional pipelines will be required. As such this recommendation should be viewed in the larger context of constructing a water system to deliver Okanagan Lake water through the entire District.

3.2.7 Upgrading Okanagan Lake Pump Station

In conjunction with the preceding conclusion regarding utilizing Okanagan Lake water as the supply source for the District's domestic needs, the Peer Review Team supports this conclusion. As previously mentioned though, this recommendation must be viewed in the context of the broader picture of how the District's complete domestic needs could be met with Okanagan Lake water.

The detailed analysis should consider capital and O&M costs to upgrade the station and associated storage to meet domestic needs within the District. Included with this analysis should be an examination of the long-term domestic needs of the District, how the water would be delivered through the District and the integration with the existing irrigation system sourced from Vernon Creek.

3.2.8 Booster Pump/Pressure Reducing Station on Glenmore Road

The Master Water Servicing Plan envisions the Winfield and Okanagan Centre water system being jointly supplied from interconnected Vernon Creek and Okanagan Lake sources. The Okanagan Lake pump station would deliver water to the proposed Glenmore Road pump station, which in turn will raise the Okanagan Lake supplied water to the Vernon Creek operating pressure, allowing the two systems to be interconnected.

This recommendation as it stands would interconnect the Okanagan Lake system and the Vernon Creek system, mixing Okanagan Lake's higher quality water with Vernon Creek water. Under this scenario, treatment of Vernon Creek water would ultimately be required.

In light of the detailed analysis we recommend the District carry out to examine the Okanagan Lake domestic supply option further, the Peer Review Team recommends this work be deferred pending completion of the further analyses.

3.2.9 Construction of a Water Treatment Facility on Vernon Creek

As detailed under the previous section, the Master Water Servicing Plan recommends the Okanagan Lake and Vernon Creek systems be interconnected to allow water from each source to intermix. Under this scenario, in order to supply Vernon Creek water at a comparable quality to that of Okanagan Lake, the Vernon Creek water would require treatment.

The scheme as currently proposed would utilize a reservoir to store low turbidity Vernon Creek water for later supply during periods of high turbidity. Water from this facility would then be treated to comply with provincial regulations, resulting in all water delivered through the District meeting provincial drinking water standards.

Insufficient information is provided on the details of this facility for the Peer Review Team to adequately comment on this issue at this time. Questions remain on the quality of water that will be present in the reservoir at any particular time, how intermixing of Vernon Creek and Okanagan Lake water will impact the system and the viability of pumping Okanagan Lake water to the same operating head as the Vernon Creek system. Generally it has been shown that capital and O&M costs associated with facilities sized to treat irrigation flows to drinking water quality standards could prove prohibitive. In order to investigate this, Mould Engineering should:

- Determine the method of treatment necessary to achieve the proposed treated water quality standards.
- Determine the quantity of water to be treated; the associated raw water quality to be treated and the anticipated duration the treatment will be required.
- Assign capital and O&M costs appropriate for the anticipated conditions and complete a Net Present Value (NPV) financial analysis.
- Compare this analysis to NPV analyses conducted for other alternatives.

3.2.10 Groundwater as a Possible Source for the Winfield and Okanagan Centre Water System

The Master Water Servicing Plan does not deal with groundwater as a potential source. To address this question, the Peer Review Team interviewed Mould Engineering. They advised that groundwater had been investigated in the past and there is potential for encountering reasonably large yields, although not enough to supply the District's demand.

Mould reported that groundwater quality has typically been low because of high iron concentrations and high mineralization and therefore characterized as hard water. Implications associated with using this ground water could result in extensive treatment to reduce hardness levels. Use of groundwater without treatment may result in scaling and staining of fixtures, and iron precipitation in the distribution system.

To investigate groundwater as a primary source further, the District could commission a literature study on available groundwater sources. From this information Mould Engineering would determine the total volumes of water available, water quality characteristics, well and pump requirements, treatment methods to reduce the hardness and the associated capital and operating costs.

Based our cursory review and considering the other options available for water supply, the Peer Review Team concluded that groundwater may be a limited resource that would have relatively high operating costs to treat and deliver, and as such should not be considered as part of the overall water supply solution

3.2.11 Dual Distribution System for Winfield and Okanagan Centre

The Commission requested the Peer Review Team comment on the development of a separate domestic water supply system for Winfield and Okanagan Centre. Initially the Team developed a dual distribution system concept, which is detailed below. We reviewed the Master Water Servicing Plan and one section of Mould Engineering's letter report to the District dated December 10, 2002, which deals with this subject. Mould Engineering determined that a dual distribution system would have a lower capital cost than the improvements recommended in the Master Water Servicing Plan, however discounted the concept based on several operational concerns.

The Peer Review Team supports further detailed investigation of a dual distribution system, in particular sourcing from the Okanagan Lake pump station. Such a system should consider:

- Use of the existing water system for irrigation and fire protection, incorporating operation modifications recommended in the Master Water Services Plan.
- Installation of a dedicated domestic water system sourced from the Okanagan Lake pump station and reservoir.
- Identification of development centres within the context of the Official Community Plan, and service these areas with the dedicated domestic water system. Areas outside of these centers could continue to use Vernon Creek water as the source of domestic water, and consider the use of "Point of Entry" (POE) treatment at each residence.

We point out that the USEPA is proceeding with the development of implementation standards for POE and Point of Use (POU) water treatment devices. If BC adopts a similar approach, this should address concerns regarding this type of equipment.

A further refinement of this concept that the District could investigate would involve a separate domestic water system serving the development centers previously suggested, using individual water treatment plants. Details should consider:

- Use of the existing water system, incorporating operation modifications recommended in the Master Water Services Plan, as the Community's irrigation and fire protection system.
- Identify development centres within the context of the Official Community Plan, and service these areas with a dedicated domestic water system.
- Source the water for each development centre from the irrigation system and Vernon Creek.
- Provide each development centre with a water treatment plant sized to meet the domestic needs of the centre.
- Service areas outside of these centers with "Point of Entry" (POE) treatment at each residence.

Although the concepts for the dual distribution system proposed above and analyzed by Mould Engineering appear similar, insufficient information was provided for the Peer Review Team to assess the validity of the costs provided.

The financial analysis of these options must consider the trade-off between capital and operating costs for each scenario. For the purpose of initial decision-making and concept development, the analysis should compare:

- Upgrading the Okanagan Lake pump station and providing increased reservoir storage.
- Installation of a separate domestic distribution system including pressure reducing stations, domestic services and individual POU treatment units.
- Operating costs for the Okanagan Lake pump station and additional overall maintenance associated with the extra infrastructure and POU treatment units.

Against:

- Construction of the proposed Vernon Creek reservoir and Glenmore Road pump station
- Construction of a water treatment plant to treat flows from Vernon Creek.
- Operating costs for the treatment plant.

The cost analyses should include a Net Present Value (NPV) calculation, which will incorporate capital and long-term O&M costs into the evaluation.

The cost analysis must be particularly sensitive to the agricultural rate impacts associated with operating a separate agricultural system. At first glance, it appears separating the systems and having the separate sectors fund "their" systems will require a substantial agricultural rate increase.

4.0 WATER QUANTITY

The Peer Review Team analyzed the Master Water Servicing Plan quite closely to understand the present and future water quantity requirements the District will be providing. Our review identified questions for clarification by Mould Engineering, which are summarized in the following sections.

4.1 Currently Licensed Water

The District of Lake Country has licenses for storage on Swalwell Lake and extraction on Vernon Creek. The District also has an extraction license on Okanagan Lake. A summary of the main licenses follows (as provided in Annex 3 of the Master Water Servicing Plan):

Water Source	Licensed Quantities		
Swalwell Lake (Storage)	10,222 acre-feet	=	12,623 ML
Vernon Creek (Storage)	5,330 acre-feet	=	6,582 ML
Vernon Creek (Diversion)	282,875,000 gals/year	=	1,284 ML/year
Okanagan Lake (Diversion)	1,934,500,000 gals/year	=	8,780 ML/year

4.2 Consumption

For consistency with industry standards, the Peer Review Team felt relevant consumption parameters should be defined in accordance with the period of demand. For example:

- Total annual consumption (TAC) – licenses and source yield
- Maximum Day Demand (MDD) – the delivery rate required on the highest consumption day of the year, determined by reviewing historical flow data.
- Average Day Demand (ADD) – average daily consumption, determined by dividing the total annual volume of delivered water by 365.
- Peak Hour Demand (PHD) – the required rate of delivery at the most intensive use during the day, determined from the MDD historical record.

4.2.1 Current Consumption

The Master Water Servicing Plan reports the following current consumption from available data:

- Total Annual Consumption (TAC) 7,825 ML/year
- Maximum Day Demand (MDD) 52 ML/day
- Average Day Demand (ADD) 2 ML/day
- Peak Hour Demand (PHD) 750 L/s

The above is based on:

- 928 Ha of Grade "A" agricultural serviced land.
- 1,910 connections of residential, commercial and institutional services.

The Master Water Servicing Plan reported the approximate split between agricultural and domestic *use* is 65% / 35% respectively. The source of this approximation is not known. The following, however, is available:

$$\text{Total yearly ratio: } \frac{\text{Irrigation (annual)}}{\text{Total Consumption (annual)}} = \frac{6775}{7825} = 86.5\%$$

$$\text{Maximum Day ratio: } \frac{\text{ADD}}{\text{MDD}} = \frac{2.0}{52} = 3.9\%$$

The recorded numbers unfortunately do not distinguish between irrigation water used for commercial agriculture and water used for residential sprinkling. It is apparent however, that inside use accounts for less than 4% of total use during the summer months.

4.2.2 Future Consumption

The Master Water Servicing Plan uses two future demand scenarios: Year 2020 and Ultimate (Ultimate reflects a full build-out of designated residential areas in the Official Community Plan).

The Year 2020 horizon is anticipated to produce roughly 2,900 additional residential connections, for a total of 4,810 services. Agricultural Grade "A" land is expected to remain unchanged at 928 Ha. The "Build-out" horizon (very long-term) is expected to yield an additional 4,800 units for a total of 6,710 units. Again, agricultural land would remain at 928 Ha.

The current, and resultant demands for future horizons are as follows:

Demands	Units	Present	Year 2020	Build-out	Available
Total Annual (TAC)	Irrigation		6,775	6,775	
	Domestic		1,838	3,448	
	Total (ML/year)	7,825	8,613	10,223	10,064
Maximum Day (MDD)	(ML/day)	52	79	98	118
Average Day (ADD)	(ML/day)	2	5	7	
Peak Hour (PHD)	(L/s)	750	1,075	1,295	

4.2.3 Demand versus Capacity

The licensed storage on Swalwell Lake and Vernon Creek is 19,200 ML, or 128 ML/day over a 150-day irrigation season. Year round extraction license is 1,284 ML/year, or 3.5 ML/d. Okanagan Lake allows a future extraction of 8,780 ML/year, or 24 ML/day.

The safe capacity of the Vernon Creek pipeline is given in the Master Water Servicing Plan as 900 L/s, or 77.8 ML/day. The safe capacity of the Okanagan Lake pump station is given in the Master Water Servicing Plan as 460 L/s, or 39.7 ML/d. Neither of the two sources alone can meet the ultimate Maximum Day Demand, but can easily do so if combined.

It will be prudent, therefore, for the District to retain both sources for the long-term.

5.0 Peer Review Team Conclusions

The Master Water Servicing Plan presents an assessment of the utility's condition and its ability to deliver water to the users. This "audit" concludes that significant capital investments are required to update the system to current standards of delivery for water quality, system reliability and operator safety.

The Plan also identifies concerns over water quality from seasonal high turbidity in Vernon Creek, colour, and a history of yearly boil water advisories.

The Plan concludes that filtration of all Vernon Creek water is uneconomical as more than 65% of the summer demand is used for agricultural irrigation. It also concludes that construction of a totally separated domestic/irrigation system is uneconomical in the long term due to the high operating costs of two systems.

The Master Water Servicing Plan presents a two-stage approach to improving water quality:

Stage 1

- Construction of a reservoir to store Vernon Creek water when turbidity is low. Stored water would be used during high turbidity events.
- Extending the service area of the Okanagan Lake supply with the Glenmore Road pump station and interconnecting it with the Vernon Creek system.

Stage 2

- Construction of a water treatment plant on the Vernon Creek source to provide treated water to a quality comparable to Okanagan Lake for *all* domestic, commercial and irrigation purposes.

Interviews with Commission members, District staff, and residents revealed some key issues that should be addressed:

- The scheme as presented provides little benefit to the agricultural sector. Agricultural users do not necessarily support cost sharing for water quality improvements to meet domestic or regulatory needs, particularly as the related agricultural rate impacts are not identified.
- Water quality improvements associated with the proposed Vernon Creek reservoir or ultimate 'full treatment' schemes have not been quantified.
- A dual distribution system, with irrigation water supplied from Vernon Creek and domestic water sourced from Okanagan Lake, may address the water quality and agricultural cost issues, this option has not been fully explored.
- The value of agriculture to the residents of Lake Country is recognized, and there appears to be a willingness to support sustainable agriculture through assistance with water rates. Public sentiment on water quality, and what the public is willing to pay for high quality water and agricultural assistance is generally unknown.
- Cost analyses including Net Present Value and Life-Cycle Costing of alternatives have not been developed. O&M costing has not been considered in alternative selection. Rate impact studies have not been carried out.
- The report did not deal with broader issues such as integrating the WOCID system with other systems in Lake Country. There is some interest in evaluating the benefits of this.

In order to address these and other outstanding issues, the Peer Review Team recommends the District complete the following activities:

1. Install an on-line turbidimeter on Vernon Creek to record continuous turbidity measurements for a more complete understanding of raw water quality and the nature of turbidity events on Vernon Creek. The turbidimeter should be connected to a remote alarm system to provide early warning of high turbidity.

2. Clearly identify the anticipated water quality improvements (if any) that the proposed Vernon Creek reservoir scheme will provide.

3. Investigate alternative means of controlling the Vernon Creek mainline hydraulics. As the proposed large open reservoir has certain disadvantages (e.g., large area required, algae formation), a surge tank or other pressure-break structure may provide a less expensive means to the same end. Consider power generation as the means of pressure reduction upstream of the structure.

4. Proceed with property acquisition for a hydraulic control structure. This will likely require less land than the 15.7 ha (39 ac) presently shown.

5. Conduct a detailed financial life-cycle analysis of a complete dual distribution system, based on the concept that Vernon Creek supplies irrigation and fire flows and Okanagan Lake supplies domestic flows.

6. Undertake sizing and life cycle costing of the proposed Vernon Creek water treatment plant to address health-related and aesthetic water quality concerns.

7. Undertake financial analysis of cost recovery options, maintaining agricultural rates with an acceptable range, and assessing the impact on residential rates applying any of the above options. Examine the impact the proposed solutions will have on rates.

8. Summarize the findings on water quality, alternatives, costs and rate impacts and present these for public discussion and feedback. Analyze responses and develop a best apparent alternative to address public input.

9. Develop a water conservation and demand management strategy.

10. Incorporate the conclusions reached into a **Master Water Plan**.

Appendix A

Peer Review Source Material

Appendix A – Reference Material
District of Lake Country
Master Water Servicing Plan
Peer Review

The following documents were referenced during the Peer Review assignment.

1. B.C. Ministry of Municipal Affairs. March 1995. Value Engineering for Municipal Projects. Victoria, B.C.
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4. District of Lake Country. 2000 & 2001. Annual Financial Statements. Lake Country, B.C.
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6. District of Lake Country. 2002. Water Rates Bylaws #345 and #411. Lake Country, B.C.
7. Guiton, R.S. January 1982. Ground Water Supply Evaluation for Proposed Winfield Industrial Development. Winfield, B.C.
8. Guiton, R.S. April 1982. Report to K.V. Ellison on Ground Water Supply Evaluation – Frac. E ½ Sec. 12, Tp. 14. Oyama, B.C.
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10. Guiton, R.S. November 1982. Report to B.C. Development Corporation on Ground Water Supply Development – North Kelowna Industrial Park. Winfield, B.C.
11. Mould Engineering Services Ltd. December 1997. District of Lake Country, Oyama Water System Capital Works Program. 1998 – 2008, Kelowna, B.C.
12. Mould Engineering Services Ltd. December 1997. District of Lake Country, Wood Lake Water System Capital Works Program 1998 – 2008. Kelowna, B.C.
13. Mould Engineering. May 2001. Proposal to District of Lake Country to Prepare a Master Water Servicing Plan. Kelowna, B.C.
14. Mould Engineering. February 2002. District of Lake Country Master Water Servicing Plan. Kelowna, B.C.
15. Thiessen, J.W. October 31, 2002. (Letter) Comments from a Residential Water User Perspective on the District of Lake Country Master Water Servicing Plan. Lake Country, B.C.

Appendix B

Water Quality

Appendix B – Water Quality
District of Lake Country
Master Water Servicing Plan
Peer Review

The Master Water Servicing Plan presents a plot of grab sample turbidity and colour testing undertaken in Vernon Creek during the year 2000. Turbidity averages 2 NTU, with the highest reading in April at 5 NTU. It is also reported that turbidity has at times been measured at 29 NTU. Spring flooding and summer rainfall events can spike turbidity up to 600 NTU.

Colour averages 35 TCU peaking in April to 65 TCU. No testing has been undertaken to determine what percentage of colour is from inorganic components (silt, clay) compared to organic (total organic carbon). Water quality testing in Salwell Lake is not reported.

The Vernon Creek channel above the intake dam contains numerous unstable slopes and is subject to frequent landslides (one or two per year). On these occasions the water is extremely turbid (in excess of 600 NTU) and boil advisories are issued. The boil advisories are typically 1 to 2 weeks duration.

It is apparent that Vernon Creek water from the current intake would not meet any filtration avoidance parameters should such a rule be implemented. Without filtration, the barrier offered by chlorination alone would be considered minimal risk reduction.

Okanagan Lake water, sourced below the thermocline, has been extensively sampled and tested by the City of Kelowna and other purveyors. Turbidity is typically less than 0.5 NTU and this water could meet any filtration avoidance rule. To provide an additional barrier for Cryptosporidium, the City of Kelowna is proposing Ultra-Violet (UV) disinfection.

Disinfection by-product testing (Trihalomethanes) has not been undertaken on either source, and this should certainly be part of a rigorous source assessment program.

Required Barriers

Without filtration, primary disinfection must achieve a minimum of 3-log (99.9%) Giardia removal and apply appropriate CT factors for either Ozone or Chlorine. Conventional filtration provides 2.5-log Giardia removal, leaving 0.5-log required from disinfection. The use of Ozone may have additional benefits in colour reduction.

Current BC regulations do not address Cryptosporidium, although this may come in the future. If protection against Cryptosporidium is considered, Ozone or UV may be required in addition to filtration.

Okanagan Lake water is considered to have sufficiently low turbidity to avoid filtration. Chlorination would need to obtain the required CT for 3-log Giardia reduction. UV may be added if Cryptosporidium is a concern. The City of Kelowna has demonstrated over two years of testing that UV can be effective for Cryptosporidium reduction on Okanagan Lake water.

Sizing and Life Cycle Costing

Sizing of facilities is required in order to prepare accurate cost estimates. At this stage, more extensive water quality data is required to develop the sizing parameters for such elements as gravity sedimentation ponds. Nevertheless, an approximate comparison can be undertaken for the purpose of relative merits.

For the purpose of the comparison, the following is assumed:

- For unfiltered upland gravity source options, the maximum capacity of the existing pipeline will be fully utilized (78 ML/day), with the remainder made up by Okanagan Lake pumped supply (20 ML/day).
- For filtered upland gravity source options, the full extent of supply from Okanagan Lake will be utilized (39 ML/day) in order to minimize the size of filtration plant (59 ML/day).
- A separate purely domestic system would require a capacity of 7 ML/day.

Domestic System from Okanagan Lake

This option is based on the assumption (from historical data) that Okanagan Lake water (at depth) has sufficiently low turbidity to avoid filtration. It also assumes that UV disinfection would provide the required micro-organism deactivation as the primary disinfectant.

The option has the advantage of using high quality water for "in-house" use only in a completely new distribution network. Vernon Creek water would be used in the existing network for residential outside use such as lawn sprinkling, agricultural irrigation, and fire protection.

All community source waters, both surface and groundwater, are subject to some risk of contamination. In essence, there is no "risk-free" water. Regulators and other persons charged with responsibility for public health, define safe water systems in terms of risk factors and available risk management techniques.

While source water quality is a major element in risk management, there are numerous other factors, which affect risk. Some of these are (in no particular order):

- Level of control of activities in watershed or aquifer recharge area
- Accidental spill potential
- Vandalism protection
- Operator qualifications and training
- Sampling, testing and reporting protocol
- Maintenance routines
- Backflow prevention and cross-connection control
- Leakage control
- Pipe, valve and hydrant rehabilitation programs
- Loss of pressure control
- Emergency response plans and procedures
- Early warning detection and alarm systems
- Power failure impacts
- Overrides and by-passes
- Water conservation programs and consumer education
- Routine flushing and disinfection program

All of the above factors also represent "barriers" to loss of water quality which form the basis of good public health protection. It is not the intent of this review to examine all these risk factors, although some aspects will be considered in the comparison of water supply options.

For the purpose of this review, "safe" water can be defined in terms of constituents in the source water. These constituents can be classified under three basic headings:

- Chemical
- Microbiological
- Physical

Chemical constituents are typically dissolved substances and include metals (such as Arsenic, Lead, Mercury and others), which are hazardous to human health. Other dissolved constituents that incur risk include organic Carbon, Nitrates/Nitrites and synthetic chemicals.

Microbiological constituents can generally be classified under the general heading of Bacteria, Viruses, and Protozoa. Many of these microbes are pathogenic and responsible for a variety of gastro-intestinal illnesses and sometimes more serious diseases such as Hepatitis and Polio. The more prevalent organisms in Western Canada include:

Bacteria	• Campylobacter, E. Coli, Salmonella
Viruses	• Hepatitis A, Meningitis, Adenoviruses
Protoza	• Giardia Lamblia, Cryptosporidium Parvum

These microbes are common in all British Columbia surface waters and lack of human activity is no guarantee they will not be present. Indeed, one of the first major outbreaks of Giardiasis occurred in Banff; from a water source in a restricted area of a National Park.

Public Health regulators currently adopt the approach that barriers must be provided against the presence of these microbes at the tap. The extent of removal and/or inactivation of microbes is typically gauged by Total and Fecal Coliform Bacteria testing. Coliform bacteria are not inherently dangerous, but the presence of Coliforms is indicative of other pathogenic organisms. Since the Coliform test is relatively quick and inexpensive, it is used as an early warning measure.

Turbidity

Physical constituents related to turbidity include suspended solids such as clay, silt, sand and various types of algae. The importance of suspended matter to human health is related to microbes. Bacteria, viruses and protozoa are often attached to suspended particles and high particle numbers are indicative of increased risk. Some types of algae, such as blue-green algae, also result in gastro-intestinal illnesses if ingested.

The typical measurement for suspended particle risk assessment is turbidity. Turbidity, as defined by the American Public Health Association, is the "optical property of a water sample that causes light to be scattered and absorbed rather than transmitted in straight lines through the sample". It is measured in Nephalometric Turbidity Units, or NTU. Particle size and number can also be measured with more sophisticated (and more accurate) particle counting devices. Particle counting is considerably more expensive than measuring turbidity and is used for gaining more detailed water characterization.

In Canada, Provincial governments have jurisdiction over water and water quality. British Columbia currently has the Drinking Water Protection Act brought forward in the Legislature in October 2002, but has yet to develop the Regulations that would accompany the Act. A prudent assumption at this point is that the Regulation would follow closely the Canadian Drinking Water Guidelines (CDWG).

Regulators have historically linked turbidity to the presence of micro-organisms and a two-pronged approach is typically taken.

Removal of turbidity is achieved by filtration. In turn, filtration removes micro-organisms. The standard for "safe" water when filtration is practiced is therefore stated in terms of achievable percentage removals.

These are:

- 2-log (99%) removal of Cryptosporidium
- 3-log (99.9%) removal of Giardia
- 4-log (99.99%) removal of Viruses

To achieve these removals, filtration must produce water with turbidity less than 0.3 NTU in at least 95% of all measurements in any month and never be greater than 1.0 NTU.

If micro-organisms are dealt with by disinfection alone (no filtration), the parameters for inactivation of micro-organisms remain the same. That is, the same percentage of micro-organisms must be killed or inactivated through the use of a disinfectant, because turbidity may compromise the effectiveness of any disinfectant, further provisions include:

- Average daily turbidity at the source (raw water) is not to exceed 5 NTU for more than two days/year.
- Source water Total Coliform count must be less than 100/100 mL in 90% of the samples
- Watershed is to be protected from human activities and grazing.

While the above parameters are not yet legislated, due diligence would suggest a prudent water purveyor aim for these targets.

<u>Colour</u>

Colour is expressed as an Aesthetic Objective in the Canadian Drinking Water Guidelines and lists 15 TCU (Total Colour Units) as a maximum level.

If the source of colour in surface waters is organic carbon compounds (such as humic and fulvic acids), there is a risk of chlorination by-products. By-products of chlorination are classed under the general heading of Trihalomethanes (THM), and these compounds are considered carcinogenic. There are long-term risks associated with prolonged ingestion of THM and the Canadian Drinking Water Guidelines also provide a Maximum Acceptable Concentration of THM as 0.1 mg/L.

While there can be several THM's resulting from chlorination of water, the most common is chloroform and the limit placed by the CDWG is based on the risk associated with chloroform.

Chloroform is in the US EPA (U.S. Environmental Protection Agency) Cancer Group B. The designation means it is a probable human carcinogen, with a 10-4 cancer risk from long-term ingestion.

When relying on chlorination for disinfection, it is prudent to undertake rigorous checking of THM formation and assess the long-term risks. Other disinfectants such as Ozone also produce by-products but their significance to human health has not been quantified. Ultra-violet light is the only disinfectant with no known by-products.

Appendix C

Stakeholder Interviews

Appendix C
Stakeholder Interviews
District of Lake Country -Master Water Servicing Plan
Peer Review Report

Session 1
Representatives of the Water Services Advisory Commission
Malcolm Mitchell & Marc Van Roechoudt

- Both long term I.D. Trustees and agriculturalists.

Concerns

- #1: protection of water quantity for long term agricultural supply.
- #2: increasing rates.
- #3: decreasing agric land to pay for infrastructure improvements.
- Experiencing diminishing attention to agricultural interests in favour of domestic interests.
- Recent focus on water quality and associated costs.
- Agricultural landowners are locked in ALR.

History

- Explained 'commitment' by Provincial Government at incorporation time: agriculture would have long term 'protection' of rates and representation on a managing body.
- Seniority (WOCID personnel) was assured - not upheld.
- Future water quality costs should not influence agricultural rates (noted recent 25% across the board rate increase).
- Do not necessarily agree with changes proposed the present mainline system; are there alternatives? What are the impacts on agricultural rates?
- WOCID purchased the Hiram Walker OK Lake intake in 1994/95. Why?
- Pressure for increased water quality.
- Need to eventually supplement upland supply quantity and quality.
- Financial plan showed good return based on strong ICI development.

What needs to be addressed?

- There is a need for change in optics – while the municipality looks at increasing residential & commercial development, there must be a recognition of the value of agriculture in the community, and in protecting agriculture's interests
- Noted that agriculture is the largest employer in municipality
- Increasing environmental interests will reduce available water quantity
- Will there be pressure for decrease in supply to agriculture in order to serve growing domestic demand?
- Should consider phasing-in the Hiram Walker supply to improve domestic and ICI supply & water quality
- Many technical aspects with Master Plan are good
- Master Plan must address the full cost to agriculture over time. How are costs shared fairly? Must be better explained.
- Noted that some on Council are somewhat critical of low (WOCID) rates relative to other communities, however, the reality is that rates have reflected the actual cost of supply, particularly whether the systems are pumped or gravity, e.g.:

Oyama	$100/ac	pumped
Oliver	$100/ac	pumped
WOCID	$50/ac	gravity

- Concern that the Master Plan, as written, unfairly criticizes prior system designers & operators

- Would peer review process review and comment on whether system design, planning & operations is balanced, so that Council can make decisions and plan with greater understanding of situation.

System Improvements

- Discussed alternatives for source improvements
- Pipeline to lake alternative – will it allow utility to forestall filtration? Has this option received sufficient consideration?
- Concerned that present taxpayers have already paid for the system and should not be paying for (some) upgrades.
- Future extension and water quality improvement costs should be paid by future development
- Given availability of Hiram Walker system, does it make sense to treat upland sources as planned?
- Recognized that planning is necessary for future replacement of the original agricultural (ARDA) system
- Noted that benefit of increased number of residential customers to share costs of these improvements
- Noted that ARDA system upgrading needs may not be as dramatic noted in the report – pipelines are between 30 and 40 years old, whereas they should have a 50 to 100 year service life
- Concern with large unplanned and unjustified rate increases due to exaggeration of the condition of the system
  $45-47/AC under WOCD
  $57 Now
  25% increase in 2002
- Pointed out agricultural irrigation methods are improving – both flexibility and reduced water use, e.g.
    - trickle vs overhead systems (need both)
    - varying with soil type and application rates
- However, must not give away future quantity opportunities due to unknown crop market changes, climatic changes, etc.

Water Systems Advisory Commission

- What is the future of the WSAC? In 2002 it is at the discretion of Council
- Concern that recent WSAC recommendations were not understood or followed up
- Concern re: abandoning commission and future representation for agric
- Council must come to understand agricultural water interests and not over-respond to voter pressure without a consensus plan in place

Land Purchase

- Is the planned land purchase premature? It does not solve the question of domestic water quality

Session 2
Residential Sector
Jake Thiessen

Submitted written commentary.

Background	▪ P.Eng., previously Manager of St. Mary's Irrigation District. ADM, Govt. of Alberta, Ministry of Water Resources, then with UMA Engineering
Quality Concerns	▪ Resident of DLC since 1998 ▪ As newcomer, noted poor water quality (own opinion and neighbours) and has installed a home treatment device - noted need to integrate the three Master Plan components: existing system, new development, and improved water quality ▪ No need to build three separate systems ▪ Residential rate increased 36% last year with some explanation ▪ Recognizes that has not been adequate dollars invested to maintain and improve system. ▪ Noted key issues: corrosion protection – mainline, screening works should be replaced, etc. ▪ Noted frequency of boil orders should be astounding to some people, but appears to be some question on public's actual interest as he says most people do not recall prior public orders ▪ Notes relies heavily on statements re corrosion, maintenance, etc. which need to be reviewed to find actual facts, same as with mainline PRVs ▪ a/c pipe – there is concern re health risks to the public, and alarm that a/c is still in system (please address this in peer review)
Ok Lake Supply	▪ OK Lake supply – maximize use of this source not just as secondary or backup ▪ Cost of pumping from OK Lake appears to be a reasonable cost ▪ Shortcoming of Master Plan – water demand management. metering should be addressed, especially residential use
Separation	▪ Cannot say whether dual systems / separation is good idea or not (insufficient information at this time) ▪ Concerned by $12M separation cost, but recognizes that a life-cycle cost analysis is required ▪ Need to further investigate small hydro potential ▪ Insufficient discussion with watershed management
Vernon Creek	▪ Vernon Creek treatment facility: - Has design been optimized for 20 – 30 years? - How has site been selected? - Concern with size of reservoir: should err on size of larger reservoir - Alternative treatment plant or processes ▪ Noted section 3.7 – don't know annual costs ▪ Should groundwater and Wood Lake be further investigated? ▪ Section 4.6 – has concerns re: new intake ▪ Section 4.8 - $8.7M / 2,700 SFD = $3,200/home – is expensive. ▪ Are residents concerned? - health? – yes - aesthetics? – yes - cost? – to some extent – needs to be explained ▪ Many residents are concerned with water quality ▪ At what cost? ▪ Important point: decision being made with adoption of this MW Plan are key to whole future development costs for the community ▪ Feels existing and future should pay same rate ▪ Domestic and agriculture should have different rates

Session 3
DLC Administration & Finance
Randy Rose & Stephen Banmen

Key Issues	▪ Is this the right plan for DLC? ▪ Is it the most cost-effective? ▪ What is the condition of the existing water system? ▪ Land negotiations.
Plan Background	▪ Need a master plan for grant applications, rate setting, DCC's etc. ▪ Need a long-term strategy - 20 years and beyond. ▪ Recognition that this Master Plan is just one piece in DLC water system planning. ▪ Mould report is intended to provide capital plan for WOCID system only. ▪ Noted DLC's need to move from reactive to proactive in water system planning.
Expectations	▪ Not to come up with entire Master Plan, but to determine if this piece is sound. ▪ Are there gaps? Were all options adequately reviewed? - If direction is OK – identify gaps, say looks good, or note if some additional analysis is needed.
Vision	▪ Need thought about where DLC is going as a municipality – if direction looks OK – say so, if not, call a stop and provide direction ▪ Discussed role of OCP in water master plan ▪ Peer review should make recommendations, provide general terms of reference
Land Purchase	▪ Note if DLC is making a mistake in purchasing the land. ▪ Site is 40 acres. Do they need all that? Other uses? Park? Public works, storage? ▪ Gravity source, not to be abandoned in future, especially for agriculture. ▪ Noted gaps: life cycle costing, who pays what? ▪ Financial strategy is next step. ▪ Noted new water licensing on Kal/Wood Lake system.
Interconnection with OID, WLID	▪ Does this make sense to reduce need for future treatment? To service future residential developments in between lands? ▪ Share Kal Lake source to south? ▪ What are pros and cons? Are further investigations needed?
How much financial information is needed in MWP?	▪ Peer review should review and advise
	▪ Do watershed components need to be examined in greater detail? ▪ Peer review should comment on general condition of systems. ▪ Peer review comment on priority capital works for 2003 budget process. ▪ Finance is concerned with identification of priority issues.
What are final issues?	▪ Need basis of water quality improvements. ▪ Priority capital works.
Metering	▪ On Hiram Walker source – all services. ▪ Objective – all ICI to be metered.

Session 4
Consultant – Mould Engineering
Stuart Mould & Jody Good

Background	▪ Need to address Glenmore Road P/S – 1999 +/- and desire to get OK Lake water into WOCID system for water quality improvement and for growth ▪ Prior application $1M OK Lake P/S upgrade. ▪ Main issues: unstable operating system, water quality, and sufficient water supply for growth. ▪ Infrastructure Program funds are available – urgency to get applications into province.
PRVs 1 & 2	▪ Estimated $150K – 200K to upgrade PRV's 1 and 2 ▪ Could be done but in Mould's opinion not best expenditure of dollars – therefore did not address in report. ▪ Chlorine contact time is an issue. ▪ Storage requirements for future water treatment ▪ Hiram Walker system capacity limits input into residential system ▪ Integration of OID/WLID? Think not economic for benefits achieved ▪ Water conservation component – necessary for infrastructure application
Dual Water System	▪ Life cycle analysis? Recognized gap ▪ Separate system? If convert all domestics will need new OK Lake intake in 2 – 4 years ▪ Concept to phase dual water into growth area (Sewer Service area - Map 9.0 OCP) ▪ There is a clear political sound basis for separate systems, however, in this case probably doesn't make economic sense (based on PV costs analysis only) ▪ Given the need to identify and develop fair rate plan for domestic and agriculture, and possible hesitance of province to pay for treating irrigation supply, may be a good case
Urgent Issues	▪ PRV 1 & 2 – not immediately urgent in Mould's opinion. PRV stations upgrades, probably not immediate but should phase in improvements ▪ Intake tower improvements – yes – safety issue ▪ PRV 1 & 2 are getting worse though (due to operating difference in water system) but has been operating this way for 30 years (water demands are now more of a closed system than with large open irrigation services
Quality	▪ Colour – #1 customer issue ▪ Turbidity – #2 customer issue, but #1 health issue ▪ Need to develop the concept of mixing with OK Lake source
Land Purchase	▪ Other uses for Eldorado: for OK Lake source reservoir for servicing future Bennett Subdivision south of Alto Utility development ▪ Power generation? May be economic (should be close to being an economically feasible project. Would need two plant sites due to high head if came from lakes (2000 psi @ Eldorado) ▪ $10M capital cost, with $1M annual revenue ▪ Not big cost savings in treatment costs due to pipeline instead of creek ▪ Mainline corrosion? See Southwest Corrosion Control report. Anode bed decommissioned early on after ARDA.
Groundwater Potential	▪ Piteau report on groundwater for Kal/Wood basin study ▪ Good quantity +/- 5,000 gpm, but high hardness ▪ Scope/budget – anything additional? - Spent 2 – 3 weeks in office work – not fully reflected in report, mostly work on separate distribution system. - Financial analysis – could use more work, especially life cycle analysis. - Compare with Penticton WTP costs – 9,000 USgpm; DLC MDD is 11 – 12,000 USgpm. ▪ See Guiton groundwater studies 1982.

Session 5
DLC Engineering / Operations Staff
Michael Mercer & Jack Allingham

Groundwater	▪ Groundwater – how much to explore? Objective is to maximize creek, then Okanagan Lake supply.
Master Plan	▪ Staff have been part of master water plan development from day one, therefore support, with three questions: ▪ Dual distribution – consultant seems to have satisfied themselves; does peer review group agree? ▪ Eldorado reservoir – should DLC proceed? ▪ What size should the facility be? ▪ Some staff objectives are short term to solve operational problems. ▪ Water system staff: M. Mercer – ½ time to 1/3 time later; J. Allingham plus three operators. In 2003 need one new water quality tech; ½ fte for summer relief.
Urgent Work	▪ Galvanized water service replacements throughout (plus gate valves). ▪ 2002 – intake screen replacement approved. ▪ Staff priorization of key upgrading works, independent of Plan. Must do: 1) Purchase Eldorado 2) Reservoir at Eldorado? 3) Intake screens Should do: 4) PRV upgrades – ($45k/yr for 10 yrs). ▪ Staff see options for outcome of peer review report: ▪ Run system status quo as in past 30 years, but concerned with wear and tear, safety, hydraulic stability, fisheries value has increased. ▪ Integrate OK Lake supply into WOCID system, need to ensure hydraulic stability with pond at Eldorado. ▪ Make improvements to operation of whole system. ▪ Need to take a big step back at this time to re-evaluate how whole system should be operated in the future. ▪ Concern re: long term operating costs / maintenance costs and possible safety hazards associated with PRV 1 & 2. ▪ But – will the operations dollars be the same with proposed reservoir?
Agricultural Sector	▪ Explained agriculture perspective re: concern with increasing costs without increase in level of service. ▪ Note that if was only an irrigation system, would still need to address hydraulic instability of system, due to irrigation supply, i.e. different flows during spring/fall. ▪ Based on operating experience feels PRV's 1 & 2 are unsafe and cannot expect staff to operate. ▪ There is a need to demonstrate to agriculture users why rates must go up for both user sectors. ▪ Need to better recognize future needs and costs for agriculture sustainability. ▪ Reiterated difficulty with identifying and separating domestic vs. agriculture costs associated with all system upgrades.
Domestic Sector	▪ Residential sector noted they are prepared to pay more for water than agriculture on unit volume basis. ▪ Other utilities have had increases that have kept up with inflation, but WOCID rates have not.

Attachment E – 2012 Water Master Plan

District of Lake Country

LAKE COUNTRY
Life. The Okanagan Way.

Water Master Plan






1577.0048.01

November 6, 2012 (Revision 1)

Prepared by:

URBAN systems

304 – 1353 Ellis Street
Kelowna, BC V1Y 1S9
P: 250-762-2517
F: 250-763-5266

VIA EMAIL

November 06, 2012 File: 1577.0048.01

District of Lake Country
10150 Bottom Wood Lake Road
Lake Country, BC
V4V 2M1

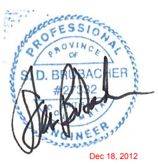
Attention: Greg Buchholz
Operations Manager

RE: WATER MASTER PLAN FINAL REPORT

Enclosed please find the Water Master Plan Final Report together with the updated Water Master Plan Financial Strategy. This Master Plan outlines a solid road map for the District to achieve its vision and goals for water service provision over the next 20 years. A significant amount of work has gone into the preparation of all of the background reports that form the basis of this plan and it has been our pleasure to assist the District with pulling together the final documentation.

Sincerely,

URBAN SYSTEMS LTD.



Steve Brubacher, P.Eng.
Principal

cc: Catherine Simpson, Urban Systems
/sb

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TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The District of Lake Country currently supplies water to the majority of residents, agriculture and other businesses located within the District. This Water Master Plan has been prepared to provide a strategy that will allow the District of Lake Country to provide water that is sustainable and affordable for the community and environment. In so doing the District is also partially satisfying one of the conditions placed on the Operating Permits by Interior Health.

This master plan provides a $79.5 million strategy, illustrated in the attached figure that achieves:

1. full compliance with existing Interior Health Authority policies by 2030;
2. adequate capacity to meet the growth needs of the District; and
3. a consistent level of service to all existing customers.

This plan takes a proactive risk management approach to address the major sources of risk exposure:

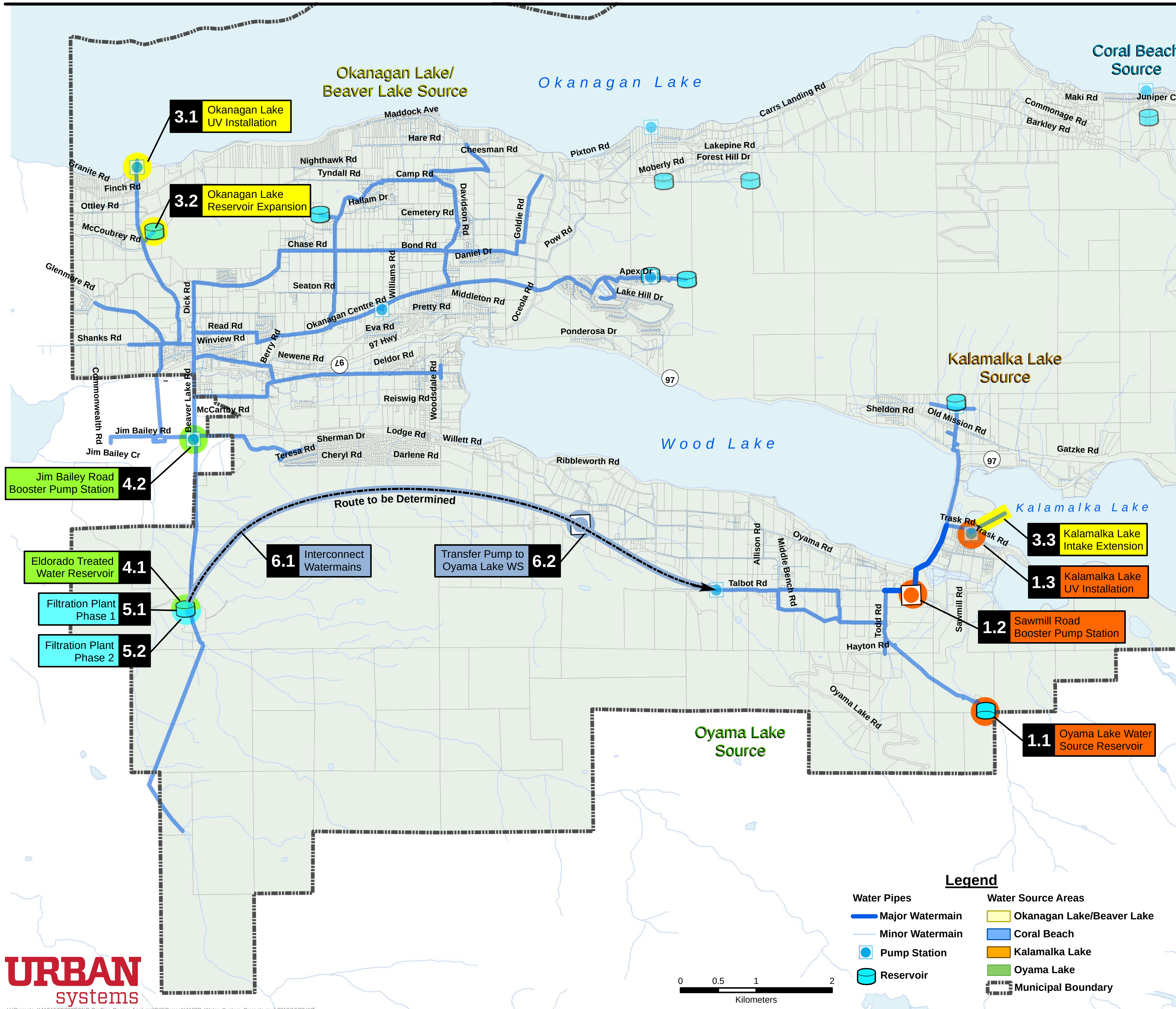
Risk	Response
Climate Change	▪ 10% Capacity Built In for Climate Change Resilience ▪ Water Conservation Measures to Reduce Water Use Requirements ▪ Updated Hydrological Assessments to be Completed for Sources
Infrastructure Failure	▪ Source Redundancy Improved ▪ In-System Storage Increased ▪ Distribution System Redundancy Increased ▪ Universal Metering Will Allow Quicker Response Time to System Leaks
Changing Regulations	▪ Provisions Made to Accommodate Future Filtration of Okanagan Lake
Changes to Growth and Development	▪ Works have been Scheduled to Allow Flexibility
Inadequate funds from government grants and Development Cost Charges	▪ Capital Works with Greatest Need for Grants and DCCs are later in the Capital Plan
Major Changes with the Watershed	▪ Protection Zones and Bylaws to be Developed to Increase Protection ▪ Collaboration with Other Jurisdictions and Stakeholders to be Undertaken ▪ Filtration Plant will Provide Buffer to Water Quality Changes ▪ Increased Depth of Kalamalka Lake Intake to Provide Increased Protection

It is recommended that the District:

1. Continue to work on obtaining support from Interior Health for this Master Plan;
2. Implement the financial plan to support the capital plan presented in this Master Plan;
3. Proceed with submitting filtration deferral applications for both Okanagan Lake and Kalamalka Lake;
4. Complete updated hydrologic studies for all sources except Okanagan Lake and convert license capacity to match long term use requirements;
5. Implement the watershed risk reduction strategies and dam safety recommendations;
6. Complete updated hydraulic models for the distribution system;
7. Monitor and update this plan at least once every 5 years or sooner if situations change;
8. Develop plans for the remaining District water systems;
9. Update the Subdivision and Development Bylaw and Development Cost Charges Bylaw; and
10. Secure the right and ability to raise the storage capacity of Swalwell Lake.

District of Lake Country - Water System Master Plan
20 Year Capital Projects Summary

LAKE COUNTRY
Life. The Okanagan Way.



Project Type Summary	
Type	**Cost**
Water Conservation Program	
2.1 Universal Metering - Phase 1	$1,000,000
2.2 Universal Metering - Phase 2	$3,000,000
Sub-total	$4,000,000
Water Treatment Facilities	
1.3 alamalka Lake UV Installation	$1,070,000
3.1 Okanagan Lake UV Installation	$2,060,000
5.1 iltration Plant @ Eldorado Reservoir Site - Phase 1	$24,000,000
5.2 iltration Plant @ Eldorado Reservoir Site - Phase 2	$10,000,000
Sub-total	$37,130,000
Water Storage	
1.1 yama Lake Reservoir	$3,010,000
3.2 Okanagan Lake Reservoir Expansion	$1,600,000
4.1 ldorado Treated Water Reservoir	$3,700,000
Sub-total	$8,310,000
Pipelines	
7.1 Watermains - Upgrade & Replacement	$13,600,000
6.1 eaver Lake/Oyama Lake Water System Interconnect	$8,000,000
Sub-total	$21,600,000
Hydraulic Control Facilities	
7.1 Miscellaneous PR Station Rebuilds & Upgrades	$1,690,000
3.3 alamalka Lake Intake Extension	$1,000,000
1.2 awmill Road Booster Pump Station	$880,000
4.2 im Bailey Road Booster Pump Station	$900,000
6.2 ransfer Pump Station to Oyama Lake WS	$1,700,000
Sub-total	$6,170,000
Minor Projects & Engineering	
7.1 Minor Project Listing < $200,000	$1,650,000
7.1 ngineering, Development & Adminstration	$600,000
Sub-total	$2,250,000
Total Water System Projects (2011 to 2030)	**$79,460,000**

Project Sequencing Summary				
Sequence	**Title**	**Project Type**	**Year**	**Cost**
1	**Kalamalka Lake Interconnect**			
	1.1 Oyama Lake Reservoir	Water Storage	2012	$3,010,000
	1.2 Sawmill Road Booster Pump Station	Hydraulic Control Facilities	2012	$880,000
	1.3 Kalamalka Lake UV Installation	Water Treatment Facilities	2012	$1,070,000
	Sub-total			$4,960,000
2	**Universal Metering**			
	2.1 Phase 1	Water Conservation Program	2014	$1,000,000
	2.2 Phase 2	Water Conservation Program	2015	$3,000,000
	Sub-total			$4,000,000
3	**Lower Lakes Water Quality Improvements**			
	3.1 Okanagan Lake UV Installation	Water Treatment Facilities	2015	$2,060,000
	3.2 Okanagan Lake Reservoir Expansion	Water Storage	2015	$1,600,000
	3.3 Kalamalka Lake Intake Extension	Hydraulic Control Facilities	2015	$1,000,000
	Sub-total			$4,660,000
4	**Eldorado Treated Water Reservoir**			
	4.1 Eldorado Treated Water Reservoir	Water Storage	2017	$3,700,000
	4.2 Jim Bailey Road Booster Pump Station	Hydraulic Control Facilities	2017	$900,000
	Sub-total			$4,600,000
5	**Filtration Plant @ Eldorado Reservoir Site**			
	5.1 Phase 1	Water Treatment Facilities	2021	$24,000,000
	5.2 Phase 2	Water Treatment Facilities	2030	$10,000,000
	Sub-total			$34,000,000
6	**Beaver Lake/Oyama Lake Water System**			
	6.1 Interconnect Watermains	Pipelines	2027	$8,000,000
	6.2 Transfer Pump Station to Oyama Lake WS	Hydraulic Control Facilities	2027	$1,700,000
	Sub-total			$9,700,000
7	**Ongoing**			
	7.1 Ongoing Annual Work ($0.88M per year)			$17,540,000
	Total Water System Projects (2011 to 2030)			**$79,460,000**

URBAN systems

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1.0 INTRODUCTION

The District of Lake Country currently supplies water to the majority of residents, agriculture and other businesses located within the District. This Water Master Plan has been prepared to provide a strategy that informs decision making based on maximizing water system efficiency and effectiveness in order to help the District achieve long term viability and sustainability. In so doing the District is also satisfying one of the conditions placed on the Operating Permits by Interior Health.

The District of Lake Country is located within a series of watersheds that supply water to Okanagan Lake. Prior to reaching Okanagan Lake a portion of the runoff is stored within Oyama, Swalwell (Beaver), Crooked-Dee, Kalamalka, Allison, Damer, and Wood Lakes. At the present time the District owned water systems are supplied with water from one of four sources: Swalwell Lake, Oyama Lake, Kalamalka Lake, and directly from Okanagan Lake. These sources are fed with water from within the District boundaries as well as from runoff from upland areas that drain into Oyama Lake, Swalwell Lake and Crooked-Dee Lake. This water is either used for consumptive or non-consumptive purposes in homes or businesses, or for irrigation. Sanitary sewerage within the core of Lake Country is collected via a collection system, treated at a tertiary treatment plant and then infiltrated into ground via a leaching field. The remainder of the area is understood to either have a small neighbourhood system or individual system to collect and treat the sewage through conventional septic systems prior to discharging to ground.

1.1 Master Plan Scope

This Water Master Plan is limited to the existing large water systems and the service area that can be reached by them. This plan does not address the District operated Lakepine or Coral Beach Water Systems and also does not provide servicing strategies for areas that are not within or adjacent to the current public water systems such as Carrs Landing. The District does have a policy to acquire private utilities as they become available. This plan should be reassessed as acquisitions occur.

This plan has been prepared by Urban Systems and is based on the technical input received from background reports prepared by the District and Mould Engineering. Urban Systems has reviewed the background reports for general completeness but the accuracy of the background reports were not verified. The recommendations in this plan have been outlined in bold italics and summarized at the completion of the document.

2.0 BACKGROUND

2.1 Master Plan Process

- In 2008 in conjunction with the update of the Official Community Plan it was recognized that an update was needed to the 2004 Winfield Okanagan Centre Water System Assessment and Response Plan.
- In June of 2009 the update process was started and a steering committee was established by August 2009.
- The District engaged a consultant and developed numerous options for meeting the long term needs of the community. These options were presented in April 2010 and shortlisted to four options by the Water Services Advisory Committee (WSAC).
- The four options were further refined and supplemented with additional financial information and presented again to the WSAC in September 2010. Based on this information the WSAC selected a preferred option which was endorsed in principal by Council in November 2010.
- A detailed financial plan was prepared for the preferred option and presented to the WSAC in December 2010 and following endorsement by the WSAC was presented to Council in June 2011.
- Council endorsed the commencement of public consultation which occurred in June and July 2011.

- Council met and endorsed the financial plan in principle in July 2011 and directed staff to communicate the information and feedback package with the District's utility bills.
- The financial plan was brought back before Council in February 2012 for final budget approval. The supporting water rate was endorsed by Council in March 2012 and the water rates bylaw was amended.
- This document is the final stage in the development of the Master Plan and summarizes all of the work completed to date.

2.2 Previous Studies

The following table summarizes the previous studies that have been referenced in the preparation of this master plan:

Table 1. Previous Studies

Title	Author	Date	Comments
Winfield Okanagan Centre Water System Assessment and Response Plan	Mould Engineering	April 2004	The previous Water Master Plan that is updated and superseded by this plan.
Oyama and Vernon Creek Source Water Assessment	Ecoscape	June 2010	
Okanagan Lake Source to Tap Assessment	Larratt	July 2010	
Kalamalka Lake Source to Tap Assessment	Larratt	July 2010	
Water Master Plan Background Reports	Mould Engineering	2010	Various reports that form the basis of this master plan. Relevant reports have been included within the appendix of this master plan.
Engineering Water Conservation Initiative Study	District of Lake Country	2011	An updated summary of water demand information and recommendations for increasing water efficiency and reducing water consumption.
Water Master Plan Public Outreach Summary	District of Lake Country	January 2012	A summary of public engagement activities conducted by the District.
Crooked Lake Dam Safety Review	Mould Engineering	February 2012	
Damer Lake Dam Safety Review	Mould Engineering	February 2012	
Swalwell Lake Dam Safety Review	Mould Engineering	February 2012	

2.3 Operating Permits

The District of Lake Country currently operates water systems under the authority of a permit to operate issued by Interior Health.

On May 10, 2011 Interior Health issued the most recent conditions that apply to the major water systems operated by the District. This Master Plan is in partial fulfillment of one of the current conditions which states:

Provide Long-term Plans for Source, Treatment and Distribution System Improvements Taking into Account the Goal of 43210 Objectives

And provides the accompanying objectives:

1. ***Complete an update to the District of Lake Country Master Water Plan including a financial plan to support necessary infrastructure improvements to meet Drinking Water Objectives, the Guidelines for Canadian Drinking Water Quality and, at a timeframe acceptable to the Drinking Water Officer. This plan should include a review of rate structures and alignment with systems/ jurisdictions which presently satisfy the Drinking Water Objectives/GCDWQ; and***

2. ***Prepare an application for filtration deferral***

This master plan meets the first objective for the major water systems. The District is also working to complete the application for filtration deferral.

3.0 VISION AND GUIDING PRINCIPALS

The District of Lake Country's vision is to provide water that is sustainable and affordable for the community and environment.

The following guiding principals have been used to guide the preparation of this Master Plan:

1. Take an active role in providing stewardship of the water resources within the basin;
2. Retain all four existing sources;
3. Plan based on achieving filtration deferral for both Okanagan Lake and Kalamalka Lake;
4. Provide the same level of service to all customers:
    a. Adequate flow and pressure for both routine demands and fire protection needs, and
    b. Adequate water quality that meets Provincial regulations, health based objectives of the Canadian Guidelines for Drinking Water Quality, and where affordable meets aesthetic objectives of the Canadian Guidelines for Drinking Water Quality.
5. Strive to improve the level of service over time in a cost effective manner;
6. Provide a plan that considers risks and plans accordingly with consideration for:
    a. Climate change,
    b. Infrastructure failure,
    c. Changing regulations,
    d. Changing source water quality,

e. Changes to growth and development,

f. Inadequate funds from government grants and DCCs, and

g. Major changes within the watershed (i.e. Pinebeetle, wildfire).

7. Provide a plan based on a stable financial approach that balances capital improvement needs with infrastructure renewal requirements.

The following guiding principles within the Official Community Plan are supported directly by this Water Master Plan. In addition, many objectives and policies within the OCP are consistent with the direction outlined by this plan.

OCP Guiding Principles

- Preserve our Rural and Agricultural Character;
- Create a Vibrant Town Centre;
- Promote Development in Existing Neighbourhoods;
- Achieve Sustainable Development Through Balanced Growth;
- Protect and Enhance our Natural Environment; and
- Facilitate an Active Healthy Inclusive Community.

OCP Infrastructure Goals

- Expand and improve public infrastructure;
- Provide reliable water and sewer services in an efficient and economically feasible manner; and
- Establish an agricultural water reserve.

4.0 WATER DEMANDS

The first key element in developing a water master plan is quantifying both the existing and anticipated future demands to be placed on the water systems. In 2011 the District completed a Water Conservation Initiative Study, a copy of which is contained in *Appendix A*. This study brought together all of the best sources of information at the time in order to accurately quantify existing water use characteristics and to inform future water use needs. The key outcomes from this study are summarized in this section.

4.1 Existing Water Use

The District of Lake Country in 2011 provided water to 8,413 users through 3,236 connections. The total annual water use is currently estimated to be to be 10,000 million litres (27 ML/day) with a maximum day demand of 78 ML/day. The following graphs illustrate how this water is estimated to be used both on an average and maximum day basis:

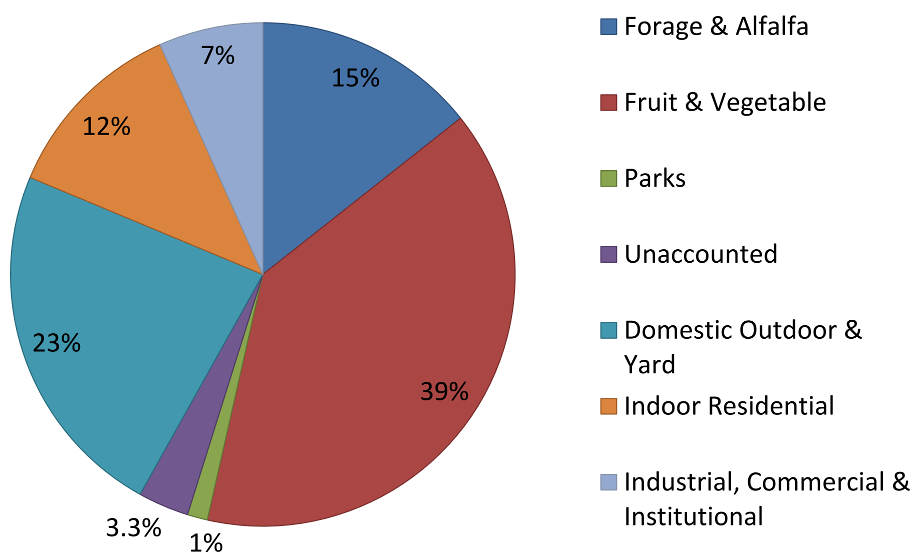

Figure 1. Existing Water Use by Category (Annual Average)

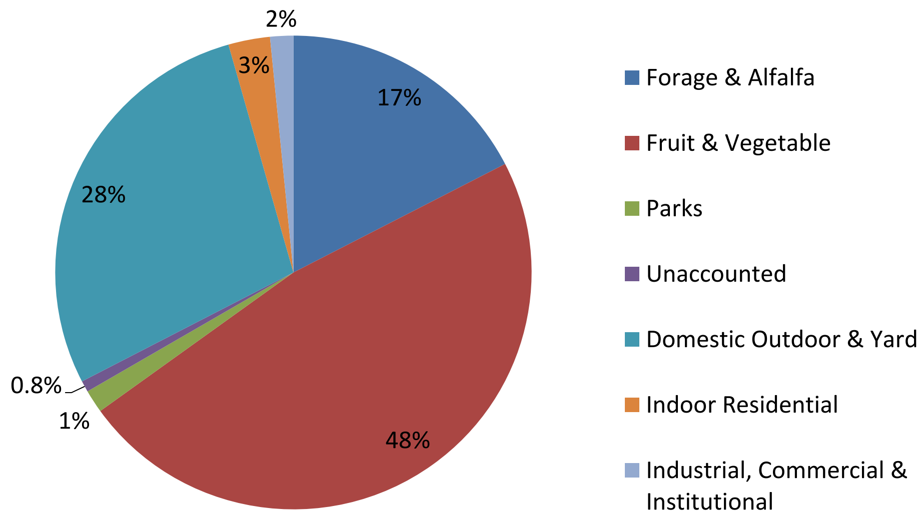

Figure 2. Existing Water Use By Category (Maximum Day)

This illustrates that over 94% of water use on a maximum day is used for agriculture and outdoor domestic uses. On a month by month basis the water use pattern currently is illustrated is Figure 3.

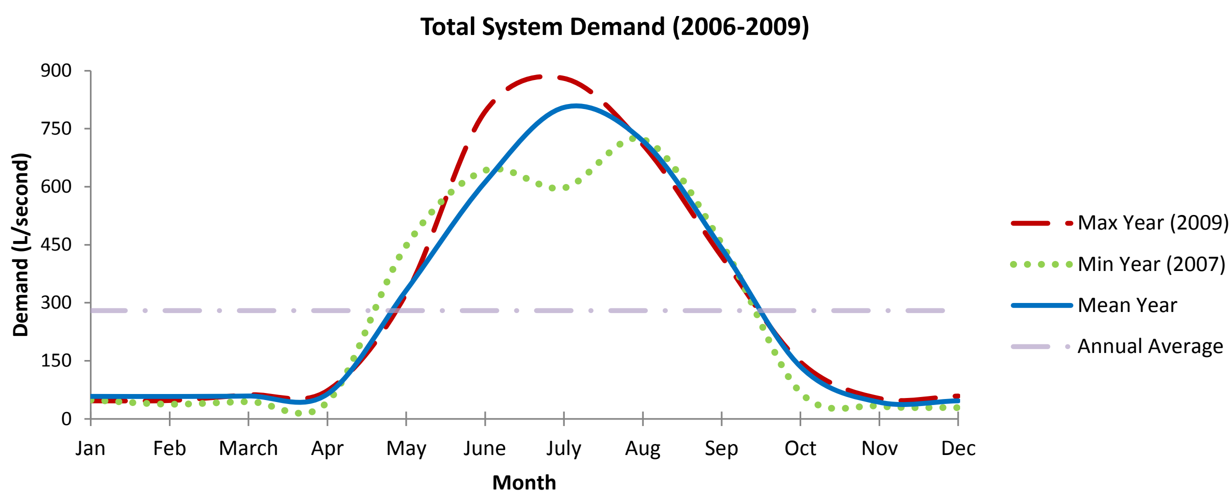

Figure 3. Existing Water Use Pattern

The District has also evaluated both its metered and unmetered residential water customers and observed a significant reduction in water use with the metered connections:

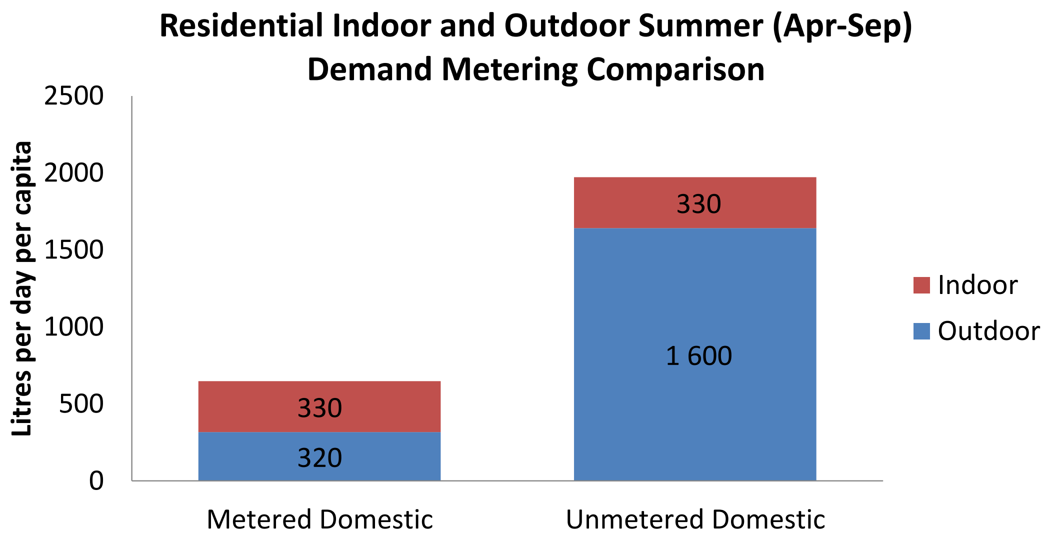

Figure 4. Residential Water Use Breakdown

Since all new construction is required to be metered the metered domestic usage rates will form the basis of water use needs for growth.

4.2 Future Water Use

According to the District's projections an additional 3,100 residential units are predicted to be added to the system by 2030. Based on an average population density of 2.25 people per unit this equates to 6,975 people. At the current metered rate of 640 litres per day per person this equates to an annual water use increase of 1,600 ML/year (4.5 ML/day). The District has also identified the potential increase in irrigated agricultural area and consistent with the OCP policy would like to reserve an additional 1,500 ML/year for future new agriculture. The District would like to ensure that its water supplies are resilient to climate change risks and as such want to preserve a 10% safety factor on existing water use or 1,060 ML/year. Finally, the District has adopted the goal of increasing water use efficiency by 25% by 2030.

The following table summarizes the projected future water use needs of the District:

Table 2. 2030 Total Water Needs

	Average Day	Maximum Day
Existing Water Use	27.4 ML/day (10,000 ML/year)	78 ML/day
25% Water Use Efficiency	-6.8 ML/day (2,500 ML/year)	-20 ML/day
Sub-Total	***20.6 ML/day (7,500 ML/year)***	***58 ML/day***
Residential Growth	4.4 ML/day (1,600 ML/year)	12 ML/day
Agricultural Growth Reserve	4.1 ML/day (1,500 ML/year)	15 ML/day
Sub-Total	**29.1 ML/day (10,600 ML/year)**	**85 ML/day**
Climate Change Safety Factor (10%)	2.9 ML/day (1,060 ML/year)	9 ML/day
Total	**32.0 ML/day (11,700 ML/year)**	**94 ML/day**

5.0 WATER SOURCES

As outlined in the Introduction the District of Lake Country receives water from four sources: Swalwell (Beaver) Lake, Okanagan Lake, Kalamalka Lake and Oyama Lake. In the case of Swalwell Lake and Oyama Lake the intakes are located within the downstream creeks of Vernon Creek and Oyama Creek. This section provides an overview of these sources with detailed information contained in the background report found in *Appendix B*.

5.1 Source Descriptions

A. Swalwell (Beaver Lake) Chain

The Swalwell Lake source has provided water to the District for over 100 years. Prior to incorporation this source was operated by the Winfield Okanagan Centre Irrigation District. It is located at the highest elevation of all the water sources and currently services the largest area. The watershed that feeds Swalwell Lake has a surface area of 63 km^2. It includes both Swalwell and Crooked Lakes as dammed storage reservoirs that rely on snowmelt to fill. The storage capacity of Swalwell Lake is 11,880 ML (9,629 ac-ft) and the Crooked Lake (plus upstream chain of lakes) store 2,939 ML (2,383 ac-ft). The District currently stores water in the lakes during the fall to spring months and releases flows during the summer. Water flows from Crooked Lake into Swalwell Lake and then into Vernon Creek where it is diverted by the District approximately 6 km downstream.

Dam safety review and consequence ratings have recently been completed in 2011 (see *Appendix C*). Based on the new dam safety regulations the dam classifications have been upgraded to extreme consequence for Swalwell Lake Dam and high consequence for the Crooked Lake Dam. The emergency protection plan and operations, maintenance and surveillance manuals have recently been updated to meet dam safety requirements.

The 2011 dam safety review outlines deficiencies for Swalwell Lake Dam which include a spillway that does not meet current standards and a deteriorating gate tower and outlet works. Repair work on the outlet pipe has been completed but additional work is required on the outlet pipe and gate. The main deficiency on the Crooked Lake Dam is material erosion on the downstream side of the spillway.

The Vernon Creek intake works and screens are housed in a concrete building that was significantly upgraded in 2002.

The Eldorado Reservoir is an open reservoir that stores 30,000 m^3 of storage. The large balancing reservoir was constructed in 2007 downstream of the Vernon Creek intake to aid in providing uninterrupted water service. Numerous landslide areas exist in the section of channel upstream of the Vernon Creek intake. Some remedial work of the slide areas has been completed, however, it is reported that large unstable banks remain which will result in further landslides, thereby potentially jeopardizing the water supply.

The construction of the Eldorado Reservoir has resulted in noticeable water quality benefits. This reservoir allows the supply from Vernon Creek to be shut off during high turbidity events. In 2009 a hydro generation facility was added to the intake to the reservoir.

B. Okanagan Lake

Okanagan Lake became a water source for the District in 1994 through the acquisition of intake infrastructure and a water license from the Hiram-Walker Distilleries. Okanagan Lake is fed by a watershed that is over 200km long with an area of over 6,000 km^2. This lake provides water to many communities in the Okanagan Valley. The quality of the water from Okanagan Lake is superior to any water in the valley particularly when it is drawn from the depth that Lake Country extracts from.

Okanagan Lake is divided into three basins by underwater sills. Lake Country's intake is located in the largest and deepest of the basins. There are distinct water chemistry differences in each of the three basins[1].

The Okanagan Lake Pump Station was built in 1968 for the Hiram-Walker Distillery. The intake is located approximately 40m from the lakeshore at a depth of 33m[1]. The intake screens are located at the inlet to the wet well and are reported to not meet current federal fisheries guidelines (see *Appendix C*). The screens are scheduled to be replaced.

[1] Okanagan Lake Source to Tap Assessment, Larratt Aquatic, July 2010.

C. Kalamalka Lake

The intake and water license from Kalamalka Lake were owned and operated by the Oyama Irrigation District prior to acquisition by the District. The watershed feeding Kalamalka Lake has an area of 572 km^2. In addition to supplying water to the District water licenses also are held by the City of Vernon for an intake at the north end of the lake. Kalamalka Lake has a maximum depth of 142m and a volume of 1.52 million ML. Approximately 80% of the annual inflow comes from groundwater and Coldstream Creek while the remaining inflow is from Wood Lake. Kalamalka Lake operates over a very tight operating range between 391.06m and 391.82m which prevents pre-freshet drawdown during high inflow periods.

The Kalamalka Lake intake is located 440m from the shoreline at a depth of 22m below the normal water surface of the lake. After screening the intake feeds the pump station that boosts the water into the distribution system.

D. Oyama Lake

The Oyama Lake source was owned and operated by the Wood Lake Improvement District prior to acquisition by the District in 1998. This source has provided water since the early 1900's. The watershed feeding Oyama Lake has an area of 23.8 km^2. The watershed includes both Oyama Lake with a storage capacity of 7,137 ML and Damer Lake with a capacity of 263 ML. The lakes rely on snow packs for annual water regeneration. The intake is located on Oyama Creek approximately 2.6km upstream from where the creek discharges into Kalamalka Lake.

Dam safety review and consequence ratings have recently been completed for both Oyama Lake and Damer Lake in 2011 (see *Appendix C*). Based on the new dam safety regulations the dam classifications have been upgraded to high consequence for both reservoirs. The emergency protection plan and operations, maintenance and surveillance manuals have recently been updated to meet dam safety requirements. There are a number of recommended action items that the District is currently working on prioritizing.

The Oyama Creek Intake includes fish screens and a balancing tank prior to discharging into the distribution system.

5.2 Water Licenses and Flow Availability

The following table summarizes the water license diversion annual volume and flow availability from each source as reported in the background study contained in *Appendix B*. These do not include the storage license volumes for the lakes.

Table 3. Water License Annual Flow Summary

	Swalwell	Okanagan	Kalamalka	Oyama	Total
Existing Water License					
a. Irrigation	7,459 ML	0 ML	1,594 ML	2,639 ML	11,692 ML
b. Water Works	1,204 ML	10,997 ML	124 ML	1,252 ML	13,577 ML
c. Total	8,661 ML	10,997 ML	1,718 ML	3,891 ML	25,267 ML
Water Availability					
a. Watershed Yield	9,868 ML	10,997 ML	1,718 ML	4,400 ML	
b. Fish Flows	-1,750 ML	0 ML	0 ML	0 ML	
c. Est. Operational Waste	-617 ML	0 ML	0 ML	480 ML	
d. Total	7,501 ML	10,997 ML	1,718 ML	3,920 ML	24,136 ML

Table 4. Water License Waterworks Maximum Day Withdrawal Summary

	Swalwell	Okanagan	Kalamalka	Oyama	Total
Existing Water License	4.8 ML/day	32 ML/day	0.3 ML/day	6.8 ML/day	44 ML/day

The following table summarizes the total water needs by licensed use type. The Waterworks use type includes all uses other than agriculture and also includes the current unaccounted for water use. The growth in water use represents the additional water source capacity needed less the water use reduction associated with conservation by existing customers.

Table 5. 2030 Water Needs by Use Type

	Average Day	Maximum Day
Existing Water Use		
- Agriculture	14.8 ML/day	51 ML/day
- Waterworks	12.6 ML/day	27 ML/day
Total	27.4 ML/day	78 ML/day
Growth in Water Use		
- Agriculture	4.1 ML/day	15 ML/day
- Waterworks	0.5 ML/day	1 ML/day
Total	4.6 ML/day	16 ML/day
Total Water Use		
- Agriculture	**16.7 ML/day**	**58 ML/day**
- Waterworks	**15.3 ML/day**	**36 ML/day**
Total	**32.0 ML/day**	**94 ML/day**

Based on the information outlined above there appears to be sufficient total source water available to meet average annual demands and maximum day demands in 2030. However, there will be the need to convert some of the irrigation license capacity into waterworks license capacity.

Swalwell and Kalamalka sources are reported to have had their latest hydrological study completed in 1977. Oyama Creek watershed's latest assessment was done by the Ministry of Environment in 1987. Okanagan Lake has recently undergone a comprehensive review by the Okanagan Basin Water Board.

It is recommended that an updated hydrological study be completed for each source, with the exception of Okanagan Lake based on current information. This assessment should consider not only the sufficiency of source waters from an annual basis but also the sufficiency of storage to meet seasonal variations in demand both under today's conditions and under future climatic variations. The adequacy of the flow monitoring and weather monitoring stations should be completed in advance of this study in order to identify additional stations that need to be added to complete the updated assessment and for ongoing monitoring. ***Water license amendments should be made to align with the future needs of the District.***

Given the overall sufficiency of water licenses this is not likely a short term high priority item. However, it should be scheduled and opportunity sought to partner with other benefiting parties.

Beyond the 20 year time frame it is identified that storage capacity should be increased at Swalwell Lake Dam by raising the existing dam. ***It is recommended that the District work to secure the right and ability in advance of requiring the upgrades.***

5.3 Watershed Assessments

The District has completed watershed assessments for the upper watersheds, including Oyama Lake and Vernon Creek, and the lower watersheds, comprised of Okanagan Lake and Kalamalka Lake. These assessments were completed to provide guidance on strategies to improve or maintain the highest quality water supply possible. In addition they fulfill a prerequisite for applying for filtration deferral for the Okanagan and Kalamalka Lake sources. ***It is recommended that the District follow through with implementing the watershed risk reduction strategies.***

Okanagan Lake

The Okanagan Lake assessment concludes that the biggest threats to water quality are activities in and around the intake zone. It is recommended that an Intake Protection Zone be established and that the District apply for a License of Occupation over the protection zone. It is also advised that a bylaw be established to protect the Okanagan Lake foreshore. It is recommended that no storm outfalls or marina activities be permitted within this zone. While not expected to be required to meet filtration deferral requirements, it is recommended that future consideration be given to extending the intake into a deeper portion of the lake to provide even greater water quality.

Kalamalka Lake

The Kalamalka Lake assessment concludes that the greatest risks to water quality are activities around the lake edge and also within the intake zone. Similar to Okanagan Lake it is recommended that an Intake Protection Zone be established, that the District apply for a License of Occupation and that a bylaw be put into place to protect the foreshore. Unlike Okanagan Lake, an intake extension is recommended for Kalamalka Lake in order to comply with the turbidity requirements for filtration deferral.

Oyama Lake and Vernon Creek

The Oyama Lake and Vernon Creek assessment concludes that activities within the watercourses and upland watersheds pose the greatest risk to water quality. Since the intakes do not have the same buffering provided by Okanagan Lake and Kalamalka Lake, the impacts of these activities are significantly higher. This is further complicated by the fact that the land within the watersheds lies both within the Regional District of the Central Okanagan and the District. It is impacted not only by local land use decisions but also those under the jurisdiction of the Provincial Government. Interagency cooperation is key to protecting the water quality within these watersheds. An extensive list of recommended actions toward this end is outlined within the report.

6.0 WATER QUALITY AND TREATMENT

6.1 Introduction

Surface water sources, such as those that supply the District of Lake Country, are vulnerable to the presence of pathogenic (disease causing) organisms due to contamination by fecal matter produced by warm blooded animals. This situation can be further exacerbated by anthropogenic causes such as cattle ranching and recreational uses within watersheds. In addition to risks associated with microbiological contamination the District of Lake Country sources also experience high turbidity and colour which, although not necessarily direct health risks, can be an indicator for health risks. High turbidity can render disinfection processes ineffective by shielding the organisms from the disinfectant. Colour in water can be caused by many factors. One such factor is organic materials. Excessive organic materials in the water can react with chlorine used for disinfection to produce levels of disinfection by-products that are shown to be harmful over extended periods of exposure.

6.2 Regulatory Requirements

The District of Lake Country's water services are governed by the *Drinking Water Protection Act* and *Drinking Water Protection Regulation*. Specific requirements for each water system are outlined in the conditions placed on the Permit to Operate. In addition to these regulations there also exists the Canadian Guidelines for Drinking Water Quality. These guidelines are not law in BC unless so imposed through conditions on operating permits. Within the guidelines there are both health based and aesthetic guideline values. The District of Lake Country has chosen to meet all health based guidelines from the CGDWQ and to meet the aesthetic objectives if the cost benefit analysis justifies it.

The current conditions on the Lake Country Operating Permits require that plans be submitted to Interior Health that demonstrate how the District will meet the Canadian Guidelines and IH water treatment objectives which include[2]:

- 4 log virus inactivation;
- 3 log *Giardia Lamblia* inactivation or removal;
- 3 log *Cryptosporidium* inactivation or removal;
- 2 treatment processes;
- 1 NTU maximum for turbidity with a target of 0.1 NTU; and
- 0 *E. Coli* and *Fecal Coliform.*

Filtration of all surface sources is required to meet these objectives, except for sources that are needed to be of sufficiently high quality. Interior Health currently grants filtration deferral providing the following conditions are met as outlined in the Interior Health Filtration Exclusion Criteria[34]:

[2] 4-3-2-1-0 Drinking Water Objective Handout, Interior Health, January 2006

[3] Criteria to Demonstrate That a Water Supplier Can Achieve the GCDW Filtration Exclusion Criteria Handout, Interior Health, February 2008

[4] Considerations for Ongoing Monitoring Programs for Systems with Filtration Deferral Guideline, February 2008

1. 4-log removal/inactivation of viruses and 3-log inactivation of protozoa (*Giardia Lamblia* and *Cryptosporidium*), using two disinfection processes;
2. Baseline of *Cryptosporidium* and *Giardia* established;
3. Watershed control program;
4. ≤10% of the source water E. coli exceed 20/100mL in any 6 month period;
5. ≤10% of the source water total coliform samples exceed 100/100mL in any 6 month period;
6. Turbidity does not exceed 1 NTU 95% of the time in any 30 day period;
7. Peak Turbidity readings do not exceed 5 NTU for more than 2 days in a 1 year period; and
8. Annual average trihalomethanes (THM) concentrations do not exceed 0.100 mg/L.

Interior Health has outlined as a condition on Lake Country's operating permits that in addition to the above requirements there is also the need for Lake Country to provide conceptual plans that illustrate the footprint for future filtration and a financial plan in the event that there is a change in the water quality and the filtration deferral criteria can no longer be met.

6.3 Water Quality Summary

Water quality sampling has been conducted on each of the sources. We have summarized in *Table 6* averages of colour, turbidity and hardness from the 2009 monthly results. These are provided for comparative purposes only since more detailed analysis is required in order to inform the design of any water treatment system. A more comprehensive summary is contained in *Appendix D*.

Table 6. Source Water Quality Summary

Parameter	Units	CGDWQ Health Based Guideline	CGDWQ Aesthetic Objective	Swalwell Lake	Okanagan Lake	Kalamalka Lake	Oyama Lake
Colour	TCU		<15	33.5	5	5	48
Turbidity	NTU	<1.0		1.2	0.35	0.9	1.35
Hardness (as $CaCO_3$)	mg/l		<500	45	138	186	37

As outlined in the *Sections 6.1* and *6.2* turbidity is of concern since it impacts the effectiveness of the disinfection process. Colour is primarily an aesthetic concern but may also provide an indication of organic matter that produces disinfection by-products. The presence of disinfection by-products within the distribution system can be confirmed by additional tests. Hardness is an aesthetic parameter that affects not only the taste of the water but also the performance of various appliances including washing machines and dishwashers.

Of the four sources, Okanagan Lake is the only source that is reported to consistently remain below the 1.0 NTU turbidity guideline. It also experiences low colour. Swalwell and Kalamalka Lake sources seasonally experience spikes in turbidity that exceed 1.0 NTU, while Oyama Lake is consistently above 1.0 NTU. Both Swalwell and Oyama Lake sources experience elevated colour and associated high levels of organic matter. Improvements to Kalamalka Lake`s intake location are expected to reduce the turbidity values to comply with the filtration deferral requirements. Kalamalka experiences low colour.

6.4 Existing Treatment and Disinfection

At the present time Swalwell, Okanagan, and Kalamalka Lake have in place chlorine disinfection facilities with adequate contact time to inactivate viruses. Oyama Lake does not presently have adequate contact time prior to the first customer. All systems provide a secondary chlorine disinfectant residual in the distribution system in order to control any system regrowth.

The following table summarizes the existing system comparison to the Interior Health Requirements:

Table 7. System Comparison to Interior Health Requirements

IH Requirement	Swalwell Lake	Okanagan Lake	Kalamalka Lake	Oyama Lake
4 log virus inactivation	Yes	Yes	Yes	No
3 log Giardia Lamblia inactivation	No	No	No	No
3 log Cryptosporidium inactivation	No	No	No	No
2 Treatment Barriers	No	No	No	No
1 NTU maximum for turbidity	No[A]	No[A]	No[A]	No[A]
0 E. Coli and Fecal Coliform	No[A]	No[A]	No[A]	No[A]

Note A: Requires Filtration to be installed or Filtration Deferral to be granted to be considered in compliance by Interior Health.

At the time of writing this master plan, due to inadequate contact time and also reliability issues with the current disinfection process, customers serviced by Oyama Lake are currently on a permanent Boil Water Notification. Water Quality Advisories are also issued by the District, at the direction of Interior Health, when turbidity exceeds 1.0 NTU. Due to the frequency of this occurring on the Swalwell Lake and Kalamalka Lake supply a permanent Water Quality Advisory exists on these sources. For Okanagan Lake an advisory is only issued when turbidity rises above 1.0 NTU.

7.0 WATER DISTRIBUTION

The District of Lake Country customers serviced by the water systems outlined in this master plan can receive water from one of four sources. In the majority of the system, customers receive water from more than one source depending on the time of year. Figure 4.5 in *Appendix C* provides an illustration of the existing distribution systems as well as details on each of the existing systems. The District posts a map on their website that illustrates to customers what their current water source is as well as any advisories that are in place for that source.

The following table summarizes the characteristics of the distribution system.

Table 8. Distribution Systems Summary

	Total
Pipeline Length (km)	125 km
Pressure Zones	36
Pressure Reducing Stations	34
Pump Stations	8
Reservoirs	7
Total In-System Reservoir Volume (m^3)	10,000 m^3

In order to deliver adequate flow and pressure to customers, water distribution system planning considers water demands under average day, maximum day and peak hour conditions. The average day situation is used to confirm that the system maximum pressures are not too high. The maximum day situation is evaluated with fire flow requirements simultaneously in order to confirm that adequate flows can be conveyed to where they are needed without drawing the system pressures too low. Peak hour conditions determine if adequate conveyance capacity exists to meet minimum system pressure requirements.

7.1 In-System Storage

Understanding and evaluating in-system storage is a key first consideration in understanding distribution system performance. The reason for this is because the location and quantity of storage can have a dramatic impact on the conveyance needs of the distribution system. The most efficient systems employ in-system storage for three purposes:

1. Fire flow storage
2. Peak hour balancing
3. Emergency storage

Storing the fire flow and peak hour balancing in an in-system storage reservoir eliminates the need to convey these high flows from extended distances or through the existing source network. Emergency storage is provided in many systems so that if a main supply pipeline, treatment plant or source experiences an interruption in water supply, then the system is not immediately out of water.

The District's objective is to provide fire storage to meet existing and future needs, in accordance with Fire Underwriters Survey, up to a maximum of 15,000 l/minute for a duration of 3.25 hours. Peak hour balancing is to be provided at 25% of non-agricultural maximum day demands. Balancing is not provided for agricultural demands because they are relatively constant during irrigation season and as such don't require balancing. Emergency storage is to be provided at an additional volume of 25% of fire storage and peak hour balancing.

At the present time the District has installed approximately 10,000 m^3 of storage. It is estimated to meet the goal of full in system storage that storage needs to be expanded to 15,500 m^3 for current demands and 22,000 m^3 for future demands.

Table 9. Distribution System Reservoir Storage Volumes

	2012	2030
Balancing Storage		
25% of Non-Ag. MDD	3,800 m^3	9,000 m^3
Fire Storage		
15,000 l/min x 3.25 hours x 1 reservoir	2,925 m^3	2,925 m^3
13,500 l/min x 2.9 hours x 2 reservoirs	4,698 m^3	4,698 m^3
3,600 l/min x 1.4 hours x 3 reservoirs	907 m^3	907 m^3
Emergency Storage		
25% of Balancing + Fire	3,100 m^3	4,380 m^3
Total	**15,430 m^3**	**21,910 m^3**

7.2 Hydraulic Network Performance

Steady-state hydraulic models of the existing distribution systems were developed by Mould Engineering using the *Waterworks* software. The documentation of these models and the results are outlined in detail in *Appendix C*. A number of design criteria have changed since this modelling was complete and the District is currently in the process of developing more detailed models of each major system area.

From a domestic supply perspective, there are a number of areas that are not able to supply fire protection flows consistent with the requirements for new development. It is recommended that, the District determine what level of service it wants to provide to existing customers from a fire protection perspective, through consultation with the Fire Underwriters Survey. Typically the fire insurance grade impacts are the most important to consider. These take into consideration not only fire flow rates but also storage volumes and the fire department capacity and systems. For new development it is expected that upgrades will be required to provide fire protection flow and volume in accordance with the Subdivision and Development Servicing Bylaw.

From a peak hour perspective it is reported that the system performs well with the exception of a few localized areas.

It is recommended that updated distribution system models be developed in conjunction with implementing the chosen system improvements outlined later in this report.

8.0 ASSET RENEWAL

The majority of the existing water system infrastructure was installed in the late 1960's and early 1970's. Two major system improvements have been completed since the initial construction: adding the Kalamalka Lake water supply in 1996 and the Eldorado Balancing Reservoir to the Swalwell Lake supply in 2007. Aside from these two improvements distribution system improvements have been completed in order to support growth and development.

The District developed an Integrated Asset Management Capital Plan in 2010. As part of this plan the estimated full replacement value of the District's water system assets were estimated at approximately $112 million, which is 45% of the total District owned assets. Of this total, the estimated average remaining value was estimated at $42 million. The plan recommends that the District determine affordable levels of service, performance and risk prior to finalizing the investment level for the water system assets. The investment level for water system renewal is discussed in further detail in *Section 10*.

9.0 SOLUTIONS

9.1 Option Evaluation

As outlined in the Background, the District evaluated sixteen options for developing the long term solution for the District's water supply needs. The sixteen options were narrowed down to four options that are summarized below:

Table 10. Option Summary

	Description
1	**Dual Distribution with Full Interconnection** Domestic Supply: Okanagan and Kalamalka Lakes Irrigation Supply: Swalwell and Oyama Lakes Treatment Provided: Dual disinfection only provided at Domestic sources. Other System Considerations: • Separate domestic and irrigation systems required
2	**Single Distribution with Full Interconnection** Domestic Supply: Swalwell, Kalamalka and Okanagan Lakes Irrigation Supply: Same as above Treatment Provided: Dual disinfection provided at Kalamalka and Okanagan Lakes. Filtration plant provided at Eldorado Reservoir for Swalwell Lake source. Other System Considerations: ▪ Common domestic and irrigation distribution system used with all existing systems being interconnected. ▪ Oyama Lake discharge diverted to Eldorado Reservoir in future when demands warranted.
3	**Single Distribution with Partial Interconnection** Domestic Supply: Swalwell, Kalamalka, and Okanagan Lake Irrigation Supply: Same as above Treatment Provided: Dual disinfection provided at Kalamalka Lake. Filtration plant provided at Eldorado Reservoir for Swalwell Lake source. Other System Considerations: ▪ Two separate distribution systems service both domestic and irrigation: Swalwell and Okanagan Lake systems interconnected. Oyama and Kalamalka Lake systems interconnected.

	Description
4	**Limited Dual Distribution with Full Interconnection** Domestic Supply: Swalwell, Okanagan, Kalamalka Lakes Irrigation Supply: Oyama Lake Treatment Provided: Filtration plant provided at Eldorado Reservoir for Beaver Lake source. Dual disinfection provided at Kalamalka Lake and Okanagan Lake. Other System Considerations: ▪ Dual distribution system provided for irrigation for portion of system. ▪ All domestic sources interconnected.

A detailed discussion of these options is provided in *Section 5.6* of *Appendix D*.

Based on an evaluation and review of the options, the District has chosen to proceed with Option 2. The Single Distribution with Full Interconnection (Option 2) maintains a single distribution system for irrigation and non-irrigation needs. Improved interconnections across the system are provided in order to allow maximum access to Swalwell Lake and Okanagan Lakes as the primary sources. A full treatment facility is planned at Eldorado Reservoir with the provisions to divert Oyama Lake water to the treatment plant when demands warrant. If filtration deferral is not able to be maintained on the Okanagan Lake and Kalamalka Lake sources, then Okanagan Lake would be pumped to Eldorado and a second water treatment plant would be needed at Kalamalka Lake.

The solution was identified to have the following advantages over the other options:

1. Fully Integrated Single Distribution System: Uses the same distribution system that is currently in place with improvements.
2. Low Social Cost: Although not the cheapest solution, this option can be constructed with the least upheaval in the community. Most of the construction will be on land outside the residential neighbourhoods.
3. The primary water sources are Swalwell and Okanagan Lake.
4. A single large treatment site at Eldorado on land already owned by the District. A central treatment facility will be more manageable, reliable, sustainable, and cost less to operate.

9.2 Preferred Option

The $79.5 million worth of capital works associated with the preferred option have been broken down into seven major categories. Each project has been assigned a timeframe. The projects are graphically shown in the attached figure and this section provides a general description of each project. For a detailed discussion of the projects please refer to *Appendix E.*

1. Kalamalka Lake Interconnect

The first set of projects improves the level of service provided from the Kalamalka and Oyama Creek Sources. Through these improvements there will be a greater ability to access the water from Kalamalka Lake and to reduce the dependence on Oyama Lake. The water quality improvements to Kalamalka and Oyama Lake are also increased. These works are currently under construction.

1.1. Oyama Lake Reservoir – $3,010,000 (2012)

The Oyama Lake Reservoir project involves construction of a 1,500 m^3 balancing reservoir to provide storage for peak hour and fire flow requirements. Once the Sawmill Road Booster Pump Station upgrade is completed this reservoir will be able to be filled with water from Kalamalka or Oyama Lake.

A second key component of this project is the construction of a new 26 ML/day chlorination station on the Oyama Lake supply, to replace the Todd Road station. This chlorination station will ensure adequate contact time and equipment reliability is provided to disinfect viruses and bacteria prior to servicing the first customer.

1.2 Sawmill Road Booster Pump Station - $880,000 (2012)

The Sawmill Road Booster Pump Station will be constructed for the primary purpose of transferring water from the Kalamalka Lake source to users within the Oyama Lake system, outside of irrigation season. The station has a capacity of 50 l/s, with the largest pump being out of service. It also provides a pressure reducing valve so that flows stored in the Oyama Lake Reservoir can be fed back into other portions of the system under emergency events (e.g., Kalamalka Pump Station fails).

1.3 Kalamalka Lake UV Installation - $1,070,000 (2012)

The Kalamalka Lake source receives a 13 ML/day UV disinfection upgrade which is designed to provide safer water and is required to achieve filtration deferral.

2. Universal Metering

The District has made a significant commitment to water conservation and has seen the benefit in reduced water consumption. In order to further this commitment the District is scheduling the installation of universal metering for all customers.

2.1 Phase 1 - $1,000,000 (2014)

The first phase of the universal metering includes a public education program and the installation of meters at all commercial, industrial, and agricultural connections.

2.2 Phase 2 - $3,000,000 (2015)

The second phase includes meter installation for all residential connections.

3. Lower Lakes Quality Improvements Project

The lower lakes quality improvements project is focussed on improving the quality of water supplied from both Okanagan Lake and Kalamalka Lake. A reservoir expansion also allows greater access to Okanagan Lake water.

3.1 Okanagan Lake UV Installation - $2,060,000 (2015)

The Okanagan Lake UV Installation involves replacement of the intake screens and installation of ultraviolet disinfection units rated to match the existing pump capacity.

3.2 Okanagan Lake Reservoir Expansion - $1,600,000 (2015)

The Okanagan Lake Reservoir Expansion will provide 2,500 m^3 of additional storage as well as a new dedicated 850mm steel main.

3.3 Kalamalka Lake Intake Extension - $1,000,000 (2015)

The Kalamalka Lake Intake Extension results in the lowering of the intake from 22m to 30m in order to improve source water quality. To complete this lowering 220m of 800mm pipe are needed together with a new intake screen.

4. Eldorado Treated Water Reservoir

4.1 Eldorado Treated Water Reservoir - $3,700,000 (2017)

The Eldorado Treated Water Reservoir provides disinfection contact time as well as balancing storage for peak hour and fire flow demands. It is currently sized at 6,000-7,000 m^3 with final sizing to be confirmed during preliminary design.

4.2 Jim Bailey Road Booster Pump Station - $900,000 (2017)

The Jim Bailey Road Booster Pump Station upgrades provides increased station capacity to match the Okanagan Lake capacity with redundancy, thereby allowing the full ability to pump greater flows from Okanagan Lake.

District of Lake Country - Water System Master Plan
20 Year Capital Projects Summary

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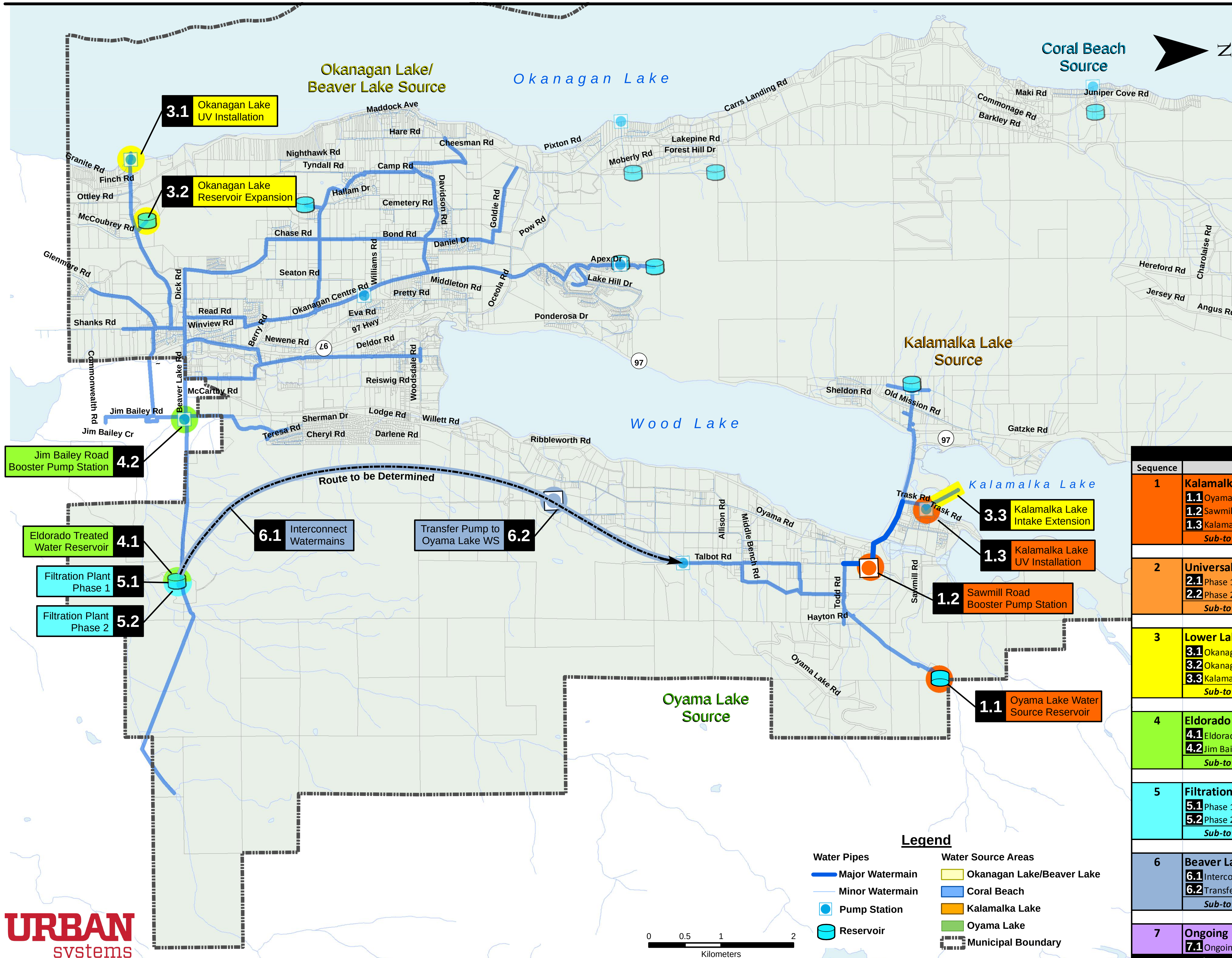

Project Type Summary

Type	Cost
Water Conservation Program	
2.1 Universal Metering - Phase 1	$1,000,000
2.2 Universal Metering - Phase 2	$3,000,000
Sub-total	$4,000,000
Water Treatment Facilities	
1.3 alamalka Lake UV Installation	$1,070,000
3.1 kanagan Lake UV Installation	$2,060,000
5.1 iltration Plant @ Eldorado Reservoir Site - Phase 1	$24,000,000
5.2 iltration Plant @ Eldorado Reservoir Site - Phase 2	$10,000,000
Sub-total	$37,130,000
Water Storage	
1.1 yama Lake Reservoir	$3,010,000
3.2 kanagan Lake Reservoir Expansion	$1,600,000
4.1 ldorado Treated Water Reservoir	$3,700,000
Sub-total	$8,310,000
Pipelines	
7.1 Watermains - Upgrade & Replacement	$13,600,000
6.1 eaver Lake/Oyama Lake Water System Interconnect	$8,000,000
Sub-total	$21,600,000
Hydraulic Control Facilities	
7.1 Miscellaneous PR Station Rebuilds & Upgrades	$1,690,000
3.3 alamalka Lake Intake Extension	$1,000,000
1.2 awmill Road Booster Pump Station	$880,000
4.2 im Bailey Road Booster Pump Station	$900,000
6.2 ransfer Pump Station to Oyama Lake WS	$1,700,000
Sub-total	$6,170,000
Minor Projects & Engineering	
7.1 Minor Project Listing < $200,000	$1,650,000
7.1 ngineering, Development & Adminstration	$600,000
Sub-total	$2,250,000
Total Water System Projects (2011 to 2030)	$79,460,000

Project Sequencing Summary

Sequence	Title	Project Type	Year	Cost
1	**Kalamalka Lake Interconnect**			
	1.1 Oyama Lake Reservoir	Water Storage	2012	$3,010,000
	1.2 Sawmill Road Booster Pump Station	Hydraulic Control Facilities	2012	$880,000
	1.3 Kalamalka Lake UV Installation	Water Treatment Facilities	2012	$1,070,000
	Sub-total			$4,960,000
2	**Universal Metering**			
	2.1 Phase 1	Water Conservation Program	2014	$1,000,000
	2.2 Phase 2	Water Conservation Program	2015	$3,000,000
	Sub-total			$4,000,000
3	**Lower Lakes Water Quality Improvements**			
	3.1 Okanagan Lake UV Installation	Water Treatment Facilities	2015	$2,060,000
	3.2 Okanagan Lake Reservoir Expansion	Water Storage	2015	$1,600,000
	3.3 Kalamalka Lake Intake Extension	Hydraulic Control Facilities	2015	$1,000,000
	Sub-total			$4,660,000
4	**Eldorado Treated Water Reservoir**			
	4.1 Eldorado Treated Water Reservoir	Water Storage	2017	$3,700,000
	4.2 Jim Bailey Road Booster Pump Station	Hydraulic Control Facilities	2017	$900,000
	Sub-total			$4,600,000
5	**Filtration Plant @ Eldorado Reservoir Site**			
	5.1 Phase 1	Water Treatment Facilities	2021	$24,000,000
	5.2 Phase 2	Water Treatment Facilities	2030	$10,000,000
	Sub-total			$34,000,000
6	**Beaver Lake/Oyama Lake Water System**			
	6.1 Interconnect Watermains	Pipelines	2027	$8,000,000
	6.2 Transfer Pump Station to Oyama Lake WS	Hydraulic Control Facilities	2027	$1,700,000
	Sub-total			$9,700,000
7	**Ongoing**			
	7.1 Ongoing Annual Work ($0.88M per year)			$17,540,000
	Total Water System Projects (2011 to 2030)			$79,460,000

URBAN systems

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5. Filtration Plant at Eldorado Reservoir Site

Filtration facilities at Eldorado will meet the Interior Health 4-3-2-1-0 treatment objectives and noticeably improved water quality. The actual treatment technology has not yet been selected.

5.1 Phase 1 - $24,000,000 (2021)

The first phase of treatment will be designed to match the maximum day demands on the Swalwell Lake Source.

5.2 Phase 2 - $10,000,000 (2030)

The second phase of treatment will expand the capacity to service areas presently serviced with water supplied from the Oyama Lake Source.

6. Beaver Lake/Oyama Lake Water System

6.1 Interconnect Watermains - $8,000,000 (2027)

The Interconnect Watermains are necessary to deliver water from the Eldorado Plant to the areas currently serviced by the Oyama Lake supply. A 600mm diameter main has been identified as being required. Adequate gravity capacity is reported to exist for almost maximum daily demands with pumping required to increase the capacity.

6.2 Transfer Pump Station to Oyama Lake Water System - $1,700,000 (2027)

The Oyama Lake Transfer Pump Station is required in order to interconnect the two distribution systems and provide water to those areas currently serviced by the Oyama Lake supply.

7. Ongoing

7.1 Ongoing Annual Work - $17,540,000 ($880,000 per year)

The final project category captures the aggregate of smaller projects which include:

- Watermain installation, replacements and upgrades in order to improve the fire protection capacity of the distribution system and address aging infrastructure - $11,800,000
- Hydraulic control facilities upgrades and refurbishments - $1,690,000
- Swalwell Lake Dam – Refurbish & Upgrade to address Dam Safety Review Recommendations - $1,800,000
- Minor projects - $1,650,000
- Development & Administration - $600,000

10.0 FINANCIAL PLAN

A financial plan has been developed to support the implementation of this master plan. This financial plan considers not only the capital requirements for the upgrades presented but also the infrastructure renewal requirements to address existing infrastructure condition while maintaining or improving the level of service.

The District is moving towards sustainable financing of its water infrastructure, and has developed a Financial Strategy (*Appendix F*) to guide investments (capital and operating) over the next 20 years, provide a defensible plan for cost recovery, and outline an approach to achieving long term revenue stability.

The Plan does include approximately $17 million of capital projects that will also result in renewal of existing infrastructure. The District has selected this level of investment in infrastructure renewal based on balancing the risks associated with infrastructure failure over the next 20 years with the ability of the District to raise rates to fund this renewal.

After considering the implications of various sensitivity analyses on the approach set out in the Water Master Plan, a preferred option has been selected. The following average user rate changes are recommended:

- Non-Agricultural – from $486 per connection (single family equivalent) in 2011 to $730 in 2016 (5 year phase in); and
- Agricultural – from $77/acre in 2011 to $120 in 2021 (10 year phase in).

A short term ramp-up of average user rates will allow for revenue stabilization over the planning horizon. Borrowing is necessary to manage cash flows, particularly in 2015 and 2021 where major capital expenditures are planned and accumulated reserves are only sufficient to cover a portion of the costs. The model analysis was completed using a constant dollar analysis. As such, these average user rates do not include inflation which should be applied on an annual basis according to current market conditions.

The risks inherent in this financial plan for the water system fall into five main categories. The first is related to climate change and whether sufficient water supplies will be available in the future. The second is maintaining filtration deferral. The third is achieving the assumed growth rate and the fourth is whether grant funding will be made available as assumed. The final risk is whether the investment level in infrastructure renewal is sufficient to sustain the level of service objectives of the District. The District has assessed these risks and will monitor them with the intention of adjusting the plan further when or if it becomes necessary.

The model shows that the District has applied a realistic, yet conservative assumption for grants to fund overall water service delivery responsibilities. A 50% assistance is assumed for future water treatment and 33% for the majority of other water improvements, with the exception of the universal metering ($4,000,000) and ongoing replacement works ($17,540,000) for which no grants are anticipated.

The District completed a water rate sensitivity analysis to determine the average rate revenue needed to achieve compliance with Interior Health Authority water treatment requirements by 2015, instead of 2021. Achieving full compliance with Interior Health by 2015 was determined to be unaffordable.

11.0 CONCLUSIONS AND RECOMMENDATIONS

In conclusion, this master plan provides a $79.5 million strategy that will allow the District of Lake Country to provide water that is sustainable and affordable for the community and environment. It will do so by achieving:

1. full compliance with existing Interior Health Authority policies by 2030;
2. adequate capacity to meet the growth needs of the District; and
3. a consistent level of service to all existing customers.

This plan takes a proactive risk management approach to address the major sources of risk exposure:

Risk	Response
Climate Change	▪ 10% Capacity Built In for Climate Change Resilience ▪ Water Conservation Measures to Reduce Water Use Requirements ▪ Updated Hydrological Assessments to be Completed for Sources
Infrastructure Failure	▪ Source Redundancy Improved ▪ In-System Storage Increased ▪ Distribution System Redundancy Increased ▪ Universal Metering Will Allow Quicker Response Time to System Leaks
Changing Regulations	▪ Provisions Made to Accommodate Future Filtration of Okanagan Lake
Changes to Growth and Development	▪ Works have been Scheduled to Allow Flexibility
Inadequate funds from government grants and Development Cost Charges	▪ Capital Works with Greatest Need for Grants and DCCs are Later in the Capital Plan
Major Changes with the Watershed	▪ Protection Zones and Bylaws to be Developed to Increase Protection ▪ Collaboration with Other Jurisdictions and Stakeholders to be Undertaken ▪ Filtration Plant will Provide Buffer to Water Quality Changes ▪ Increased Depth of Kalamalka Lake Intake to Provide Increased Protection

It is recommended that the District:

1. Continue to work on obtaining support from Interior Health for this Master Plan;
2. Implement the financial plan to support the capital plan presented in this Master Plan;
3. Proceed with submitting filtration deferral applications for both Okanagan Lake and Kalamalka Lake;
4. Complete updated hydrologic studies for all sources except Okanagan Lake and convert license capacity to match long term use requirements;
5. Implement the watershed risk reduction strategies and dam safety recommendations;
6. Complete updated hydraulic models for the distribution system;
7. Monitor and update this plan at least once every 5 years or sooner if situations change;
8. Develop plans for the remaining District water systems;
9. Update the Subdivision and Development Bylaw and Development Cost Charges Bylaw; and
10. Secure the right and ability to raise the storage capacity of Swalwell Lake.

appendix a

WATER CONSERVATION INITIATIVE STUDY (DISTRICT OF LAKE COUNTRY)

Engineering
Water Conservation Initiative Study

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Lake Country, British Columbia V4V 2M1
Ph: 250-766-6677 Fax: 250-766-0200
lakecountry.bc.ca

The District of Lake Country plans to attain the 2011 Water Master Plan's 25% reduction in water use from 2008 levels by 2030. This study defines the water demand and conservation opportunities found in the District's water distribution networks.

DISTRICT OF LAKE COUNTRY

WATER CONSERVATION INITIATIVE STUDY

Prepared By:

Steven Barrett, Operator I

Reviewed by:

Greg Buchholz, Operations Man

LAKE COUNTRY
Life. The Okanagan Way.

TABLE OF CONTENTS

LAKE COUNTRY
Life. The Okanagan Way.

1.0 INTRODUCTION

Lake Country is founded upon the values of agriculture and nature. Improved environmental protection in the form of enhanced water stewardship is important to maintain these founding values. The role water plays in this region is forefront in the work and leisure activities of the vast majority of residents. From irrigating crops to waterskiing to fishing, a sustainable water supply is imperative to Lake Country's future.

The District of lake Country must balance a limited supply of freshwater with the increasing demands of a growing population. The effects of climate change in the region may act to exacerbate this problem. The Water Conservation Initiative is intended to provide viable demand-reducing solutions to achieve a target reduction of 25% of 2008 levels by 2030 according to the Water Master Plan. The Initiative will also strive to meet the Living Water Smart provincial targets of a 33% increase in efficiency by 2020 and ensure at least 50% of new water needs be met through conservation by 2020.

Although the challenges Lake Country faces concerning water quality and supply are great they are not insurmountable. This document proposes concrete actions to increase water efficiency and reduce water consumption to ensure the future of water security in the region.

2.0 BACKGROUND

2.1 Methodology

This document serves as the most conclusive and detailed set of water demand data compiled on the District of Lake Country's water system. A number of assumptions were made to compensate for missing information which reduced the resolution of the study.

All modelled data sourced from the Okanagan Basin Water Board (OBWB) which worked under the Ministry of Agriculture and sourced data from its 2006 surveys. The communities located within the District have grown since 2006 which may augment the demand values.

The number of connections and units in the system are estimated based on billing data.

Metered indoor and outdoor data was based upon billing data for winter and the difference between summer and winter demand respectively. The summertime demands are estimated using a 6-month summer period as restricted by metering billing periods because of lack of data available.

The unmetered indoor residential demand data was estimated as equal to metered indoor residential water demand.

2.2 Lake Country Water Systems

The District of Lake Country is made up of about 12 000 people residing in the communities of Carr's Landing, Okanagan Centre, Oyama, and Winfield. The District supplies water through four water sources with interconnectivity existing only between the Okanagan Lake and Beaver Lake supplies. Approximately 8413 users were serviced through 3236 connections in the baseline year of 2008 according to the District's 2008 Annual Water Use Report. Source water supplies (in descending demand by volume) include: Beaver Lake, Oyama Lake, Okanagan Lake, and Kalamalka Lake. Water distribution networks include Beaver Lake, Oyama Lake, Kalamalka Lake, Okanagan Lake, and Coral Beach. The distribution network boundaries and land use maps are found in Figure 2.1. Water supplied to the Beaver Lake and Oyama Lake systems is disinfected and gravity fed to users. All other systems use pump stations to elevate water to reservoirs for gravity feed. Water rates are relatively low and the majority of users pay a flat rate due to a low metering penetration. Mandatory metering on new buildings has been in place since 1995. The District encompasses a large number of unmetered older properties including 2195 houses built before 1986 (Statistics Canada, 2007). Environmental factors contributing to increased consumption include: a semi-arid climate, and soil texture primarily comprised of silty soils.

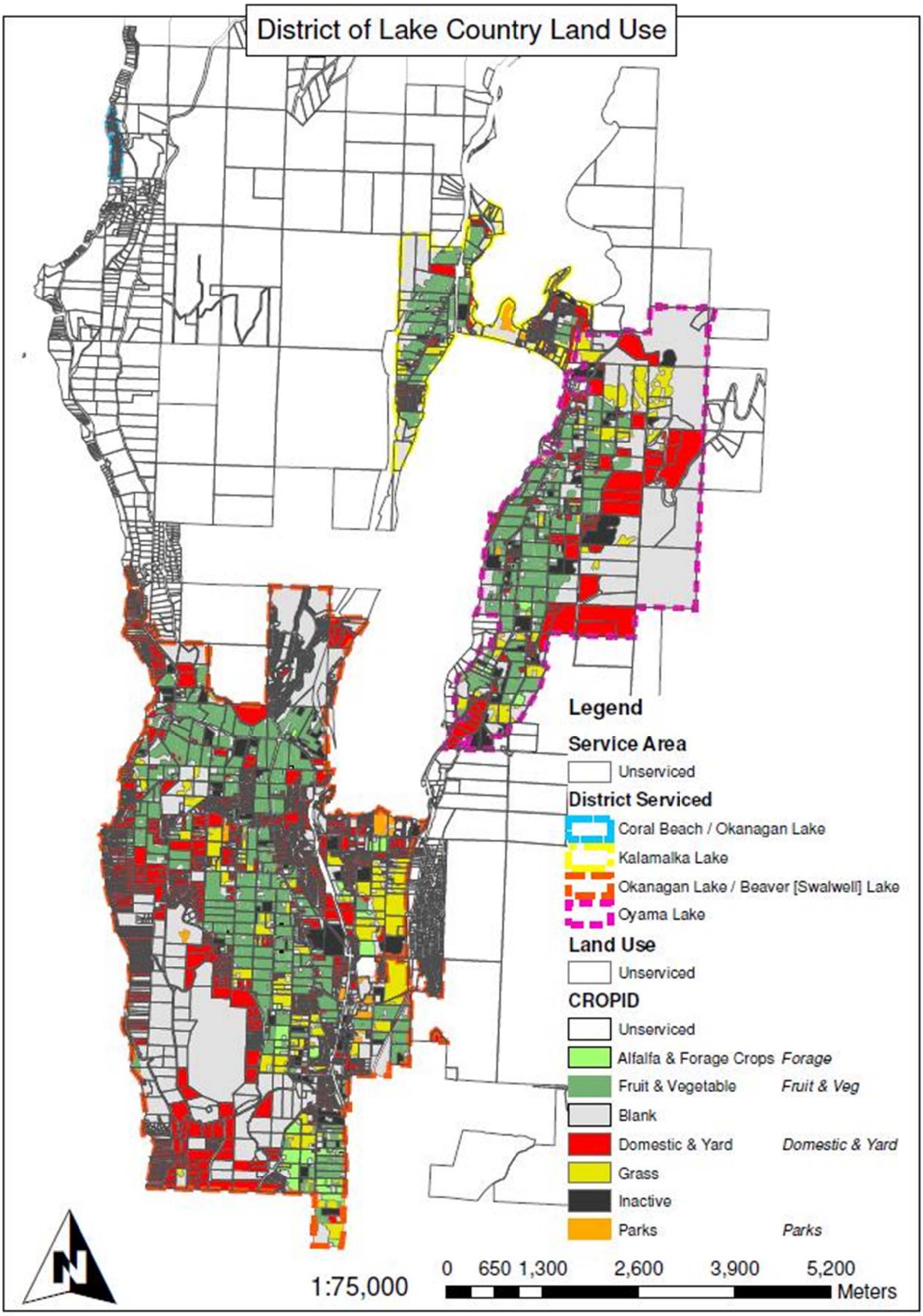


Figure 2.1: District of Lake Country by land use and water system

The Beaver Lake distribution network has historically had the highest demand. The Beaver Lake source is located in the upper watershed. It supplies the largest residential population, servicing Okanagan Centre, and Winfield, as well as considerable agricultural land as seen in Figure 2.2. The interconnected Beaver Lake & Okanagan Lake distribution networks serviced 6726 users in 2008. This distribution network is supplied by both Okanagan and Beaver Lake sources. The Okanagan Lake station was constructed with large capacities to easily accommodate future demand increases.

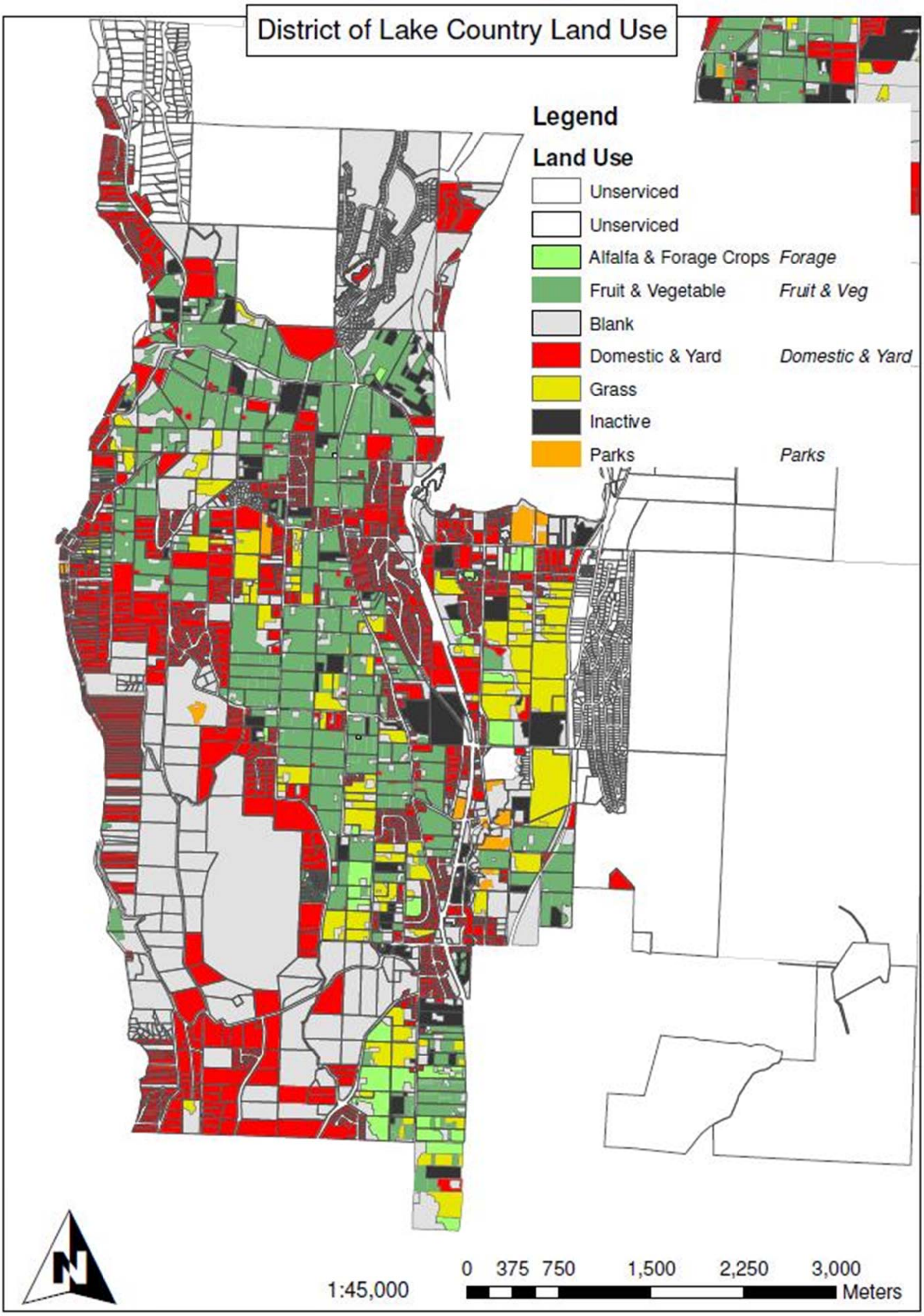


Figure 2.2: Beaver & Okanagan Lake land use map

The Oyama Lake distribution network supplies a large agricultural base and has the second highest average daily demand of 6.1ML/day. Fruit and vegetable crops make up the majority of surveyed land use within the Oyama and Kalamalka systems as seen in Figure 2.3. The system serviced 694 users in 2008 making it the third most populous system.

Current and future potential pumping capacity for the Kalamalka Lake distribution network exceeds the 2.4ML/day average demand placed on the system. This system supplied 832 customers in 2008.

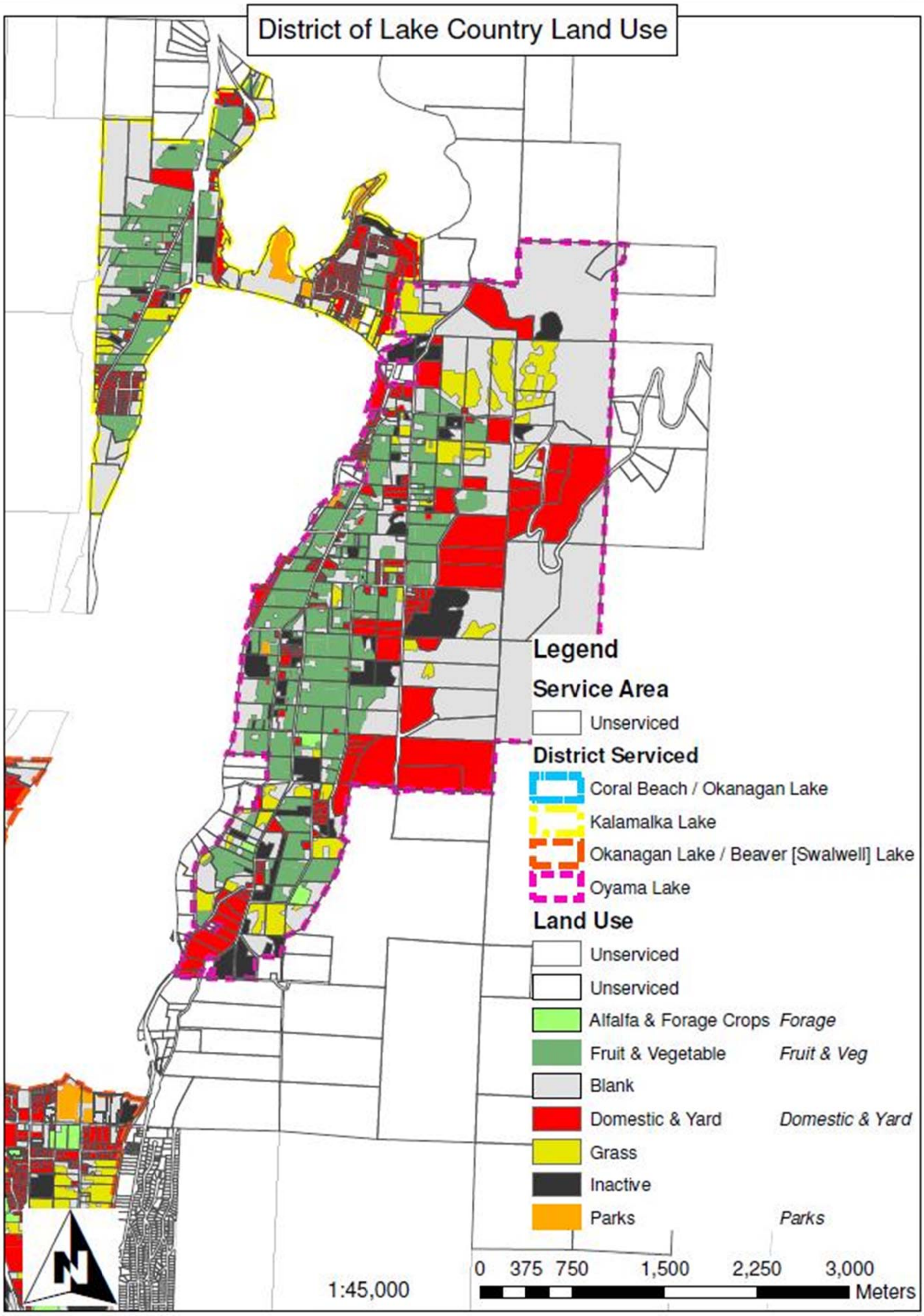


Figure 2.3: Oyama and Kalamalka Lake system map by land use

The Coral Beach system is a small residential system with sufficient long-term pumping capacity. The area is fully built-out at 161 residents making future expansion minimal. The map found in Figure 2.4 demonstrates the residential makeup of the system. This area includes holiday properties and accordingly reflects a much lower indoor water usage compared the rest of the system.

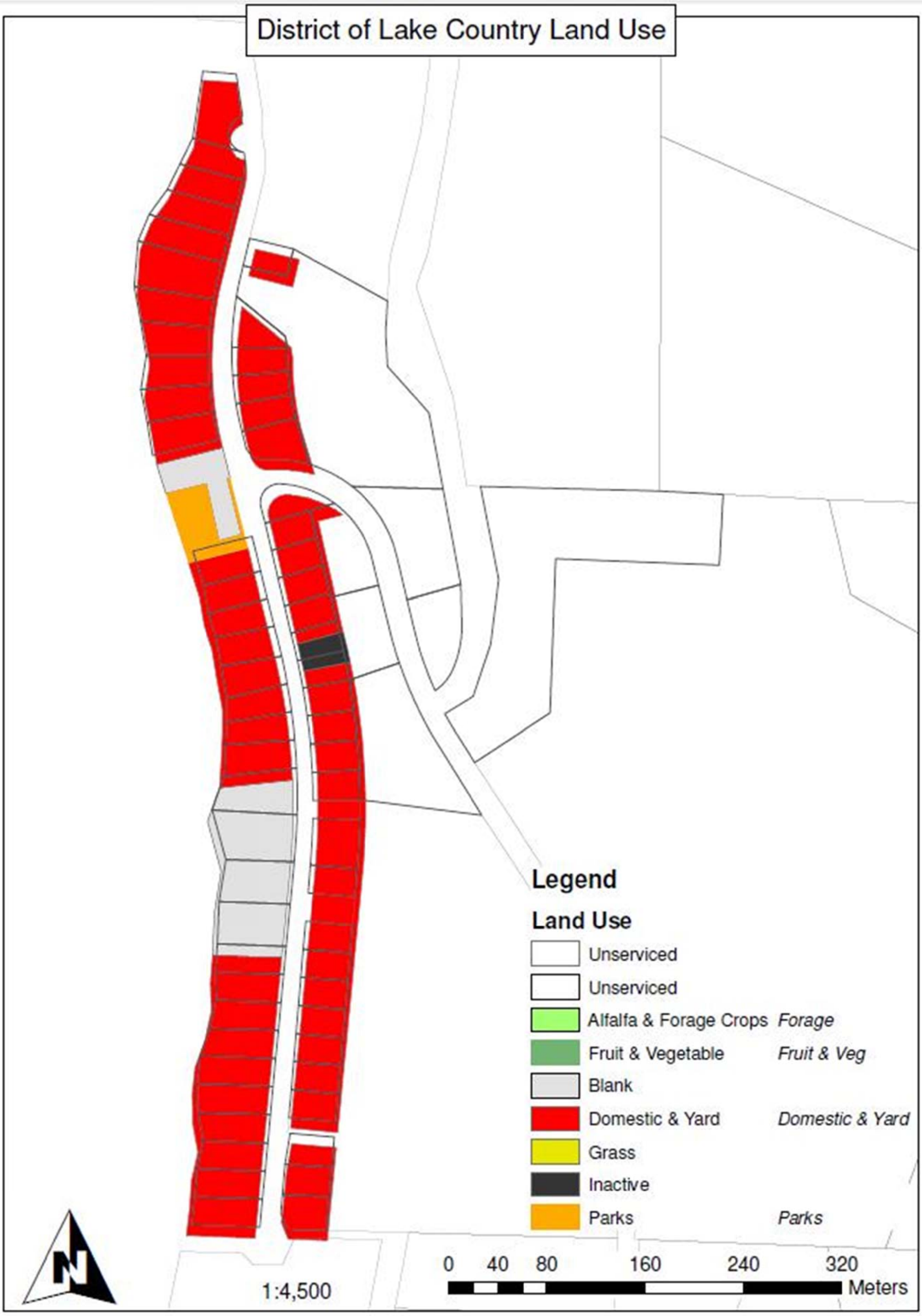


Figure 2.4: Coral Beach system map by land use

The District of Lake Country implements permanent Stage 1 watering restrictions. Stage 2 watering restrictions are implemented when upland lake levels are lower than normal. Stage 3 watering restrictions are implemented during drought conditions. The District's current defined water restriction stages can be found in Appendix A.

As the District of Lake Country moves forward with its Water Master Plan it is important to reduce overall consumption. The capacity of the potential water treatment plant on the Beaver Lake source must account for future growth. With greater reduction of water usage comes a smaller required sizing for the treatment plant. The District also plans to meet British Columbia's Living Water Smart targets.

3.0 CURRENT DEMAND

3.1 Context

To determine the most efficient opportunities for water conservation it is important to present the demand analysis. The demand has been determined through the use of Ministry of Agriculture and Lands demand models, and District of Lake Country totalizer data.

• Average winter day demand	4.7	ML/day	54	LPS
• Average winter day demand 2008 baseline	6.7	ML/day	77	LPS
• Average day demand	24	ML/day	277	LPS
• Average day demand 2008 baseline	24	ML/day	281	LPS
• Maximum average day demand	72	ML/day	837	LPS
• Unmetered residential outdoor demand per capita			1640	LPD
• Unmetered residential indoor demand per capita			330	LPD
• Metered residential outdoor demand per capita			320	LPD
• Metered residential indoor demand per capita			330	LPD

3.2 Average Winter Day Demand

Indoor residential, commercial, and industrial water usage was estimated using the average winter day water demand. The monthly average flow for December through February of 2006-2009 was 54LPS. The average flow for December-February 2008 was 77LPS.

3.3 Average Day Demand

The average daily demand compiled from totalizer data from 2006-2009 is 24.9ML per day (277LPS). See Figure 3.2 below for a comparison of average daily demand by system. The Oyama and Beaver Lake systems are proportionally the highest water consumers.

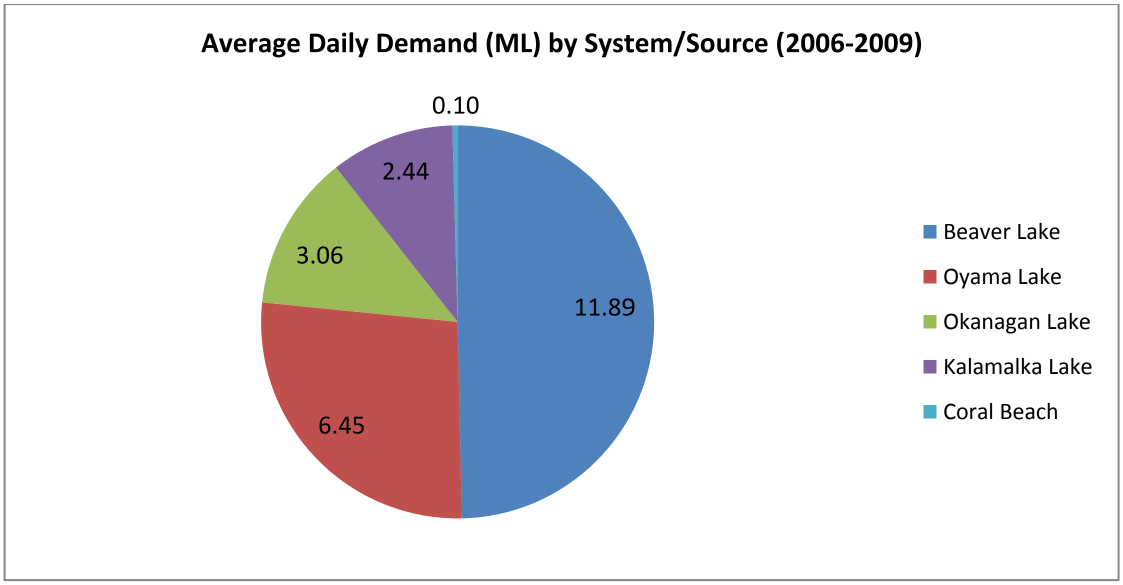


Figure 3.2: Average daily flows in ML by system using 2006-2009 totalizer data.

3.4 Maximum Day Demand

The maximum average day demand was calculated to be 72.3ML per day (837LPS) from totalizer data. This value represents the sum of indoor and outdoor commercial, industrial, residential, and agricultural water use.

3.5 Peak Hour Demand

Peak hour demand for the 2006-2009 average is estimated to be 108ML per day (1256LPS) using the design standard of one and one half max day demand.

The peak day demand for the District's three largest water sources in 2008 is found below in Table 3.1. Beaver Lake source experienced the largest demand of 50ML on 7 Aug 2008.

Table 3.1: Peak Day Demand by Source in 2008 of the District's Largest Sources

Source	Peak Demand Day	Demand (MLD)	Demand (LPS)
Beaver Lake	07-Aug-2008	50.8	588
Oyama Lake	29-Jul-2008	23.6	273
Kalamalka Lake	15-Jul-2008	9.3	108

Note: Daily system flows are only available for the systems above.

3.6 Average Residential Demand Per Capita

By determining the average day demand per capita for winter as well as annually it is possible to determine indoor water usage. As seen in Figure 3.4 below every system except Coral Beach exceeds the average total British Columbian usage per day of 490LPD (BC Hydro, 2011). This indicates the average indoor usage of 430LPD in the District approaches the provincial average total indoor and outdoor usage per day per capita.

Per capita residential water consumption in the District of Lake Country is highly dependent upon metering. Figure 3.3 displays the 3-fold increase in consumption in unmetered homes than metered homes. Metered users use water more efficiently than the provincial average of 490LPD/capita. Seasonal and vacant homes are estimated at 14% by removing residences with <20m^3/6-month (40LPD/capita). District staff estimates this rate is likely higher in newer metered homes than older unmetered residences. Unmetered homes therefore are considered to have a negligible impact on the demand data.

Total system consumption could be reduced by 1600ML per year, or 18%, if unmetered homes achieve the same level of water consumption as metered homes.

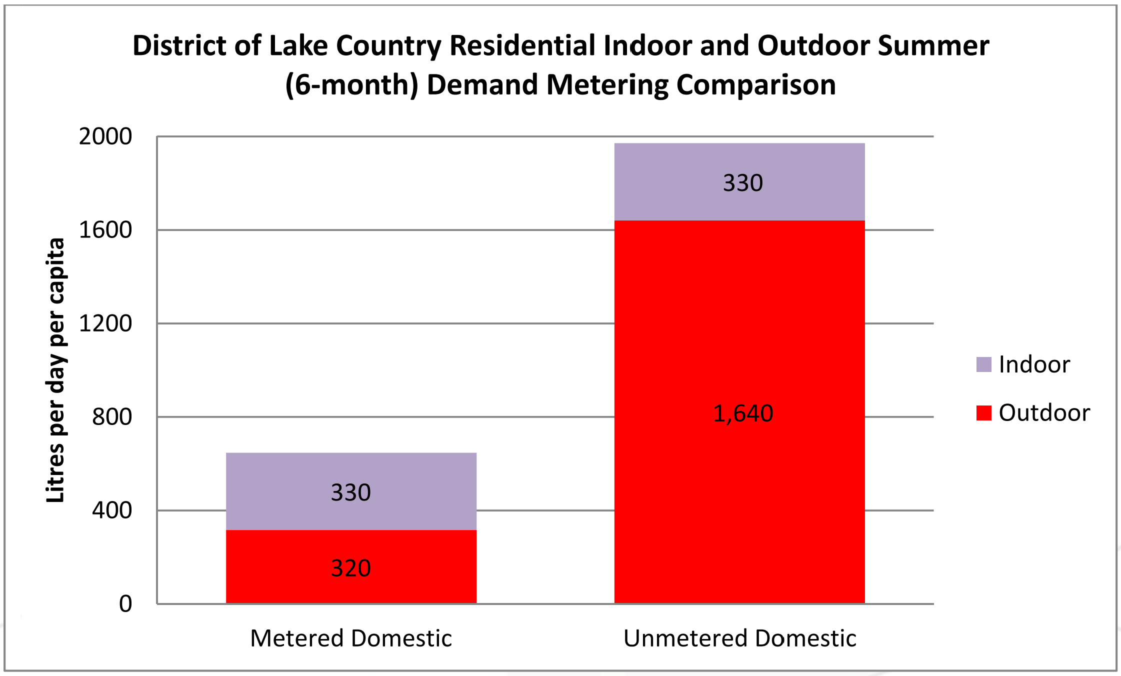


Figure 3.3: Comparison of District of Lake Country summer metered and unmetered residential water consumption per capita based on 6-month winter and 6-month summer as billed.
Note: Metered data based off 6-month 2009 summer and winter billing periods (24 & 25). Vacant properties (<20m^3/6-months) removed from dataset. Indoor unmetered water usage based upon metered indoor water usage. The 6-month billing period leads to some outdoor water usage to be included in the winter data.

3.7 Distribution of Peak Flow

Lake Country experiences a 15-fold increase in demand during summer peak flows (Figure 3.4). The distribution of the District's max day demand can be found below in Figure 3.6. Total agricultural demand accounts for about 65% of peak flow with about half peak flow attributed to fruit and vegetable crops.

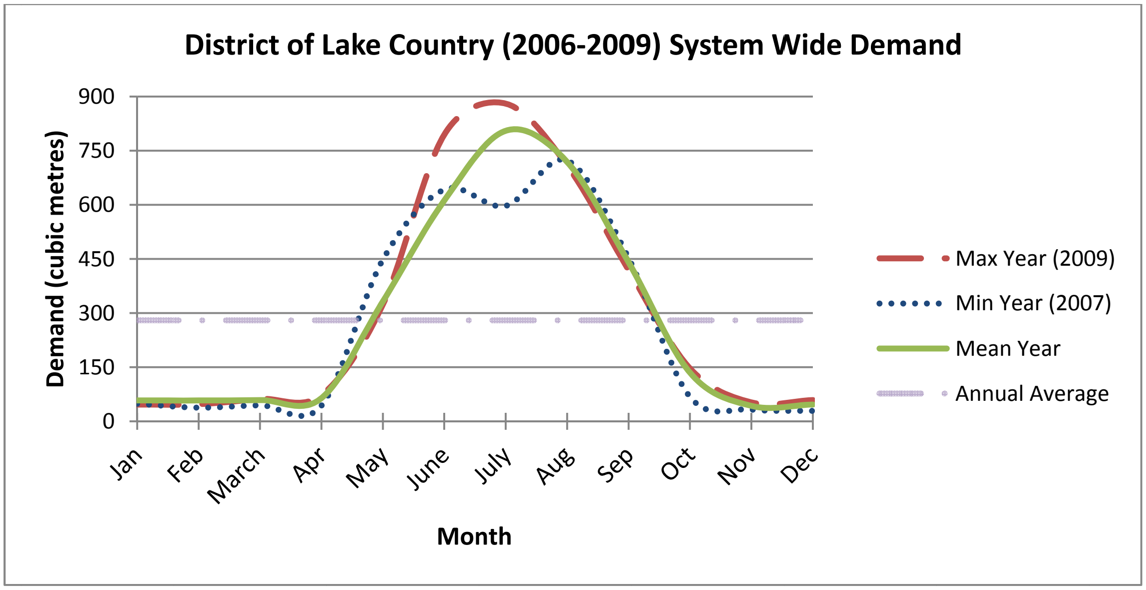


Figure 3.5: Total system monthly demand 2006-2009.

The next largest demand is the domestic outdoor irrigation. This consumption accounts for 28% of the peak flow. Large savings could be achieved in this category through conservation measures outlined in Section 5.

Indoor flows typically undergo slight variations, but become a relatively minor demand source during peak flows at 3% total. Reductions of indoor water consumption will produce negligible impacts on peak flow shaving.

District parks similarly represent 1% of peak flow and offer a minimal opportunity for peak flow reduction.

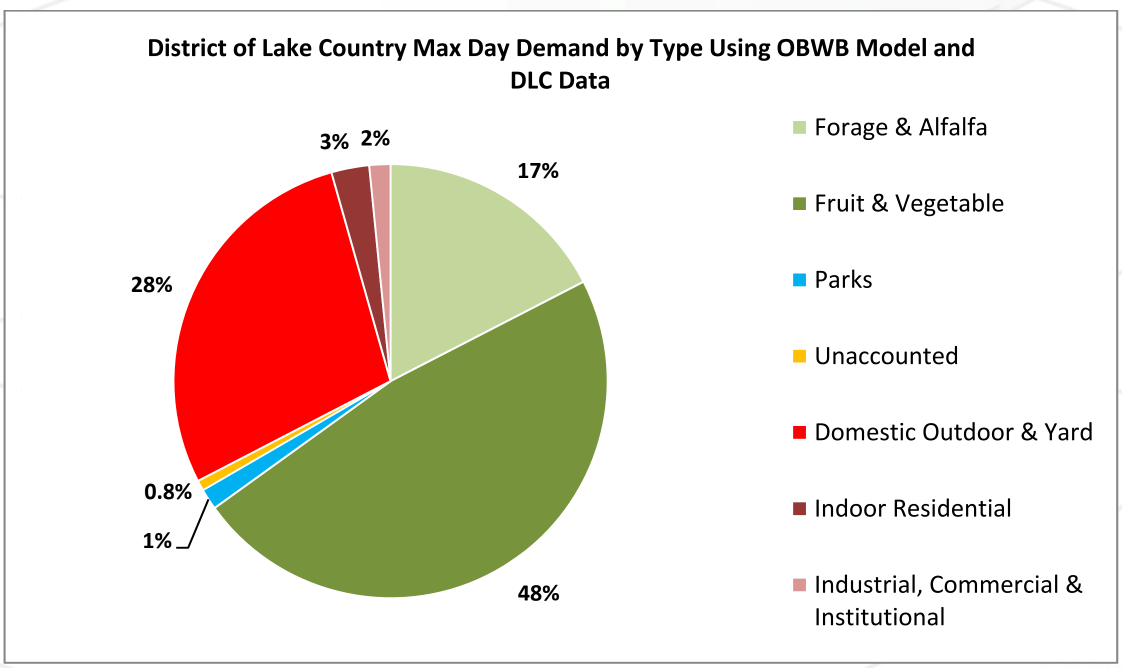


Figure 3.6: 2006 District of Lake Country max day demand modelled by type.

LAKE COUNTRY
Life. The Okanagan Way.

3.8 Annual Demand by Land Use

The rural portion of Lake Country is largely composed of agricultural land and larger residential lots. A combination of District of Lake Country measured flows, and modelled data produced for the Okanagan Basin Water Board, presented below in Figure 3.6, divides the annual water demand according to usage type.

According to Figure 3.6, 85% of all total water demand can be attributed to outdoor agricultural, residential, and parks irrigation. About 28% of all water is consumed by outdoor domestic usage. This represents an opportunity for large reductions in overall system demand.

About 39% of total water usage is for agricultural fruit and vegetable irrigation. Another 15% can be attributed to forage and alfalfa crops. These food crops are irrigated by a mixture of efficient and inefficient sprinkler systems. According to District data, about 58% of agricultural irrigation is delivered through relatively efficient systems.

Around 10% of total average water demand is attributed to grasses grown for non-food usage on agricultural lands including: overspray of irrigation systems, dust mitigation, horse ranges, and aesthetics.

Approximately 180ML of demand is consumed by parks. This represents close to 1% of annual usage. Increasingly efficient irrigation practices should continue to be utilized, however, District parks are not a significant user of water as a portion of the total system demand.

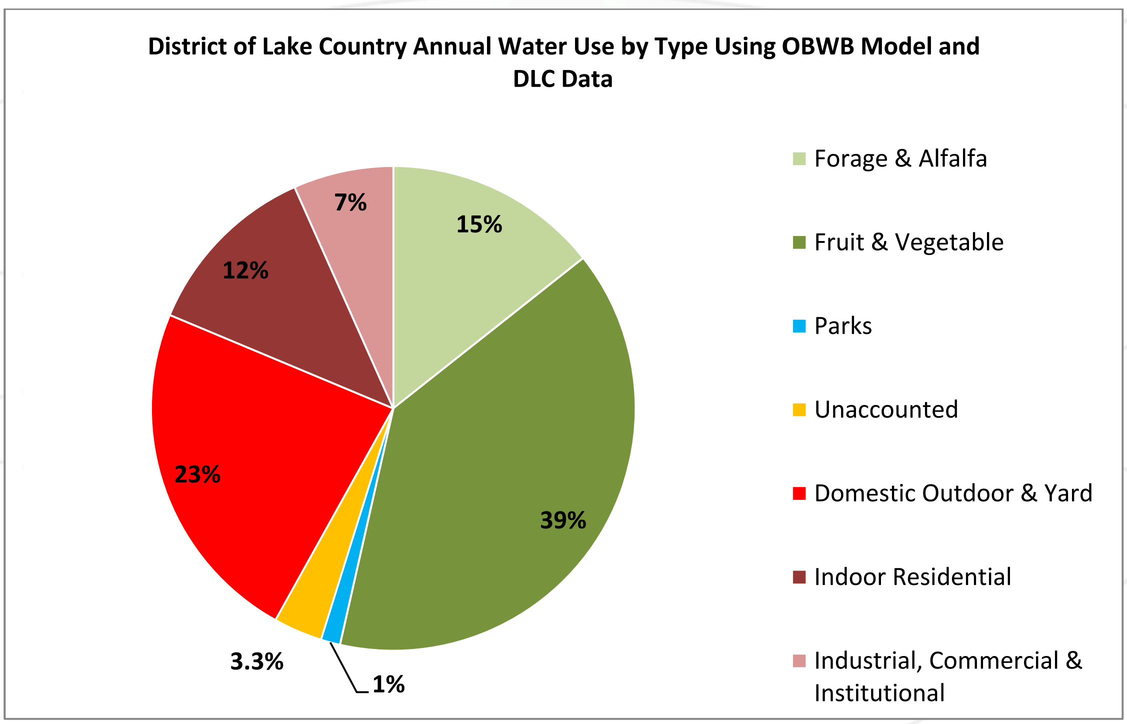


Figure 3.6: 2006 total system modelled annual demand by use as a proportion of total modelled water use

The largest residential demand reductions can be achieved through reductions in outdoor water consumption. Summer domestic demand would be reduced by 76% offering an effective reduction of peak demand.

4.0 FUTURE DEMAND PREDICTIONS

4.1 Overview

According to the District of Lake Country's projections, the 3100 units will be added to the system by 2030. Predicted 2020 and 2030 system-wide annual water use is based upon no change in water consumption efficiency. See Figure 4.1 below for District water demand projections to 2030.

• 2008 System-wide annual water use	24	ML/day	8 855ML/year
• Predicted 2020 system-wide annual water use	27	ML/day	9 970 ML/year
• Predicted 2030 system-wide annual water use	30	ML/day	10 930 ML/year
• 30% increased efficiency 2020 consumption	22	ML/day	7 955 ML/year
• 25% water conservation by 2030	22.5	ML/day	8 220 ML/year

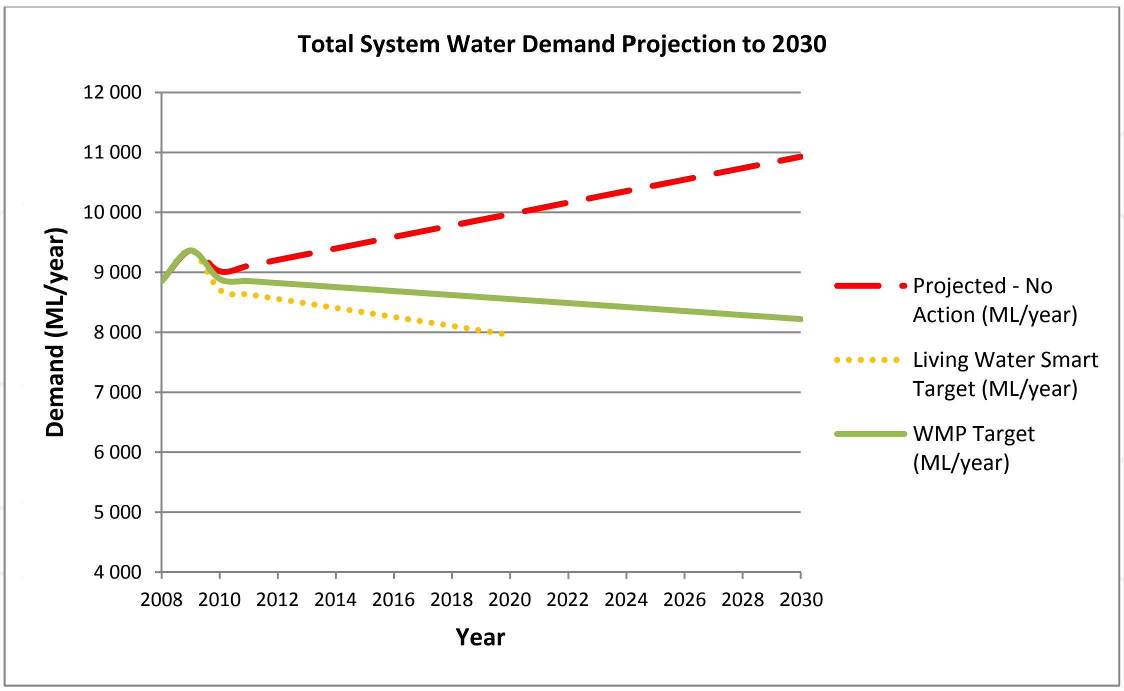


Figure 4.1: Projections of total water system annual water demand by target to 2030.
Note: use of actual data for 2008-2009; projection 2010-2020 with 2008 as base year.

4.2 Changing Demand Areas

A significant residential and commercial demand shift, measured in single family equivalents, is projected within the Okanagan & Beaver Lake system as new neighbourhoods are developed. The Lakestone development is projected to increase from 0% to 14% of total system demand by 2020 as seen in Figure 4.5 below.

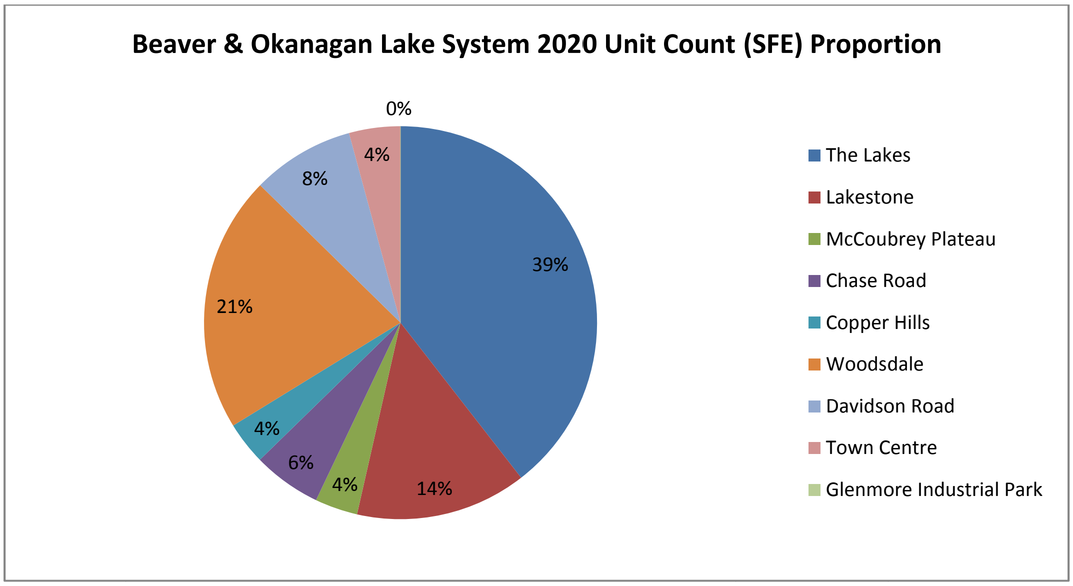


Figure 4.5: Proportion of projected single family equivalent (SFE) demand by development within the Beaver Lake & Okanagan Lake System (2020).

5.0 PROPOSED CONSERVATION STRATEGIES

5.1 Overview

The District of Lake Country should focus on water conservation in domestic indoor/outdoor areas as well as agricultural efficiency. Universal metering is effective at increasing water conservation in all demand areas. According to the 2011 Water Master Plan, this will be implemented in the 2013-2015 time period.

Although water usage indoors is a relatively small proportion of usage compared to agricultural and domestic outdoor demand, the strain on the wastewater collection and treatment system would be reduced. This is particularly important as the District moves forward with expansion of its wastewater treatment plant treatment and disposal systems. All measures taken to reduce indoor demand have the added importance of reducing wastewater infrastructure capital and operational costs.

To create a measurable impact on water consumption in the District of Lake Country, it is important to identify which areas will produce the greatest benefits. Figure 5.1 below illustrates an order of magnitude of difference in system water demand from summer to winter months. Considering the agricultural nature of the District, most of this difference can mostly be attributed to agricultural irrigation. Domestic irrigation has been found to be of almost equal demand.

The District has historically reported irrigation to the Ministry of Environment as the sum of domestic and agricultural irrigation. The District has a very low density of 78.6 persons per km^2 which indicates large lot sizes (Statistics Canada, 2007). Watering of grassy large lots may account for a sizeable portion of water demand in the summer months. Outdoor domestic irrigation accounts for nearly one-third of annual outdoor demand. Conservation efforts in outdoor domestic irrigation and agricultural irrigation offer the best savings potential.

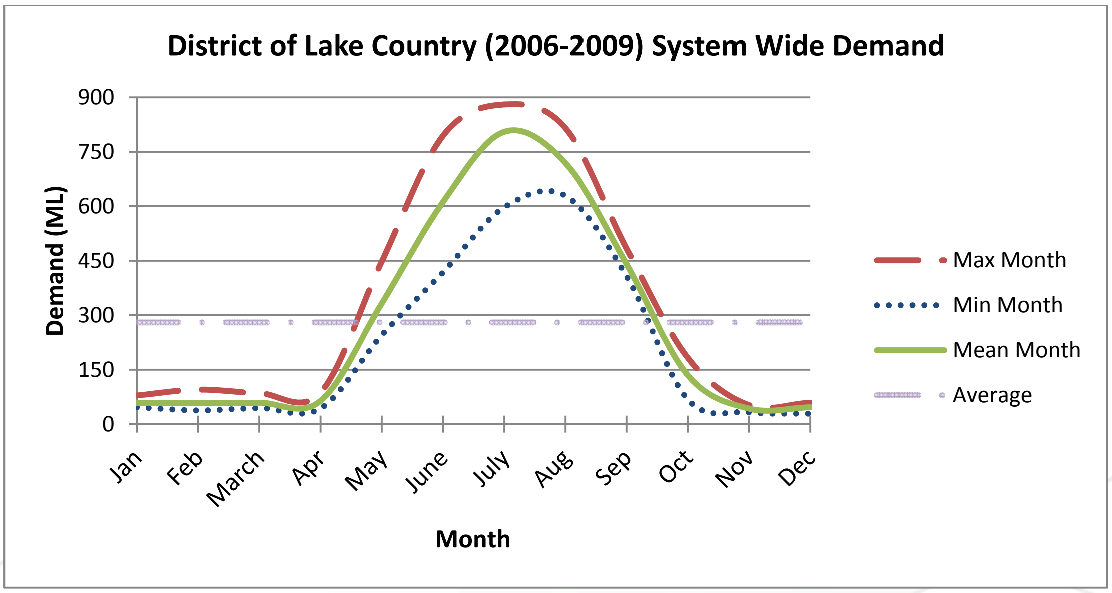


Figure 5.1: System wide water demand (ML) including min, max, and mean month and annual mean from 2006-2009 graphed by month.

5.2 Education and Outreach Strategies

Education of residents is an effective and low-cost means of encouraging voluntary indoor and outdoor residential and agricultural water consumption. Outreach programs are effective tools to encourage long-term water efficiency. This is especially true when the target audience is children. Children are quick learners and are effective at instilling ideas in their parents. Teaching water conservation to young people can increase the likelihood of lifelong water efficiency. Youth and general public water conservation awareness seminars could be hosted in the spring or summer through the District of Lake Country WaterSmart program.

Specialised xeriscaping seminars hosted by the WaterSmart program with trained guest demonstrators would offer an effective method of encouraging outdoor domestic water conservation. An aspect of the program could include a public xeriscape garden similar in concept to the Winfield Community Garden located on Bottom Wood Lake Road. This garden could act as a hosting site for hands-on seminars.

WaterSmart water conservation brochures could be produced and mailed out with water bills. These pamphlets should contain information similar to the WaterSmart website but can also include information on upcoming seminars. This method offers communication to residents who lack internet access. Additionally, friendly warning brochures could be attached to bills of metered users who use excessive volumes of water. Existing “Use Water Wisely” doorknob warning notices should be applied to houses violating watering bylaws.

Irrigation technology seminars could be held to target outdoor water use in the District. These seminars should be divided into those directed towards farm owners and those directed towards residential users. Professional installers or distributors of irrigation supplies would likely offer a free information session for the chance to advertise their products. The installation of drop, micro-spray, micro-sprinkler, over tree drip, and SDI systems will be encouraged.

The District of Lake Country may join the Okanagan Irrigation Management program to offer farmers access to an online database and modelling tool which aids in efficient irrigation practices. The WaterSmart program could offer assistance with the use of this tool to unfamiliar users.

5.3 Regulatory Strategies

The District of Lake Country has required all newly built homes to include a water meter. The use of water meters allows the District to set water rates according to consumption which has been shown to reduce consumption by 10-30% on its own. As an additional requirement for new homes, the District consider potential benefits of grey-water recycling systems which reuse sink and shower water for toilet flushing. The largest benefit of the grey-water recycling system is an estimated 40% reduction in household effluent thereby reducing strain on the wastewater treatment plant (Brandes, 2006).

Agricultural users are currently allowed an allotment of 6 USGPM/acre. This allowance should only be adjusted upon consultation with agri-food experts. The preferred option is to encourage improved irrigation efficiency through new systems and management. Figure 5.2 shows the current bylaw allowance for agricultural irrigation. Figure 5.3 presents an opportunity for savings with a modest decrease in the irrigation allowance to 5USGPM/acre. This exceeds the 800mm/year estimated by the BC Ministry of Agriculture as the maximum required in the Okanagan Valley.

$$\frac{6USgal/min}{acre} bylaw\ for\ 120\ days = \frac{970mm}{year}$$

Figure 5.2: Current District bylaw allotment to agricultural irrigation

$$\frac{5USgal/min}{acre}\ for\ 120\ days = \frac{808mm}{year}$$

Figure 5.3: Possible District bylaw allotment to agricultural irrigation

5.4 Financial Strategies

With the implementation of mandatory metering of new-builds in 1995, the District of Lake Country gained the opportunity to enforce a tiered metering scheme on these users. Future expansion to universal metering would offer 10-30% water savings to residential consumption. The District estimated a yearly total savings of 1700ML/year with the implementation of universal metering. Currently the District does not offer a tiered rate scheme. There is a significant potential for residential water savings through the use of a steeply stepped rate scheme. The scheme can also be modified to increase in summer to reinforce the need to conserve water during peak usage. Another option is to offer extra fees for users exceeding a predetermined limit. Conversely, rebates can be offered to the most efficient users.

Agricultural users could be offered a lower flat rate or metered rate if they install high efficiency irrigation systems. Users who do not upgrade would be charged the regular rates. This system would offer farmers a long-term financial incentive to upgrade their systems.

Rebates or discounted prices on high efficiency shower heads, tap aerators, toilets, and appliances can be offered for relatively little investment. Rain barrels could also be offered. Free shower heads and tap aerators can be offered for little cost to the District and realize immediate water savings.

Grass turf is generally the largest water consumer in non-agricultural outdoor water usage. The District could offer a rebate per square metre of turf removed by commercial, industrial, and residential users. This can be offered as a rebate on future water bills. This method encourages landscaping with reduced water demand and presents a large water saving opportunity.

To ensure widespread adoption of high efficiency fixtures, the District could contract a distributor to perform retrofitting of older homes. All liability is covered by the distributor's insurance when this delivery method is used. This program would offer a potential reduction of 115ML per year if two toilets were replaced in each of the 2195 pre-1986 homes. The strain on the wastewater treatment facility would be reduced through this measure.

5.5 Operational Strategies

The District of Lake Country water operations must continue to monitor water wastage and act to reduce water wastage due to system loss, system design, illegal connections, and overrated flow control devices.

System losses are about 280ML measured between 2AM and 4AM on the District's SCADA. This represents just over 3% of annual consumption. An unaccounted leakage rate of less than 10% is considered low which indicates efforts to reduce the unaccounted demand would offer little reward. Most of the water consumed during this time of the night can be attributed to leaking infrastructure. Abnormal gaps in water consumption data between metered connections to direct operations to an area with a potential leak. A listening device can then be used to find the specific location of the leak.

6.0 SUMMARY AND RECOMMENDATIONS

Water demand management is important for the sustainability of Lake Country's water supplies. Outdoor water use in both the domestic and agricultural sectors should be targeted in early stages of the plan. Although the District's water conservation targets are system-wide, it is important to recognize the finite and sometimes volatile nature of the Beaver and Oyama Lake supplies. The District has recently taken aggressive action in watershed management to improve the reliability of water supply and quality in these systems. Long-term sustainability can be achieved through a multifaceted approach including both demand side conservation and supply side management efforts. The goals found in this section will provide the District with the demand-side tools to ensure a sustainable future.

According to the demand models found in Section 3, 85% of total water consumption can be attributed to outdoor demand. To achieve maximum savings for effort outdoor domestic and agricultural demand should be targeted. These two demand sources also account for the largest portion of peak demand.

A 25% increase in water consumption efficiency will require a strong, well-maintained framework developed early on in the plan. **A two phase strategy based on these requirements has the highest possibility of immediate and long-term success.**

Water Conservation Initiative Phase 1

Phase 1 of the water conservation initiative will focus on domestic indoor and outdoor water usage. A strong campaign must be founded upon: educational, regulatory, financial, and operational strategies. Some or all of the following operational, financial, regulatory, and educational programs will be implemented by 2015:

1. Universal Metering
    - The 2011 Water Master Plan sets a 2013-2015 time line to implement universal metering on all system users.
    - Universal metering encourages water conservation across all user groups
    - A water use reduction of 10-30% can be achieved based upon experience in similar municipalities

2. Education and Outreach
    - Establish recurring public seminars to engage the community and establish water conservation awareness through the WaterSmart program.
    - Develop and distribute WaterSmart water conservation brochures.
    - Provide xeriscaping seminars and create a community xeriscape garden.
    - Host agricultural and domestic irrigation seminars.
    - Join OKIM to provide farmers with irrigation planning data.
    - Contact and educate excessive users.

3. Regulation
    - Continued enforcement of all new homes requiring install of a water meter.
    - Mandate grey-water recycling systems for all new homes to achieve a 40% reducing in household effluent.
    - Research adjustment to agricultural irrigation allowance

4. Financial
    -
    - Implement a stepped metering scheme on existing metered residents with seasonally adjusted rates.
    - Supply tap aerators and low-flow shower heads.
    - Subsidize or offer rebates on rain barrels and high efficiency toilets
    - Offer water rate discount to agricultural users who upgrade to efficient irrigation systems.
    - Rebates for turf removal for ICI and domestic users.
    - Contract distributor to hire contractors for toilet retrofits on existing homes.
    - Begin to retrofit existing homes with water meters.

5. Operational
    - Ensure agricultural connections are compliant with flow restrictions.
    - Trace and eliminate illegal connections and leaking infrastructure.
    - Loop future developments and retrofit existing systems to reduce flushing wastage and improve water quality.

Water Conservation Initiative Phase 2

Phase 2 of the water conservation initiative should aim to maintain outreach programs to ensure continued voluntary savings. This phase should be continued and improved upon from 2015 onwards.

1. Continuation of Phase 1
    - Education and outreach programs will be continue and be improved
    - Regulations will become more effective through updates
    - Operations will continue maintenance programs

References

BC Hydro. (2011). *Water Guide*. Retrieved from: http://www.bchydro.com/guides_tips/green-your-home/water_guide.html (accessed February 12, 2011).

Brandes, O. M., Maas, T., & Reynolds, E. (October 2006). *Thinking Beyond Pipes and Pumps.*

Statistics Canada. 2007. *Lake Country, British Columbia (Code5935016)* (table). *2006 Community Profiles*. 2006 Census. Statistics Canada Catalogue no. 92-591-XWE. Ottawa. Released March 13, 2007. http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-591/index.cfm?Lang=E (accessed January 25, 2011).

Appendix A- Agricultural water demand calculations

According to the District's 6USgal/min/acre 120-day season agricultural irrigation bylaw:

OBWB model land area 2006:

$$(2438.88acre)\left(\frac{6USgal/min}{acre}\right)\left(\frac{120day}{year}\right)\left(\frac{172800min}{120day}\right)\left(\frac{3.785L}{USgal}\right)\left(\frac{m^3}{1000L}\right) = 9\ 570\ 868m^3/year$$

DLC billing data land area 2011:

$$(3050.41acre)\left(\frac{6USgal/min}{acre}\right)\left(\frac{120day}{year}\right)\left(\frac{172800min}{120day}\right)\left(\frac{3.785L}{USgal}\right)\left(\frac{m^3}{1000L}\right) = 11\ 970\ 687m^3/year$$

Non Class 9 allotment 2011:

$$(519.78acre)\left(\frac{6USgal/min}{acre}\right)\left(\frac{120day}{year}\right)\left(\frac{172800min}{120day}\right)\left(\frac{3.785L}{USgal}\right)\left(\frac{m^3}{1000L}\right) = 2\ 039\ 766m^3/year$$

If the bylaw was reduced to 5USgal/min/acre 120-day season:

Model:

$$(2438.88acre)\left(\frac{5USgal/min}{acre}\right)\left(\frac{120day}{year}\right)\left(\frac{172800min}{120day}\right)\left(\frac{3.785L}{USgal}\right)\left(\frac{m^3}{1000L}\right) = 7\ 975\ 723m^3/year$$

Billing

$$(3050.41acre)\left(\frac{5USgal/min}{acre}\right)\left(\frac{120day}{year}\right)\left(\frac{172800min}{120day}\right)\left(\frac{3.785L}{USgal}\right)\left(\frac{m^3}{1000L}\right) = 9\ 978\ 843\ m^3/year$$

Current bylaw irrigation:

$$\left(\frac{6USgal/min}{acre}\right)\left(\frac{120growingday}{year}\right)\left(\frac{24hr}{day}\right)\left(\frac{60min}{hr}\right)\left(\frac{3.785L}{USgal}\right)\left(\frac{m^3}{1000L}\right)\left(\frac{acre}{4046.86m^2}\right) = 0.9697m/year$$

5USGPM bylaw irrigation:

$$\left(\frac{5USgal/min}{acre}\right)\left(\frac{120growingday}{year}\right)\left(\frac{24hr}{day}\right)\left(\frac{60min}{hr}\right)\left(\frac{3.785L}{USgal}\right)\left(\frac{m^3}{1000L}\right)\left(\frac{acre}{4046.86m^2}\right) = 0.8081m/year$$

Appendix B- 2008 Average daily demand by system

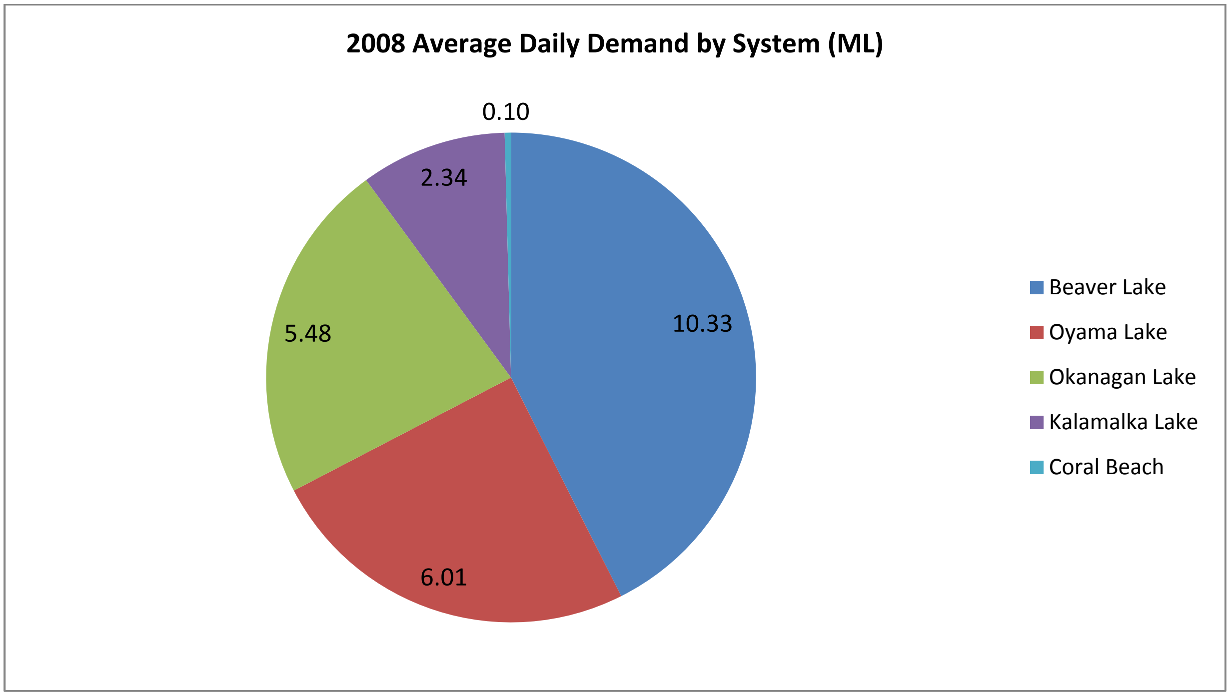


Figure B: Average daily flows in ML by system using 2008 totalizer data.

Appendix C – Current Stage 1,2, and 3 Watering Restrictions

<table>
<tr><th colspan="3">Water Conservation Stages</th></tr>
<tr><td>Stage 1</td><td>Normal Conditions</td><td>Sprinkling is permitted on alternating days according to the following schedule:
Even numbered addresses - even calendar days only
Odd numbered addresses - odd calendar days only
Underground systems with timers - Alternate days only</td></tr>
<tr><td>Stage 2</td><td>Lower than normal reservoirs</td><td>Sprinkling is permitted two (2) days per week according to the following schedule:<table><tr><th>Addresses ending in</th><th>Schedule</th></tr><tr><td>0</td><td>Saturday and Wednesday</td></tr><tr><td>1</td><td>Sunday and Wednesday</td></tr><tr><td>2</td><td>Monday and Saturday</td></tr><tr><td>3 & 4</td><td>Tuesday and Saturday</td></tr><tr><td>5</td><td>Wednesday and Saturday</td></tr><tr><td>6 & 7</td><td>Thursday and Sunday</td></tr><tr><td>8 & 9</td><td>Friday and Sunday</td></tr></table></td></tr>
<tr><td>Stage 3</td><td>Drought Conditions</td><td>Sprinkling is permitted one (1) day per week according to the following schedule:<table><tr><th>Addresses ending in</th><th>Schedule</th></tr><tr><td>0</td><td>Saturday</td></tr><tr><td>1</td><td>Sunday</td></tr><tr><td>2</td><td>Monday</td></tr><tr><td>3 & 4</td><td>Tuesday</td></tr><tr><td>5</td><td>Wednesday</td></tr><tr><td>6 & 7</td><td>Thursday</td></tr><tr><td>8 & 9</td><td>Friday</td></tr></table></td></tr>
</table>

General Restrictions

- Customers who constantly do not abide by the restrictions will be subject to water service turn off and/or fines.
- Automatic underground sprinkler systems must be programmed properly as per water regulations.
  - Set the timer to water between midnight and 6:00 a.m.
  - Remember to turn off your system during rainy periods.
  - Don't set it and forget it.
- Properly operated micro or drip irrigation is allowed anytime.
- Soaker hoses are not eligible.
- Vehicle and boat washing with trigger nozzle is permitted in Stage 1 conditions
- Watering with a watering can or hand watering with a triggered hose is allowed anytime. The nozzle must be actively hand held by an individual.
- New landscaping placed in a year may apply in writing for an exemption

Appendix D – British Columbian Drought Level Classification

Level	Conditions	Significance	Objective	Target
1 (Green)	Normal Conditions	There is sufficient water to meet human and ecosystem needs	Preparedness	Ongoing reductions in community water use
2 (Yellow)	Dry Conditions	First indications of a potential water supply problem	Voluntary conservation	Minimum 10% reduction
3 (Orange)	Very Dry Conditions	Potentially serious ecosystem or socioeconomic impacts are possible	Voluntary conservation and restrictions	Minimum additional 20% reduction
4 (Red)	Extremely Dry Conditions	Water supply insufficient to meet socio-economic and ecosystem needs	Voluntary conservation, restrictions and regulatory response	Maximum reduction
Loss of Supply		Potential loss of a community's potable or fire fighting supply	Emergency response	Ensure health and safety

appendix b

SOURCE WATER SUPPLY AND DEMAND BACKGROUND REPORT (MOULD ENGINEERING)

Source Water Supply & Demand

3

DISTRICT OF LAKE COUNTRY
WATER MASTER PLAN

SECTION 3.0 – SOURCE WATER SUPPLY AND DEMAND

TABLE OF CONTENTS

TABLES

FIGURES

3.0 SOURCE WATER SUPPLY AND DEMAND

In this section of the Water Master Plan, the service area for each water source is identified, the hydrology and storage are discussed, and the irrigation and domestic licenses are compared.

The supply versus demand is also analyzed to provide the water availability for each source. Although some of the distribution systems are interconnected, relatively low water volumes can be moved between source systems. The supply versus demand analysis is therefore based on each source supplying its typical service area.

The major water systems WOCWS, OWS, and WLWS were renamed to reflect the new vision for DLC. These water systems are now referred to as the following:

- Beaver Lake Water Source
- Okanagan Lake Water Source
- Kalamalka Lake Water Source
- Oyama Lake Water Source

Other DLC owned and operated public systems with separate source water supply and demand characteristics are mentioned but not analyzed in this report. These public systems include:

- Coral Beach
- Lakepine

These systems are quite small and should be analyzed individually as the design parameters, ability to support growth, and water quality improvement technologies, can differ substantially from the large systems.

The following private water systems and utilities within DLC are also mentioned but not evaluated:

- Alto Utility
- Eastside Utility
- Moberly Users Group
- Kal Pine
- Private Water Systems

The four major water sources provide in excess of 10 billion litres of water annually. Agriculture uses over 80 % of the water annually. Water use has steadily declined since 1995 due to water conservation measures, changes in agricultural irrigation methods and restrictions to residential lawn and garden watering.

Table 3.1 below shows the history and progress of the water supply for the community of the District of Lake Country. Over the last 100 years, the water supply has progressed from an insufficient supply during drought years with no water quality standards, to a reliable source water throughout the year with strict water quality guidelines.

Table 3.1 – District of Lake Country Water Supply History

Year	Details
Over 100 years ago	Community water services began in Lake Country. Before that, residents directly extracted water from streams, lakes, or the ground (via a hand pump). Some irrigation was available by using ditches to irrigate crops.
1907 - WW1	Irrigation systems were constructed to supply water to new farm lots. Diversions, dams, ditches, pipelines, and flume systems were built to supply the newly developed farming properties. The WOCWS was operated by Okanagan Centre Irrigation and Power Company, and OWS was operated by Wood Lake Water Company & Long Lake Irrigation Company.
WW1 - 1930	The new water systems experienced fast growth, but had difficulties meeting demands associated with the growing irrigated acreages. Dams, diversions and other components were upgraded. After 20 years, the infrastructure needed to be replaced, which facilitated the establishment of Oyama Irrigation District.
1930 - WW2	There were extreme drought years in the early 1930's causing irrigation water shortages. Many dam cribbing structures were rotting, flumes and wood pipes were leaking causing an insufficient supply of water. Major upgrading and replacement projects were performed to renew the infrastructure. To guarantee the supply of water, the Oyama Irrigation District abandoned the gravity supplied water and replaced it with pump station installations on Kalamalka and Wood Lake.
WW2 - 1960's	Until the 1960's, the irrigation systems operated efficiently with the system rebuilding and continuous upgrading. In 1948, the Okanagan Centre Irrigation and Power Company became the Winfield and Okanagan Centre Irrigation District. In 1964, the Wood Lake Water Company became the Wood Lake Improvement District.
1966 - 1972	All water systems were rebuilt or newly constructed. The systems installed in the 1930's needed to be replaced. Roger's Pass opened, resulting in an economic boom, creating a need for residential water servicing. The irrigation water systems started in May annually and were closed down before heavy frosts. Over the winter, domestic water was supplied by a well or a cistern, which was filled at the end of September.
1973 - 1995	The water system operated year-round for irrigation and domestic purposes. Water quality issues were a concern.
1995 - Today	Major emphasis has been put on upgrading and improving the quality of water. The Beaver Lake/Vernon Creek system and the Okanagan Lake system were upgraded and the Kalamalka Lake system was installed. The hydroelectric generating station was constructed, after 100 years of initially being envisioned.
Future	The domestic and irrigation water supply systems need to be renewed and improved. The District plans to ensure water supply for farmers and residents for the future.

Figure 3.1 shows the current water source distribution areas in the District of Lake Country.

Figure 3.1 – Current Water Source and Distribution Areas

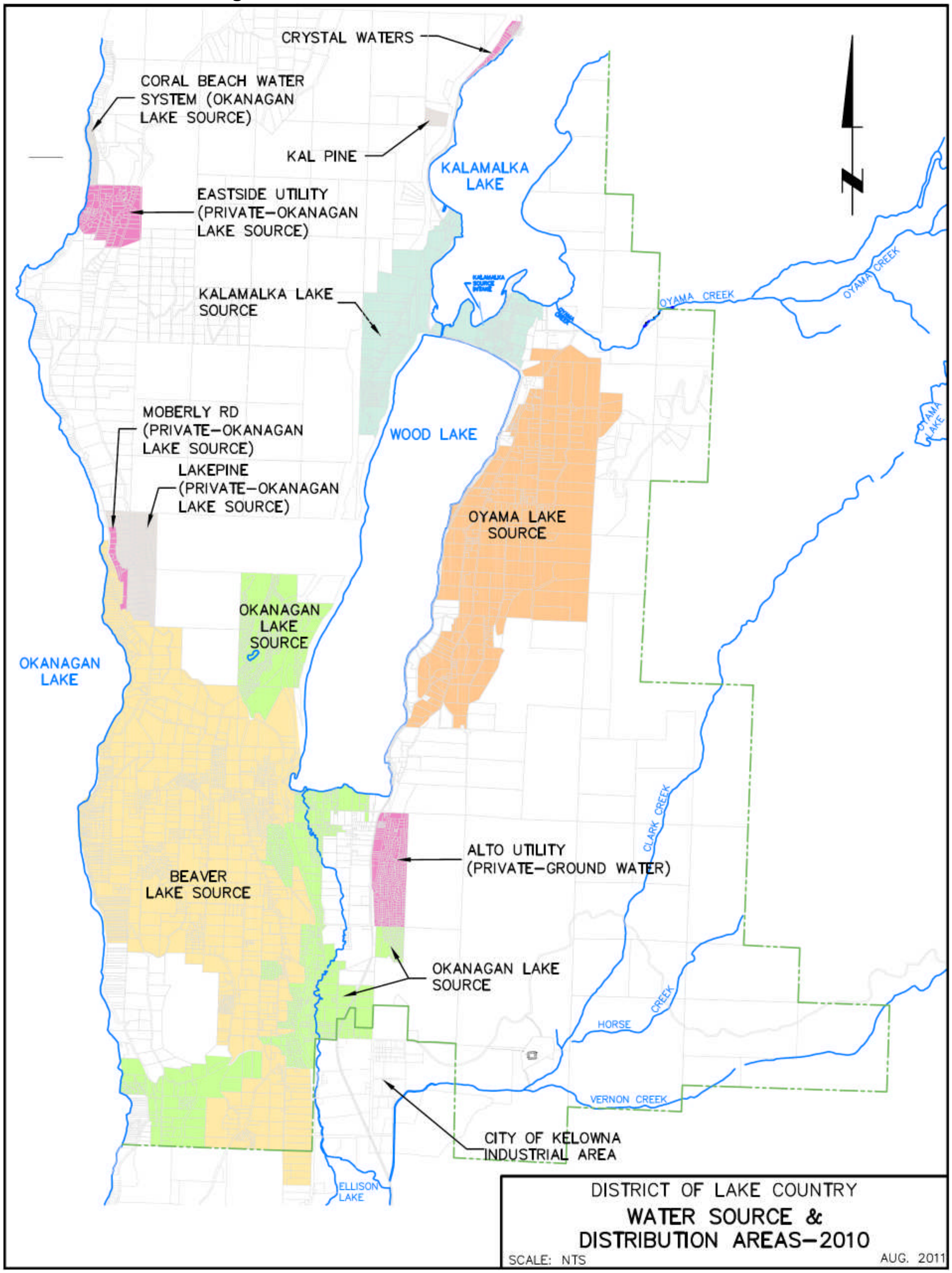


Figure 3.2 – District of Lake Country ALR Zones

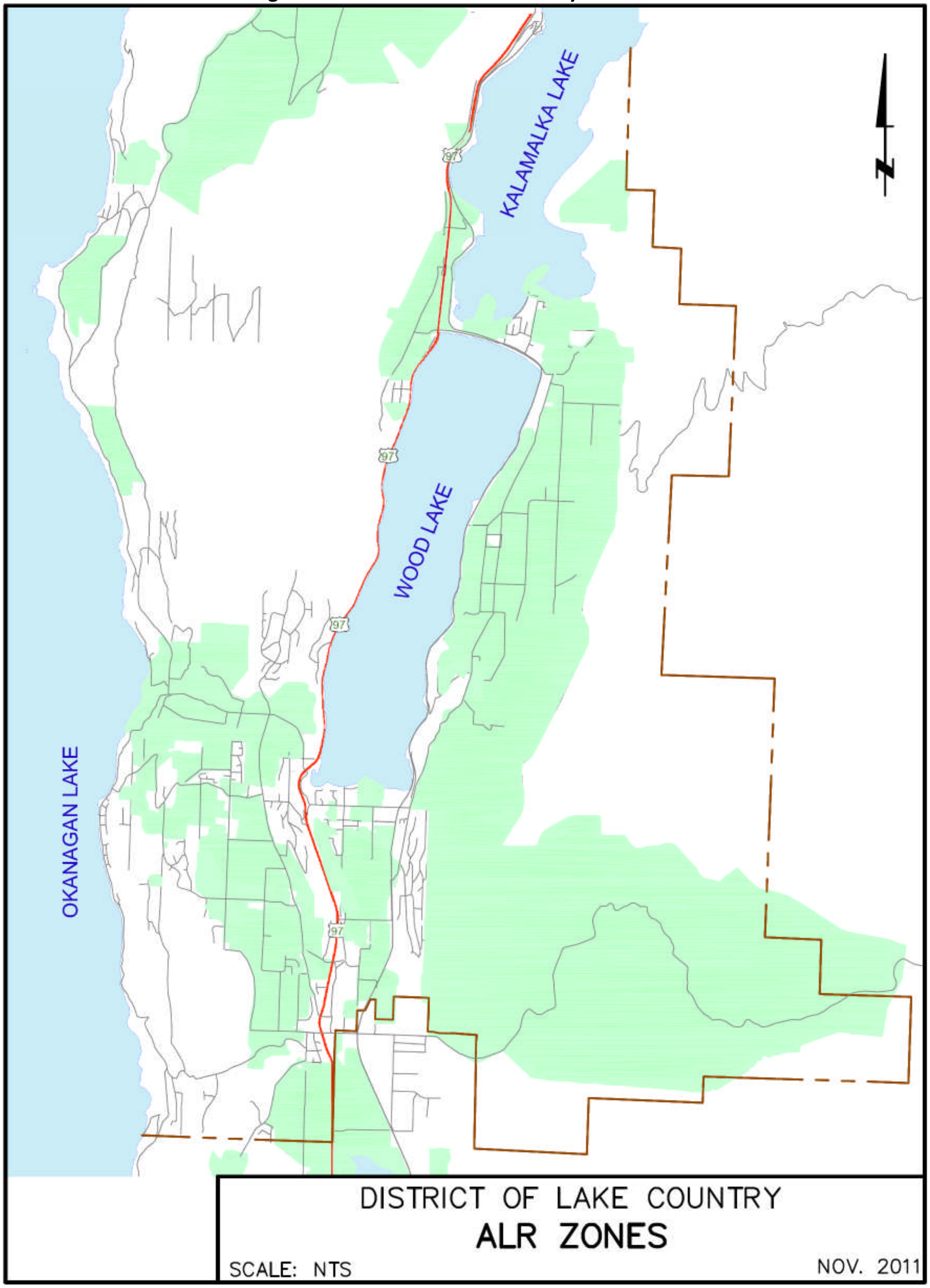


Figure 3.2 shows the ALR (Agricultural Land Reserve) zones within the District of Lake Country. In these zones, agriculture is recognized as the priority use and farming is encouraged in these regions.

3.1 BEAVER LAKE WATER SOURCE

The Beaver (Swalwell) Lake has the highest hydraulic grade line and the largest service area. Beaver Lake has been a reliable water source for over a century. The upland snowpack from the watershed fills the storage reservoirs, where water is released when needed in the valley bottom.

3.1.1 SERVICE AREA

The service area of Beaver Lake Water Source includes: approximately 1,400 residential connections, 200 multi-family and strata units, 30 commercial and industrial connections, and 870 hectares of irrigated land. The majority of the service area is within the Agricultural Land Reserve (ALR). Refer to Figure 3.2 for the ALR boundary.

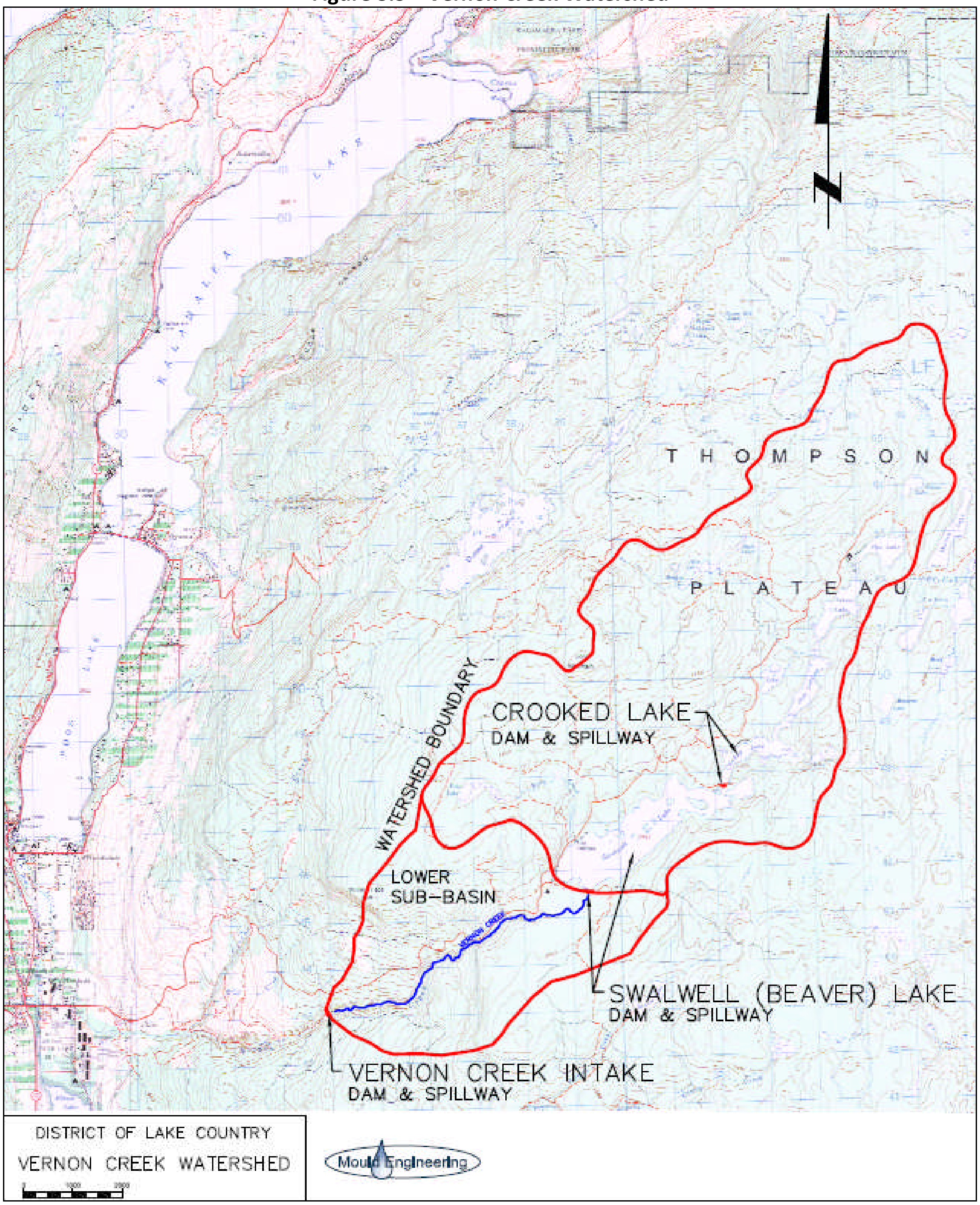
The service area is generally located within the southern portion of the District of Lake Country. It is bound by the City of Kelowna to the South, and elevated lands to the East. Wood Lake bounds a portion of the service area to the north. The service area is also interconnected with Okanagan Lake Water Source at several locations. The location of the Beaver Lake Water Source within the District is shown in Figure 3.1.

The terrain over which water is supplied is relatively sloped, resulting in numerous pressure reducing stations within the system. With this, the water can be supplied to the most elevated lands as well as the low-lying areas. The service area is mostly rural, with large property sizes (typically between 1 ha to 4 ha) and numerous pockets of residential.

3.1.2 VERNON CREEK WATERSHED

Figure 3.3 shows the Vernon Creek Watershed to the east of the District of Lake Country.

Figure 3.3 – Vernon Creek Watershed



The watershed above the District's Vernon Creek intake has a surface area of 63 km² and is susceptible to numerous conditions including drought. Fishing and lodging as well as several lease lots are located around the lakes. The watershed includes Beaver and Crooked Lakes, which are both dammed storage reservoirs that rely on snowmelt to fill. Refer to section 5.0 of the Water Master Plan for the summary of the *Oyama and Vernon Creek Source Water Assessment* completed by Ecoscape Environmental Consultants.

The watershed elevations range from a maximum of 1,450 m, to 1,340 m at Beaver (Swalwell) Lake, to 820 m at the District's diversion pond on Vernon Creek. Beaver Lake is located at the headwaters of Vernon Creek, south of the Crooked Lake dam and spillway.

Water from Beaver Lake reservoir is released into Vernon Creek and then flows into the Vernon Creek diversion pond and intake screening structure 6 km downstream. The water flows through the Vernon Creek Intake and continues down Vernon Creek through the District and City of Kelowna. The water converges with Ellison (Duck) Lake, and flows into the creek known as Middle Vernon Creek. Middle Vernon Creek flows north through a portion of First Nations land to Wood Lake and Kalamalka Lake.

3.1.2.1 HYDROLOGY

In 1977, the BC Ministry of Environment conducted a detailed hydrology study. The study concluded that "the results indicate that a total annual demand of 9,868 ML could be supplied in 49 out of 50 years on the average". The report further stated that "Because of the difficulty in making efficient use of inflows to the lower sub-basin, the annual demand would best be supplied from the reservoirs only, with sub-basin inflow considered as a safety factor to offset wastage due to delays in adjusting the reservoir outflow in response to changing demand." A report entitled *Winfield and Okanagan Centre Irrigation District Water Supply Study* from 1977 indicates that Crooked and Swalwell Lakes have an average annual runoff of 13,150 ML and a 1:33 year low runoff year had a volume of 6,350 ML, which was recorded in 1970.

The landowners and operations staff of Lake Country expressed concern about the accuracy of the estimates above because the data was from the '60s and '70s and the amount of runoff from the watershed today may differ and occur at a different time period than 40 years ago. The low water level in Swalwell (Beaver) Lake at the end of the summer of 2003 was noted to be particularly concerning. Members of the Oceola Fish and Game Club also expressed concern that flows in Middle Vernon Creek, between Duck and Wood Lakes, were too low in 2003 for the Kokanee to successfully spawn. The Ministry uses snow pillows as a rough planning tool to forecast runoff. However, the actual flow data, such as the spill and release information, is needed over numerous years to update the hydrology estimates.

Beaver Lake impounds 11,880 ML (9,629 ac-ft) of water. In addition, Crooked Lake plus a chain of lakes including Deer, Island, and Dee Lakes, contains 2,939 ML (2,383 ac-ft) of storage. Watershed runoff is stored in the lakes during spring and fall months and released during the summer. While the releases are closely controlled for water conservation, the District ensures that the fish flow requirements and the water system demands are met after flowing through the hydrogenation facility.

Runoff from the lower sub-basin cannot be stored, and although the water quality is often poor, it can be used to generate power and meet some water use requirements. When the runoff cannot meet the flow requirements, discharge from the upland reservoirs is required and there are significant time delays between the storage release stage and downstream diversion works phase. The Eldorado Reservoir provides balancing in the system and, therefore, peak hour flows do not have to be released from the upstream storage. This allows for less manual reservoir adjustments and allows the District to retain more storage upstream.

3.1.2.2 FISH FLOWS

There are no guarantees of minimum creek flows downstream because some are lost to ground water. The combined losses to groundwater from Upper Vernon Creek and Duck Lake are approximately 4,400 ML per year. In order to accommodate for the spawning of Kokanee in Middle Vernon Creek, releases from Swalwell and Crooked Lakes need to be significantly more than the water availability for a dry year.

The annual 25th percentile for a dry year flows from the lower basin. The percentage of average flows is small, and during runoff period, it is likely that Beaver or Crooked will fill. Therefore, a release of storage is required. Refer to Table 3.2 for the annual releases from Beaver Lake to meet the annual fish flow requirements. The fish flow requirements only pertain to the area between Vernon Creek diversion works and Clark Creek confluence.

A total of 1,750 ML needs to be released annually to meet new fish flow requirements below the Vernon Creek intake as a result of the hydrogenation facility. This value has increased by almost 20 % from the annual Vernon Creek fish flow requirement used in the Winfield Okanagan Center Water System Assessment and Response Plan, April 2004.

A storage amount of 18,511 ML is available to meet the fish flow annual requirements of 1750 ML. The storage license for Vernon Creek, C021807, has a priority date from 1952. This license is combined with the storage licenses from Beaver Lake, which have priority dates as early as 1907. Refer to the Annex for details.

Table 3.2 – Releases from Swalwell (Beaver) Lake to meet Annual Fish Flows

Releases from Beaver Lake to Meet Annual Fish Flows								
Months	Outlet Monthly Mean Discharge (1969-1995)			Hydrology & Power Study for Sub-basin 1b (1969-1995)		Dry Year Specifications (2011)	Current Releases	
	A: Dry 25th Percentile of Average Year (m³/s)	B: Average of 26 years (m³/s)	C: % Yield from Sub-Basin (Avg Dry/Avg)	D: Sub-basin 1b mean monthly flow between Beaver outlet & Vernon Creek Intake Pond (m³/s)	E: 25th Percentile of Sub-basin 1b (m³/s)	F: Minimum Fish Flow below Vernon Creek Intake (m³/s)	F-E (m³/s)	Monthly Releases (ML)
January	0.073	0.117	63%	0.012	0.008	0.06	0.052	139
February	0.073	0.158	46%	0.013	0.006	0.06	0.054	140
March	0.066	0.219	30%	0.024	0.007	0.06	0.053	142
April	0.115	0.369	31%	0.188	0.058	0.06	0.002	5
May	0.277	1.348	21%	0.473	0.099	0.2	0.101	271
June	0.518	1.008	51%	0.313	0.160	0.2	0.040	104
July	0.620	0.772	80%	0.085	0.068	0.2	0.132	354
August	0.694	0.720	96%	0.024	0.023	0.06	0.037	99
September	0.265	0.373	71%	0.025	0.018	0.06	0.042	109
October	0.068	0.126	54%	0.024	0.013	0.06	0.047	126
November	0.054	0.104	52%	0.025	0.013	0.06	0.047	122
December	0.060	0.107	56%	0.012	0.007	0.06	0.053	142
Annual Release in a 25th percentile (dry) year to meet Fish Flows (rounded)								**1750**

A & B	Refer to Table 3.16 in the Annex
D	Reference: "Figure 2 - Vernon Creek Intake Pond - Mean Monthly Inflow (1969-1995), Lake Country Hydroelectric Generation Power Study, February 2006, Prepared by Sigma Engineering"
F	The information for "F" was obtained from the Eldorado Reservoir Hydroelectric Project Conditional License: 121792, Section A of the Water Act, which specifies these minimum flows in Vernon Creek, during a dry year, immediately below the intake structure. A dry year is when the combined flows for May and June for Clark Creek are below the 25th percentile of the historic combined monthly Clark Creek May and June flows based on the yearly updated recorded data.

3.1.3 WATER LICENSES

Refer to Table 3.3 below for the authorized water diversions on Vernon Creek. The District also has storage licenses on Crooked Lake and Beaver Lake. The priority date on Vernon Creek dates back to 1891 and storage dates back to 1952. Refer to the Annex for details.

Table 3.3 – Vernon Creek Licensing

Authorized Water Diversion		
Purpose	Imp. Units (ac-ft)	Metric Units (ML)
Irrigation	6,048	7,459
Waterworks (Domestic)	976	1,204
Total	**7,024**	**8,663**

During low runoff years, the yield from this watershed is lower than the total licensed amount therefore storage reservoirs were built to meet the annual water demand. As a result, this watershed is considered fully recorded and no additional licenses are available.

3.1.4 ANNUAL WATER DEMAND

Beaver Lake Water Source

Water demand for the Beaver Lake source equates to approximately 93 % irrigation water use and 7 % domestic water use. This is ideal as it is supplied by gravity, which is the most economical source method.

During a high-use year, the annual water requirements for the current commitments are estimated to be 6,488 ML for Vernon Creek.

This could be considered a theoretical value as it assumes that all residences and agricultural users are utilizing their full annual allotment. It does not include an allowance for water that may from time to time be pressure reduced into the Okanagan Lake Water Source. The water licenses at 8,663 ML are adequate to meet the theoretical water requirements. The breakdown for water usage is shown in Table 3.4 below.

Table 3.4 – Vernon Creek Annual Water Requirements

Annual Water Requirements		
Usage	**Imperial (ac-ft)**	**Metric (ML)**
Irrigated Grade "A" Land, 870 ha @ 6.9 ML/ha	4,867	6,003
Rural Residential (with Grade "A" Land), 750 conn @ 0.17 ML/conn	103	128
Rural Residential (without Grade “A” Land), 10 conn @ 1.5 ML/conn	12	15
Urban Large Residential, 120 conn @ 0.75 ML/conn	73	90
Single Family Residential, 520 conn @ 0.4 ML/conn	169	208
Multi-family & Stratas, 200 units @ 0.17 ML/unit	28	34
Commercial, Industrial & Institutional, 30 conn @ 0.34 ML/conn	8	10
Total Theoretical Annual Use	***5,260***	***6,488***

Notes:

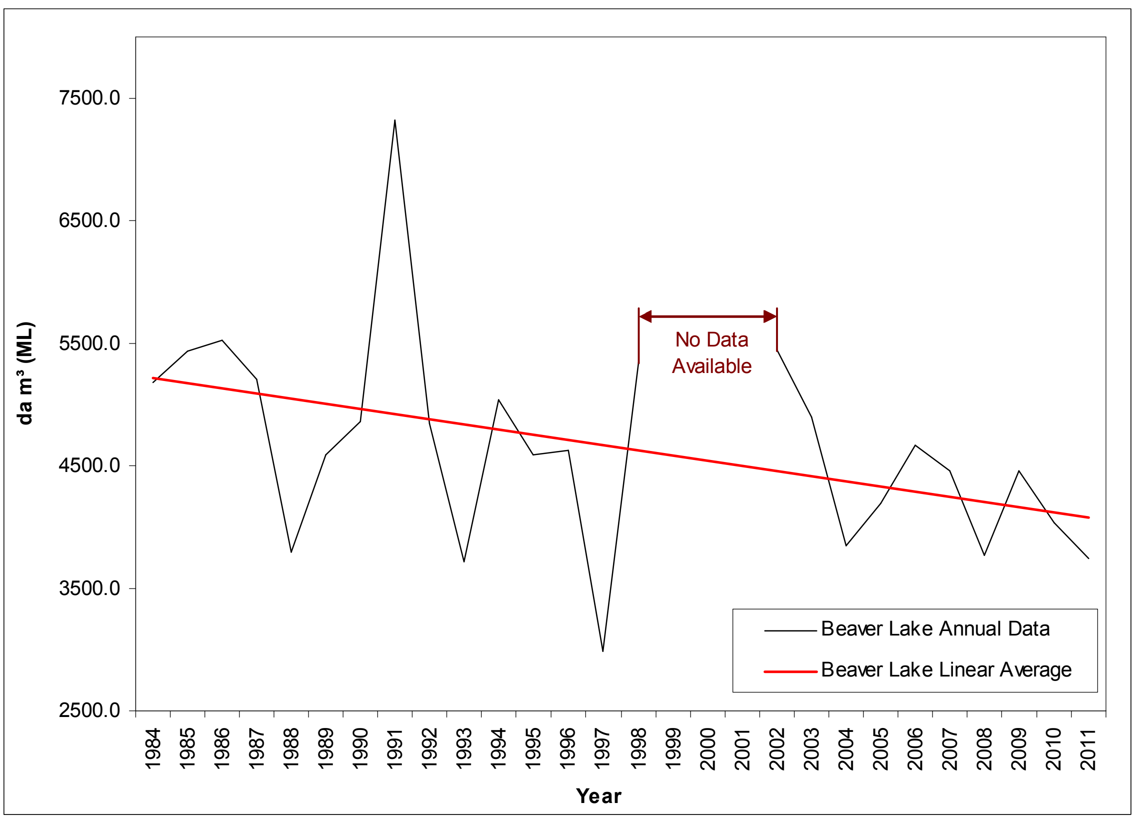
1. The estimated annual irrigation requirements are based on the Irrigation Design Manual prepared by the British Columbia Ministry of Agriculture.
2. The Grade “A” land serviced area includes the irrigated areas within the Rural Residential, Multi-family & Strata, and Commercial, Industrial & Institutional developments.
3. Water use on Urban Large Residential lots (0.12 – 0.25 ha in size) includes irrigation of lawns and gardens.
4. Rural Residential lots are between 0.25 – 0.4 ha in size, and Single Family Residential lots are smaller than 0.12 ha in size.

Figure 3.4 graphically shows the water usage for the Beaver Lake Source Area from 1984 to 2010. The graph shows a linear average trend decreasing at approximately 42 ML/year. The graph also shows a reduction in water use fluctuations over the last 10 years. The decreasing trend and fluctuation reductions can be attributed to numerous items including:

- Improved irrigation practices;
- More water being pumped into the Beaver Lake Water Source from the Okanagan Lake Water Source;
- Some prominently domestic areas being transferred to the Okanagan Lake Source; and
- Greater conservation messages and practices followed the drought years, particularly since 2002 and 2003.

The theoretical annual requirement of 6,488 ML was compared to water use in 2002 and 1998, both known as hot, drought condition years. Figure 3.4 confirms that 2002 had one of the highest recorded water usages in the last 10 years. The theoretical annual water requirement is 19 % higher than the water usage value in 2002. The comparison shows the theoretical annual water requirement is conservative but not unreasonable considering there are users that have purchased water rights but are not currently utilizing their entitlement.

Figure 3.4 – Beaver Lake Annual Water Use



3.1.5 ANNUAL WATER AVAILABILITY

Using runoff estimates from the 1977 report, the new fish flow requirements and peak annual water demand requirements, an estimate of water availability from Vernon Creek was made. Refer to Table 3.5 below.

The table shows the water availability for Vernon Creek after fish flows and operational waste due to delays from reservoir releases are accounted for. The positive surplus indicates that the theoretical annual usage does not exceed the yield and that there is still 1,013 ML available to be used.

Table 3.5 – Vernon Creek Water Availability

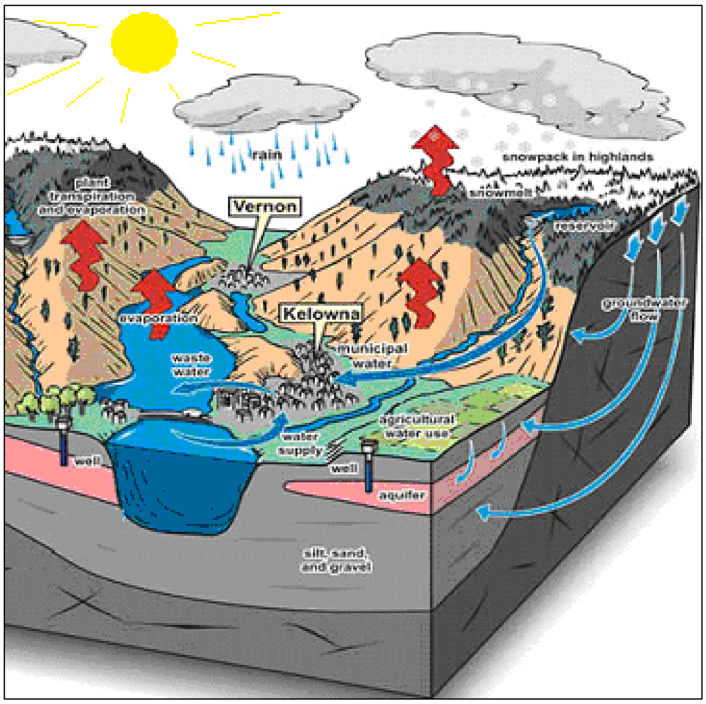
Annual Water Availability		
Breakdown	**Imperial (ac-ft)**	**Metric (ML)**
Watershed Yield, 49 years in 50	8,000	9,868
Fish Flows	1,420	1,750
Estimated Operational Waste	500	617
Theoretical Water Use (Year 2011)	5,260	6,488
Surplus	***820***	***1,013***

Until the 1977 hydrology study has been updated using the current data, no allocation should be made to new users of the Vernon Creek Watershed. The “Estimated Operational Waste” value needs to be updated based on current water and hydrogenation system configurations in conjunction with operating practices.

3.2 OKANAGAN LAKE WATER SOURCE

Okanagan Lake became a water source for the District when infrastructure was purchased from Hiram-Walker Distilleries in 1994. The Okanagan Lake Water Source is interconnected with the Beaver Lake Water Source at several locations. It has been considered a secondary supply to the Beaver Lake Water Source due to the high cost of pumping water to the service area. With recent pump station improvements and the need to supply new growth areas, Okanagan Lake has become a major source of good quality drinking water for the urban areas of the District.

Okanagan Basin Water Cycle



The cross section shows the water cycle illustrating how water is stored and transported within the Okanagan basin region. The water cycle consists of the following processes:

- Precipitation
- Canopy Interception
- Snowmelt
- Runoff
- Infiltration
- Subsurface Flow
- Evaporation
- Sublimation
- Advection
- Condensation
- Transpiration

3.2.1 SERVICE AREA

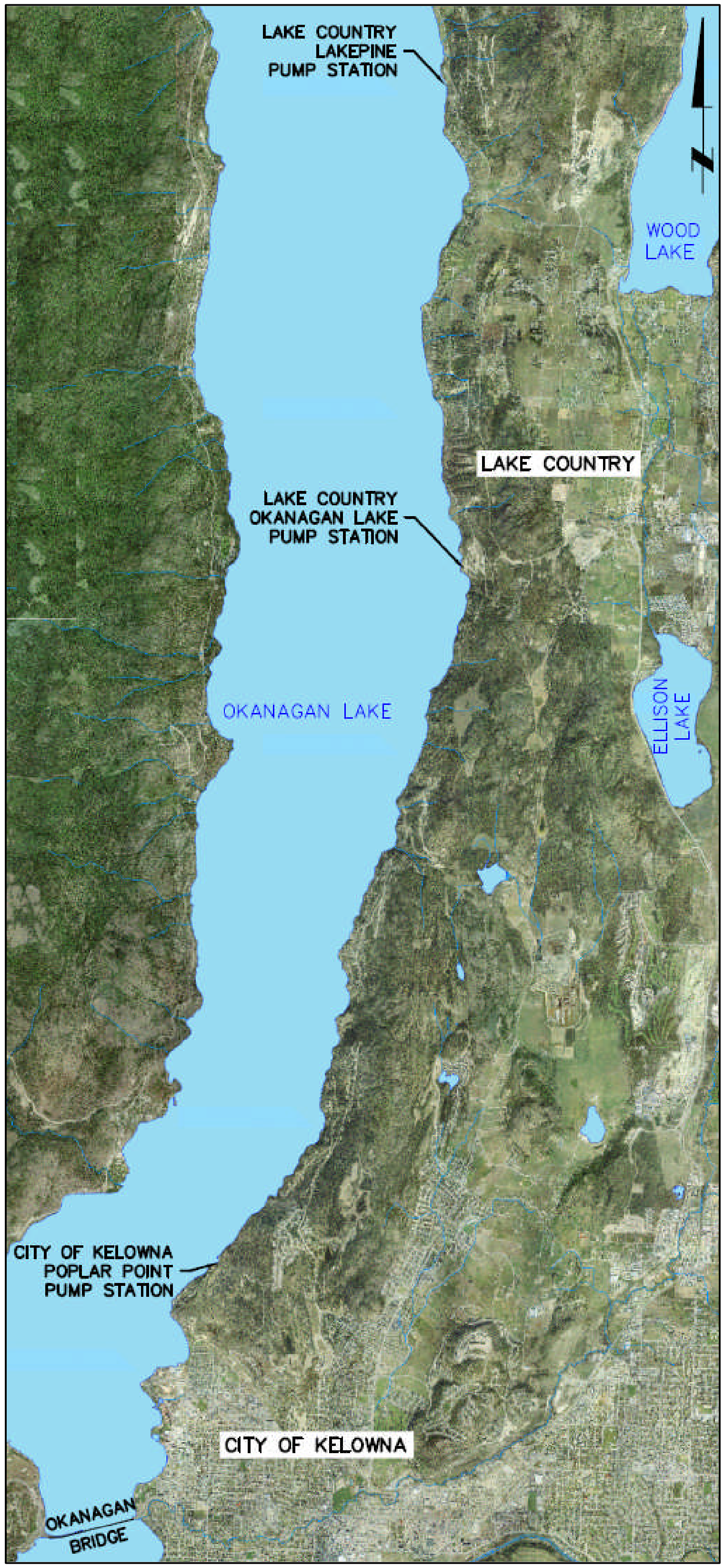
The service area of Okanagan Lake Water Source, as shown in Figure 3.1, is typically Single Family Residential (parcels under 0.12 ha) and includes the following:

- Stubbs & McCourbrey Roads;
- Town Centre;
- Copperhill subdivision;
- City of Kelowna Industrial Park;
- Janet, Mountview, & Harwood Roads;
- Kel-Vern and Winview Roads;
- Roberts, Eva Roads, and a portion of Pretty Road; and
- The Lakes Development & Ponderosa Area (through a booster pump station at Jardines Road)

In 2008, the principle infrastructure along Okanagan Centre Rd East, including a watermain and booster pump station, was installed to supply Okanagan Lake water to The Lakes development.

The Okanagan Lake Source serves to approximately 1,080 domestic connections, 60 commercial and industrial connections, 750 multi-family and strata units, 114 industrial area connections, and 60 ha of irrigated land.

Okanagan Lake Watershed



3.2.2 OKANAGAN LAKE WATERSHED

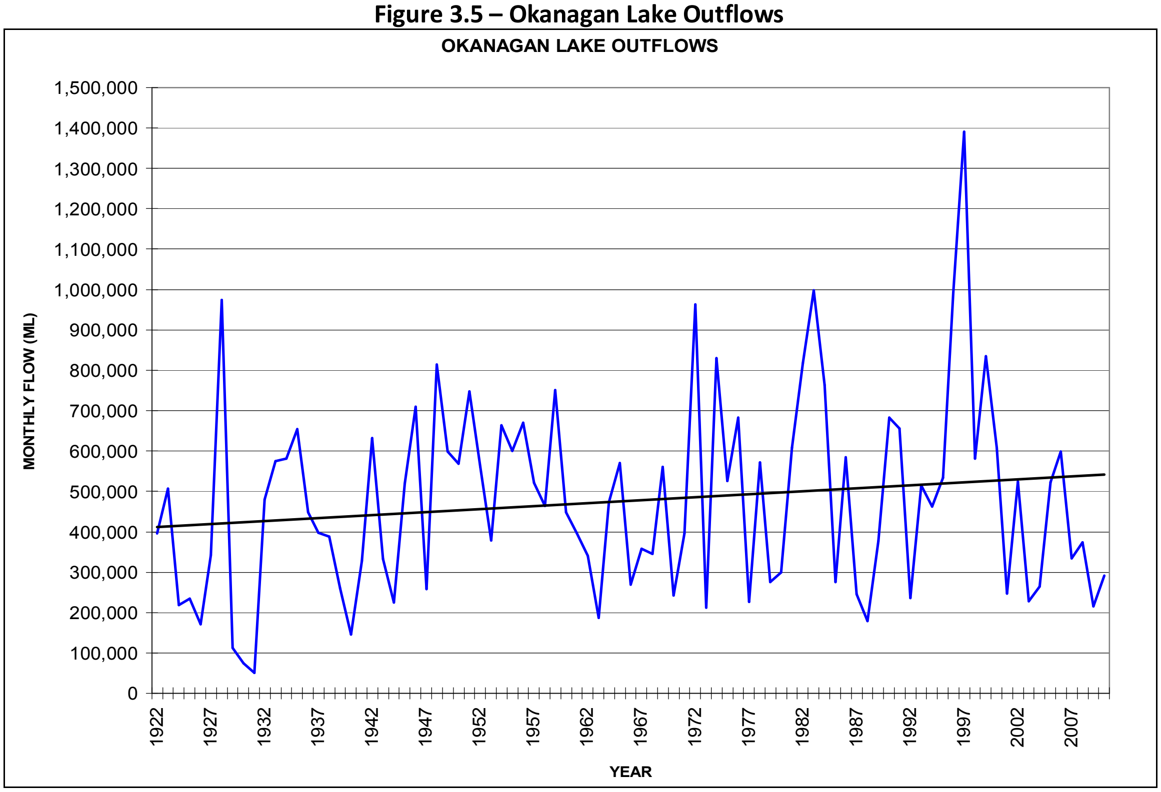
Okanagan Lake is located in South Central BC and is the largest of the main interconnecting lakes within the Okanagan Valley. The Okanagan watershed is approximately 200 km long with an area of over 8000 km^2. The Okanagan basin is regarded as one of the most arid watersheds in Canada.

Okanagan Lake is the source of water for many communities in the Okanagan Valley. The quality of the water, especially when drawn from beneath the thermocline zone, is superior to any water in the valley. The lake is the most studied in BC and is the centre of continuing discussions by residents, scholars, governments and municipalities. The *Okanagan Water Basin Board* was created to gather all the information pertaining to the lake and its tributaries to plan accordingly for the future.

3.2.2.1 HYDROLOGY

From the outflow graph in Figure 3.5 below, it is evident that 1930 & 1931 remain to be the most severe drought years in the Valley. In the last 10 years, there has also been severe drought in 2001, 2003, 2004 and 2009. Although the largest officially recorded flood year occurred in 1997, floods in the earlier 1900's are the reason the lake is now controlled by a dam outlet gate structure. The annual flow trend line from 1922 to 2010 suggests that outflow is slowly increasing at a rate of approximately 1500 ML per year. However, the trend for the last 40 years, independent from the readings from the earlier years, suggests that the outflow is marginally decreasing.

Figure 3.5 – Okanagan Lake Outflows



The Lake level is controlled at Penticton, where the elevation typically ranges between 341.2 m and 342.5 m (considered full pool).

Okanagan Lake has a residence time of over 53 years, compared to a residence time for Kalamalka Lake ranging between 55 and 65 years. Okanagan Lake Water Source is interconnected to the Beaver Lake Water Source at a few locations.

Due to evatranspiration and evaporation, only 12 % of precipitation reaches the lake and 2 % of the water flows from the lake. During an average year, the input causes the lake level to rise by 2.5 m and the volume to increase by only 3.3 % because the lake surface evaporation removes about 1 m of water per year.

3.2.3 WATER LICENSES

Okanagan Lake is not fully recorded. Table 3.6 shows that the District's authorized diversion from Okanagan Lake Pump Station is 10,997 ML per year. This represents the total of 3 licenses for this facility, the priority dating back to 1969. The license total does not include license number Z121654 because the license has not yet been adjudicated even though the application has been cleared. Refer to the Annex for details.

Table 3.6 – Okanagan Lake Licensing

Authorized Water Diversion		
Purpose	**Imp. Units (ac-ft)**	**Metric Units (ML)**
Irrigation	0	0
Waterworks (Domestic)	8,917	10,997
Total	***8,917***	***10,997***

3.2.4 ANNUAL WATER DEMAND

Table 3.7 shows the breakdown of the annual water requirements for Okanagan Lake. The water demand for Okanagan Lake has a 25-75 % split between irrigation and domestic. The table shows that the total theoretical annual requirement is 1,645 ML.

Table 3.7 – Okanagan Lake Annual Water Requirements

Annual Water Requirements		
Usage	**Imperial (ac-ft)**	**Metric (ML)**
Irrigated Grade "A" Land, 60 ha @ 6.9 ML/ha	336	414
Rural Residential (with Grade "A" Land), 35 conn @ 0.17 ML/conn	5	6
Rural Residential (without Grade "A" Land), 45 conn @ 1.5 ML/conn	55	68
Urban Large Residential, 200 conn @ 0.75 ML/conn	122	150
Single Family Residential, 748 conn @ 0.4 ML/conn	243	299
Bareland Strata, Single Family, 52 conn @ 0.17 ML/conn	7	9
Multi-family & Stratas, 750 units @ 0.17 ML/unit	103	128
Commercial, Industrial & Institutional, 60 conn @ 0.34 ML/conn	17	20
City of Kelowna Industrial Area, 80 ha @ 6.9 ML/conn	448	552
Total Theoretical Annual Use	***1,334***	***1,645***

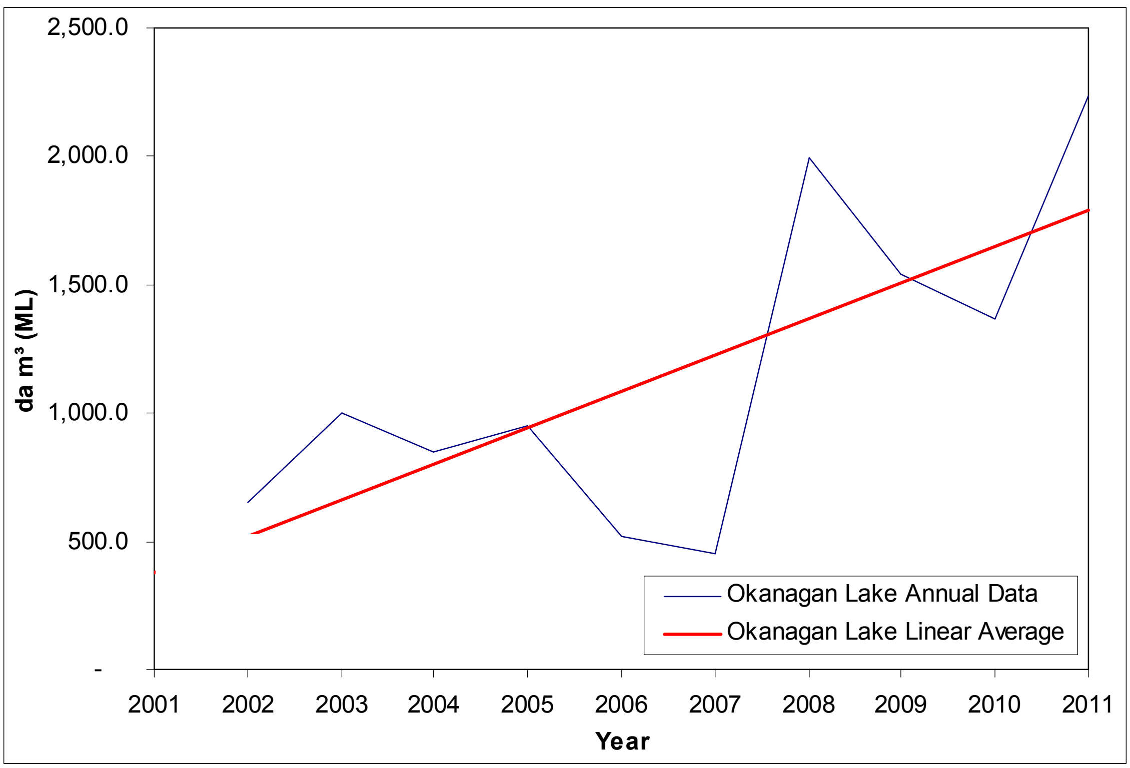
The total estimated annual use is theoretical as it is based on the assumption that all residential and agricultural users are using their entire annual allotment.

Notes:

1. The estimated annual irrigation requirements are based on the Irrigation Design Manual prepared by the British Columbia Ministry of Agriculture.
2. The Grade "A" land serviced area includes the irrigated areas within the Rural Residential, Multi-family & Strata, and Commercial, Industrial & Institutional developments.
3. Water use on Urban Large Residential lots (0.12 – 0.25 ha in size) includes irrigation of lawns and gardens.
4. Rural Residential lots are between 0.25 – 0.4 ha in size, and Single Family Residential lots are smaller than 0.12 ha in size.

Figure 3.6 below graphically shows the annual water usage for the Okanagan Lake Source Area since 2002. The graph shows a linear trend increasing at approximately 142 ML/year.

Figure 3.6 – Okanagan Lake Annual Water Use



The theoretical annual requirement of 1,645 ML was compared to the water use in 2008 and 2011, where the highest water usages occurred. Figure 3.6 shows that the water usage was 1,998 ML in 2008 and 2,235 ML in 2011, both higher than the total theoretical annual water usage. However, the water transferred through the interconnections is not taken into account for the theoretical annual water use.

The annual water usage is increasing as a result of more water being pumped from Okanagan Lake Water Source into the Beaver Lake Water Source. The growth impact also has a contribution to the increased water demand, subsequently resulting in an increased water use trend.

3.2.5 ANNUAL WATER AVAILABILITY

Table 3.8 shows the water availability for Okanagan Lake. There are no competing water uses, such as minimum fish flows, for this source. The surplus shows that the theoretical usage does not exceed the licensed volume and that there is still 9,352 ML available. The future water availability is calculated in the Growth Impact section of the Water Master Plan.

Table 3.8 – Okanagan Lake Water Availability

Annual Water Availability		
Breakdown	**Imperial (ac-ft)**	**Metric (ML)**
Water License	8,915	10,997
Estimated Operational Waste	0	0
Theoretical Water Use (Year 2011)	1,334	1,645
Surplus	***7,581***	***9,352***

3.3 KALAMALKA LAKE WATER SOURCE

The Kalamalka Lake Water Source was previously owned and operated by the Oyama Irrigation District (OID). Ground water was the only source of supply until the Ministry of Environment granted the District a water reserve on Kalamalka Lake and partial funding for a major rehabilitation program in 1996. Kalamalka Lake is considered a good source of water based on both quality and reliability of quantity.

The system is presently interconnected and can receive water from the Oyama Lake Water Source through a pressure reducing interconnection chamber on Oyama Road. However, this is about to change with the water quality and supply improvements scheduled to be completed by 2013. As part of an approved Building Canada Infrastructure program, water system components will be installed to allow the Kalamalka Lake water to be pumped into the Oyama Lake Source.

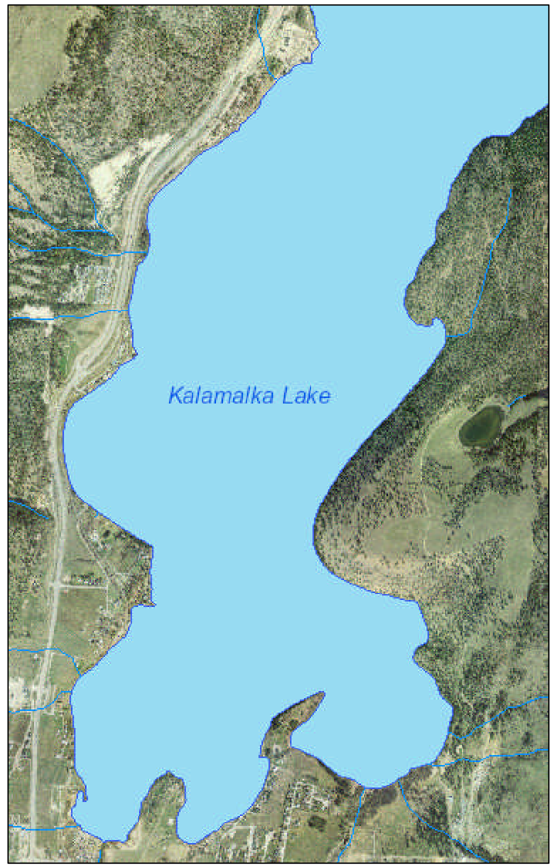
3.3.1 SERVICE AREA

South End of Kalamalka Lake

The service area of Kalamalka Lake Water Source includes: 127 hectares of irrigated land, 290 domestic services, 22 multi-family and strata units, and 25 commercial and industrial connections. The land within the Kalamalka Lake Water Source is largely within the Agricultural Land Reserve. Refer to Figure 3.2 for the ALR boundary.

3.3.2 Kalamalka Lake Watershed

Kalamalka Lake Watershed



Kalamalka Lake is located east of Okanagan Lake, as shown in Figure 3.1, and has a surface elevation of 391 m, which is 49 m higher than Okanagan Lake. Kalamalka Lake has a watershed area of 572 km² and a lake length of over 12 km.

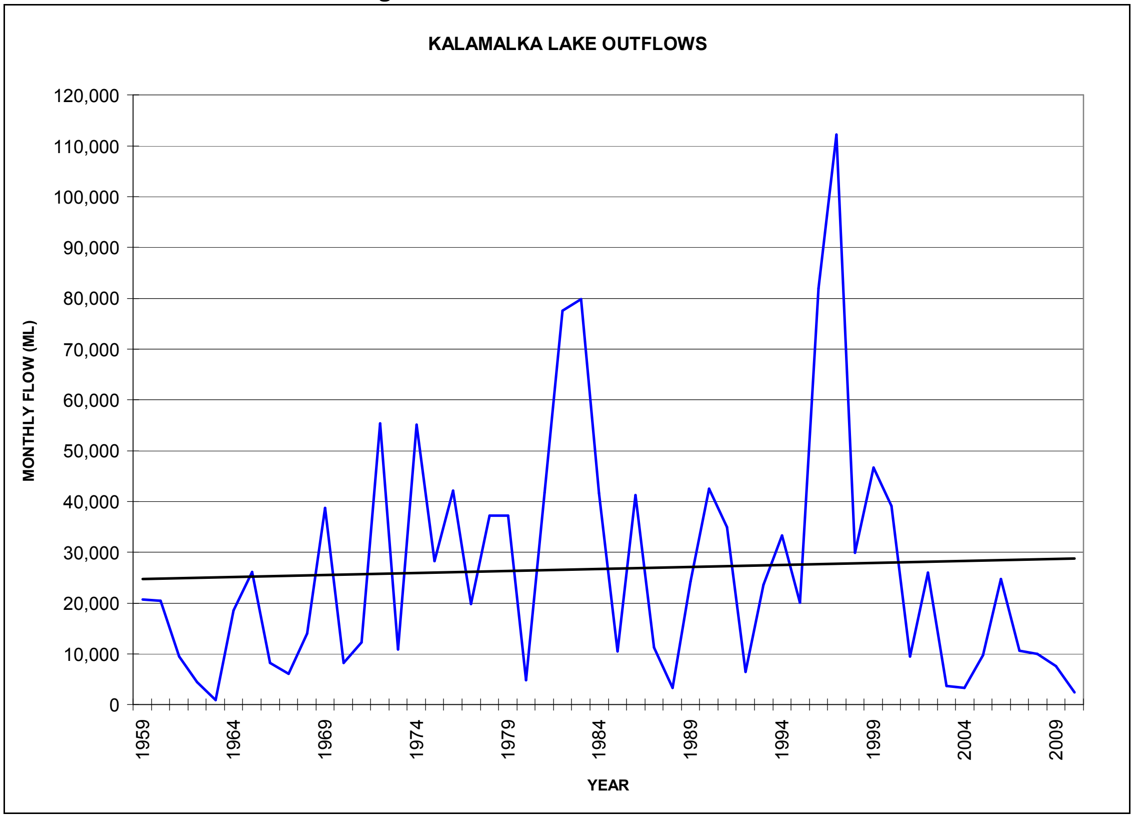
DLC in conjunction with the City of Vernon, who have an intake at the north end of the lake, have been the lead parties in studying Kalamalka Lake for approximately 15 years. Ongoing water sampling occurs and several studies have been completed.

3.3.2.1 Hydrology

The Kalamalka Lake outflow graph, in Figure 3.7, shows that 1963 was the most severe drought year in over 50 years, with an outflow level of 883 ML. The outflow in 2010 was also uncharacteristically low with a level of 2428 ML.

The graph also shows that the largest officially recorded flood year occurred in 1997, which is the same flood time period as that of Okanagan Lake. Although the most recent outflow levels have been low, the trend line shows that the annual outflow levels are gradually increasing at a rate of almost 80 ML per year.

Figure 3.7 – Kalamalka Lake Outflows



Coldstream Creek, Oyama Creek, and Vernon Creek are major tributaries to Kalamalka Lake. The outflow from Kalamalka Lake flows through Vernon Creek to Okanagan Lake, through the City of Vernon.

Kalamalka Lake has a surface area of 3483 ha, including the Wood Lake area. The upstream diversions and storage reservoirs significantly affect the low to medium inflows, but insignificantly affect the high inflows.

A 200-year flood hydrology report was conducted by the Water Investigations Branch of BC Water Resource Service in 1976. The report can be found on the government of BC's official website. The most recent report that reviewed the watershed yield and licensing was prepared by the Water Management Branch of the Ministry of Environment. This report outlined the Wood-Kalamalka basin studies that were carried out between 1971 and 1974 and summarized the report from 1976.

Kalamalka Lake has a maximum depth of 142 m and a volume of 1520 million m^3. Other than Okanagan Lake, Kalamalka Lake is considered to be the largest source of potable water in the North Okanagan. Approximately 80 % of the annual inflow comes from the combination of groundwater and Coldstream Creek, while the remaining 20 % of inflow is from Wood Lake. Kalamalka Lake is classified as oligotrophic because the main water body lacks plant nutrients and contains large amounts of dissolved oxygen. Kalamalka

Lake has a residence time ranging between 55 and 65 years. The overlays of colour in the water are derived from the scattering of light and caused by the precipitation of calcite.

Kalamalka Lake has a low-head discharge capacity which prevents pre-freshet drawdown during high inflow periods. The normal operating levels range between 391.06 m and 391.82 m.

3.3.3 WATER LICENSES

The Kalamalka Lake basin is fully recorded. As shown in the table below, the District is authorized to divert and use a total of 1,718 ML of water from Kalamalka Lake.

Table 3.9 – Kalamalka Lake Licensing

Authorized Water Diversion		
Purpose	**Imp. Units (ac-ft)**	**Metric Units (ML)**
Irrigation	1,292	1,594
Waterworks (Domestic)	101	124
Total	***1,393***	***1,718***

The water licenses are more than adequate for irrigation purposes but not for domestic use. The District might have to apply to have irrigation licenses converted to domestic licenses. The earliest priority date of Kalamalka Lake dates back to 1910. Refer to the Annex for details.

3.3.4 ANNUAL WATER DEMAND

Table 3.10 shows the annual water requirements for Kalamalka Lake. The total theoretical annual use is 1,019 ML, where 86 % is for irrigation purposes, and the remaining 14 % is for domestic purposes.

Table 3.10 – Kalamalka Lake Annual Water Requirements

Annual Water Requirements		
Usage	**Imperial (ac-ft)**	**Metric (ML)**
Irrigated Grade "A" Land, 127 ha @ *6.9 ML/ha	710	876
Rural Residential (with Grade "A" Land), 65 conn @ 0.17 ML/conn	9	11
Rural Residential (without Grade “A” Land), 15 conn @ 1.5 ML/conn	18	23
Urban Large Residential, 40 conn @ 0.75 ML/conn	24	30
Single Family Residential, 164 conn @ 0.4 ML/conn	53	66
Bareland Strata, Single Family, 6 conn @ 0.17 ML/conn	1	1
Multi-Family, 22 units @ 0.17 ML/unit	3	4
Commercial, Industrial & Institutional, 25 conn @ 0.34 ML/conn	7	9
Total Theoretical Annual Use	***826***	***1,019***

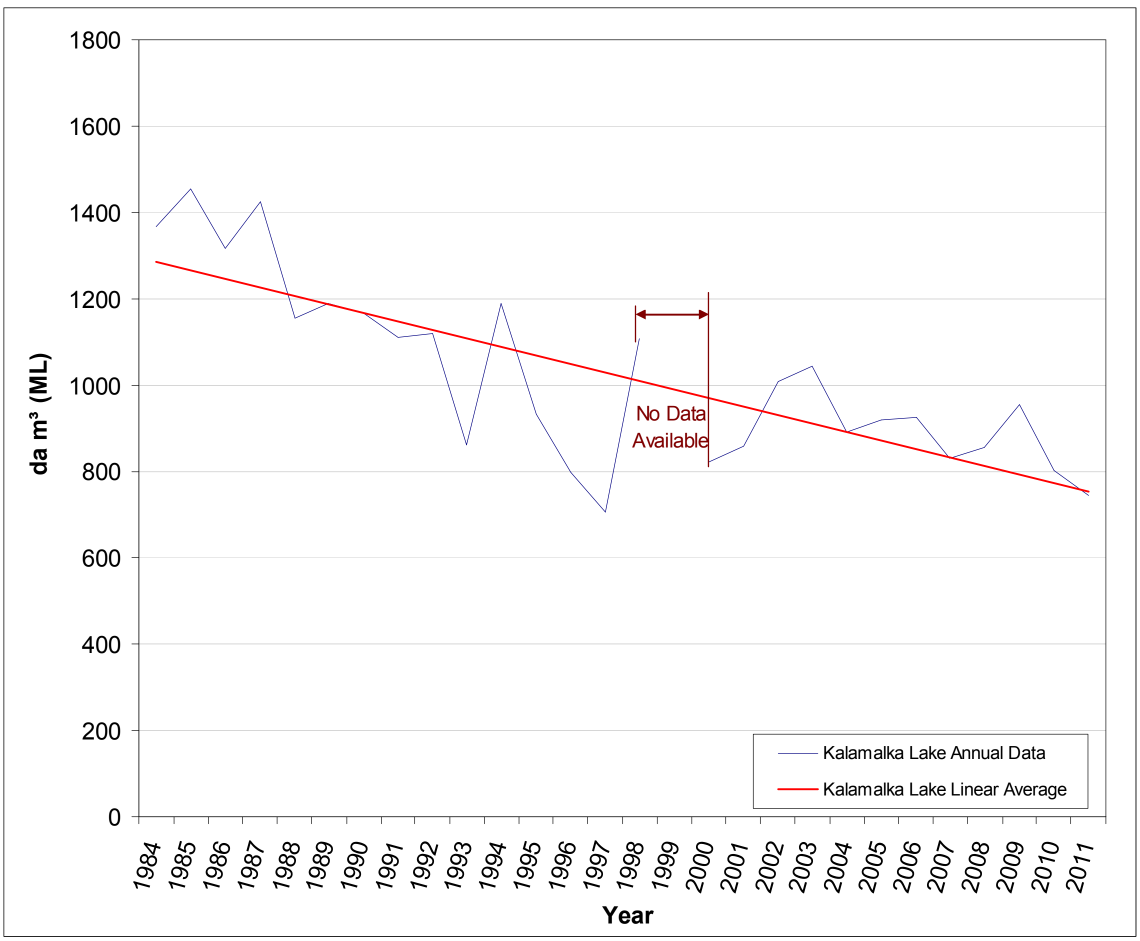
Since the total estimated annual use is based on the assumption that all residential and agricultural users are capitalizing their entire annual allotment amount, the usage should be considered to be theoretical.

Notes:

1. The estimated annual irrigation requirements are based on the Irrigation Design Manual prepared by the British Columbia Ministry of Agriculture.
2. The Grade "A" land serviced area includes the irrigated areas within the Rural Residential, Multi-family & Strata, and Commercial, Industrial & Institutional developments.
3. Water use on Urban Large Residential lots (0.12 – 0.25 ha in size) includes irrigation of lawns and gardens.
4. Rural Residential lots are between 0.25 – 0.4 ha in size, and Single Family Residential lots are smaller than 0.12 ha in size.

Figure 3.8 below shows the annual water demand for the Kalamalka Lake Source area from 1984 to 2010. The graph shows that the water usage is decreasing over time by approximately 20 ML/year.

Figure 3.8 – Kalamalka Lake Annual Water Use



The figure shows that the highest use year in the last 10 years occurred in 2003, with a water usage of 1,044 ML. The total theoretical annual water requirement of 1,019 ML is less than the high water usage in 2003. The annual use seems high compared to that of other predominantly agricultural water use areas. The high usage could be due to each property utilizing their entire allotment, extra areas being irrigated, or water use above allotment. A survey was not completed in 2003 to see if any Grade "A" Land was dormant, which would have helped determine the above.

3.3.5 ANNUAL WATER AVAILABILITY

Table 3.11 shows the water availability for Kalamalka Lake. The table shows that the theoretical annual usage does not surpass the licensed volume and that there is still 699 ML available to be used.

Table 3.11 – Kalamalka Lake Water Availability

Annual Water Availability		
Breakdown	**Imperial (ac-ft)**	**Metric (ML)**
Water License	1,393	1,718
Theoretical Water Use (Year 2011)	826	1,019
Surplus	***567***	***699***

3.4 OYAMA LAKE WATER SOURCE

The Oyama Lake Water Source was formerly operated by the Wood Lake Improvement District (WLID) and has been a reliable water supply since the early 1900's. The District of Lake Country took over operations of the water system on January 1, 1998. There have been no major upgrades or improvements to the system since the ARDA program installation.

The funding application for drinking water and supply improvements was recently accepted by Building Canada. The funds will be used to construct a balancing reservoir, a new chlorinator, and a booster pump station.

Oyama Lake Water Source

The main source of water is Oyama Creek, which runs out of Oyama Lake watershed into Kalamalka Lake.

The Oyama Lake Water Source is currently interconnected with the Kalamalka Lake Water Source through a pressure reducing interconnection chamber located on Oyama Road. The system improvements will improve water quality by allowing Kalamalka Lake water to be pumped into Oyama Lake Water Source mainline and providing a secondary supply source.

3.4.1 SERVICE AREA

The Oyama Lake Water Source, as shown in Figure 3.1, serves 420 *hectares* of highly productive agricultural land in addition to providing domestic water to 255 residential homes and 15 multi-family units. The service area is the eastern slopes of the area above Wood Lake and is mostly agricultural. Land within the WLWS is typically in the ALR and new residential development is limited.

3.4.2 OYAMA LAKE WATERSHED

The Oyama watershed includes Oyama and Damer Lake, as well as some smaller lakes, and has an area of 23.8 km². Oyama Lake is located east of Wood Lake at an elevation of 1357 m. Refer to Figure 3.9 for the watershed location and size. The lake is surrounded by lease lots and a fishing lodge. The lake relies on snow packs for annual water regeneration.

The elevation ranges from 1400 m in the upper watershed above Streak Lake to a low elevation of 613 m at the intake. The Oyama Creek mainstem branches from the upper watershed to the Kalamalka Lake entrance and is approximately 12.7 km long. The Vernon Creek intake is located approximately 2.6 km upstream from Kalamalka Lake.

3.4.2.1 HYDROLOGY

A hydrology report prepared by D.B Letvak of the Ministry of Environment in 1987 estimated that the Oyama Creek watershed can supply an annual demand of 4400 ML with very little risk of a shortage. Storage reservoirs are located on Oyama Lake (7137 ML) and Damer Lake (263 ML).

3.4.3 WATER LICENSES

The District has Water Licenses on Oyama Creek authorizing diversion of water as follows. There are also storage licenses on Oyama and Damer Lakes. The priority date for Oyama Creek shows that the oldest licenses were established in 1892 and have been in operation since then. This watershed is considered fully recorded and no additional licenses are available. Refer to the Annex at the back of this section for details.

Table 3.12 – Oyama Creek Licensing

Authorized Water Diversion		
Purpose	**Imp. Units (ac-ft)**	**Metric Units (ML)**
Irrigation	2,140	2,639
Waterworks (Domestic)	1,015	1,252
Total	***3,155***	***3,891***

Figure 3.9 – Oyama Lake Watershed

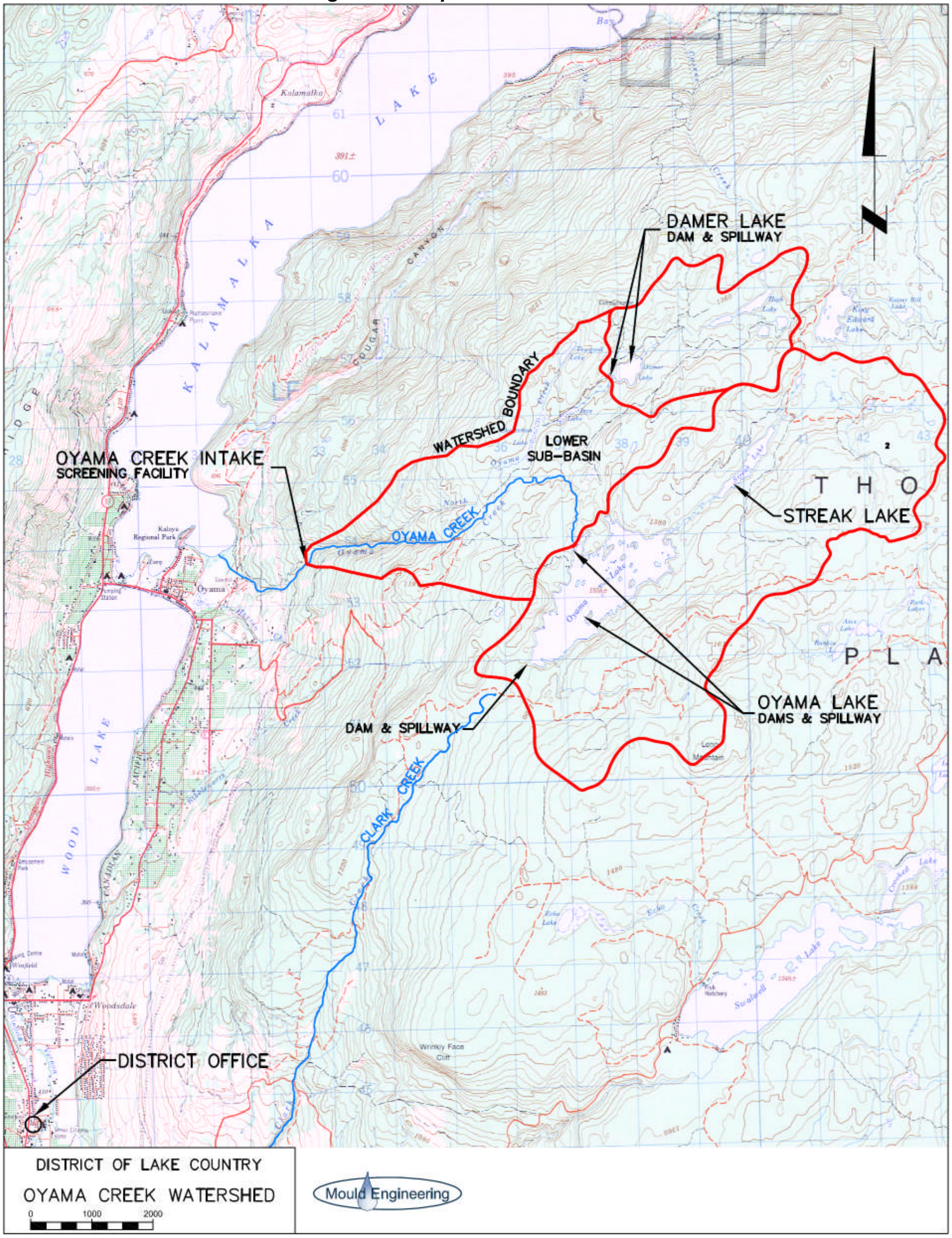


Figure 3.9 shows the Oyama Lake watershed area location and size in relation to Oyama Creek and Clark Creek.

3.4.4 ANNUAL WATER DEMAND

Refer to Table 3.13 for the annual water requirements during a high-use year. The total theoretical annual usage is 2,983 ML.

Table 3.13 – Oyama Lake Annual Water Requirements

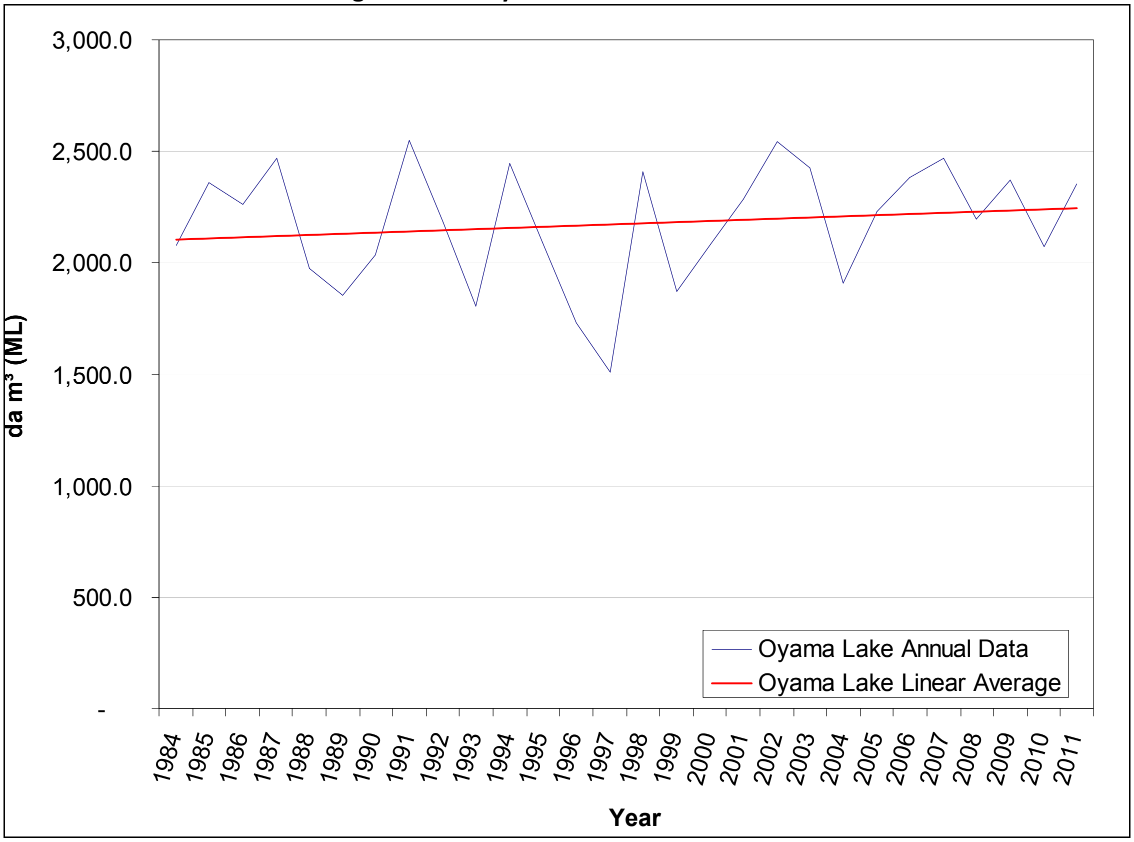
Annual Water Requirements		
Usage	**Imperial (ac-ft)**	**Metric (ML)**
Irrigated Grade "A" Land, 420 ha @ *6.9 ML/ha	2,349	2,898
Rural Residential (with Grade "A" Land), 185 conn @ 0.17 ML/conn	25	31
Rural Residential (without Grade "A" Land), 10 conn @1.5 ML/conn	12	15
Urban Large Residential, 35 conn @ 0.75 ML/conn	21	26
Single Family Residential, 25 conn @ 0.4 ML/conn	8	10
Multi-Family, 15 units @ 0.17 ML/unit	2	3
Total Theoretical Annual Use	***2,419***	***2,983***

Notes:

1. The estimated annual irrigation requirements are based on the Irrigation Design Manual prepared by the British Columbia Ministry of Agriculture.
2. The Grade "A" land serviced area includes the irrigated areas within the Rural Residential, Multi-family & Strata, and Commercial, Industrial & Institutional developments.
3. Water use on Urban Large Residential lots (0.12 – 0.25 ha in size) includes irrigation of lawns and gardens.
4. Rural Residential lots are between 0.25 – 0.4 ha in size, and Single Family Residential lots are smaller than 0.12 ha in size.

The theoretical water demand calculates to be a 97-3 % split between irrigation and domestic. The total annual usage is theoretical, as it assumes that all residential and agricultural users utilize their entire annual allotment amount. The actual annual water demand for the Oyama Lake Source area is shown in Figure 3.10 below. The graph shows that although there are considerable fluctuations in the water usage over time, the usage is increasing overall by approximately 5 ML/year.

Figure 3.10 – Oyama Lake Annual Water Use



The above figure shows that the high water use years occurred in 2002 and 2003 with usages of 2,545 ML and 2,426 ML respectively. The theoretical annual water use requirements are over 15 % more than the actual water usage of high use years. The estimations are therefore a good representation of an actual high use year, as it is unlikely that all users were utilizing their full allotments in 2002/2003.

3.4.5 ANNUAL WATER AVAILABILITY

Refer to Table 3.14 for the water availability for Oyama Lake. The table shows that the current yield of 4,400 ML is greater than the sum of the theoretical water use and the estimated operational waste, resulting in a surplus of 937 ML.

Table 3.14 – Oyama Lake Water Availability

Annual Water Availability		
Breakdown	**Imperial (ac-ft)**	**Metric (ML)**
Watershed Yield	3,567	4,400
Estimated Operational Waste	389	480
Theoretical Water Use	2,419	2,983
Surplus	***759***	***937***

3.5 PUBLIC WATER SYSTEMS

There are other much smaller water systems that the District owns and operates. Three previously private utilities: Ponderosa, Woodsdale, and Lakepine, have been dissolved into the District within the past seven years. The Ponderosa and Woodsdale systems are now connected to and supplied by the Okanagan Lake Water Source. The following two systems are not connected to any of the District's four major water sources and have not been analyzed in detail as part of preparing this Water Master Plan.

3.5.1 LAKEPINE WATER SYSTEM

The Lakepine utility is the most recent water system to be transferred to the ownership of the District. This system obtains water from Okanagan Lake and consists of a lake intake, pump station, chlorination facility and reservoir. Some recent upgrades to principle facilities as well as system expansions have been made to facilitate the Raven Ridge subdivision. The utility is located on the eastern shoreline of Okanagan Lake, at the northern end of the Beaver Lake Water Source service area. Lakepine Water System supplies to approximately 98 users.

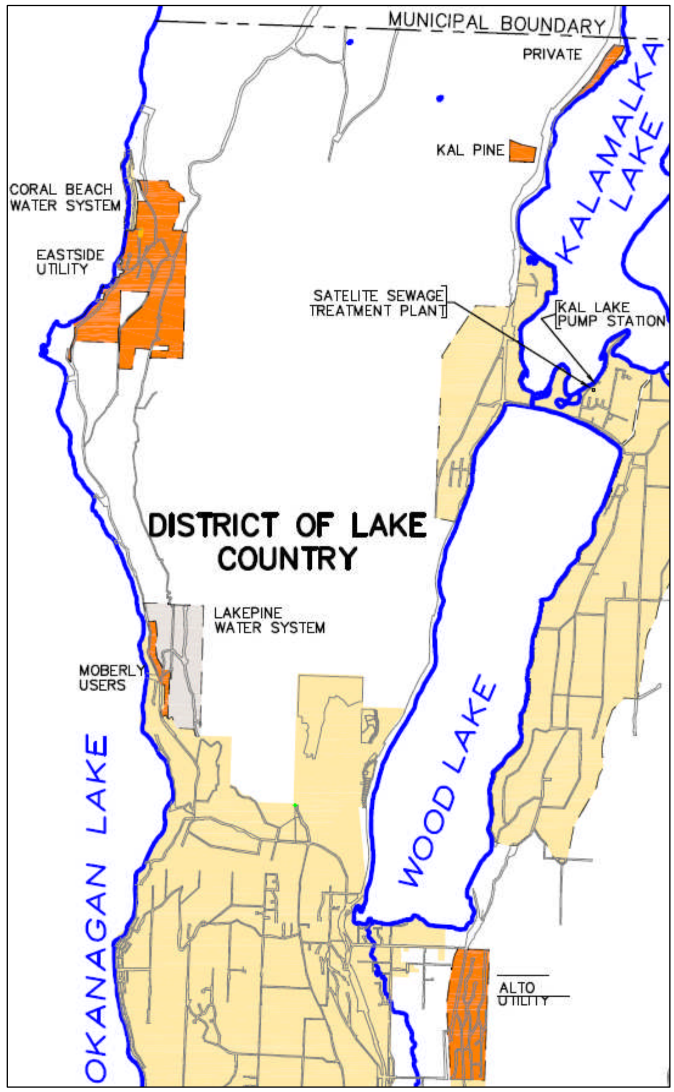
3.5.2 CORAL BEACH WATER SYSTEM

Coral Beach Water System is also owned and operated by the District of Lake Country and supplies a local service area. The system has a small pump station on an Okanagan Lake balancing tank, and supplies approximately 62 users. The utility is located on the eastern shoreline of Okanagan Lake, in the Carr's Landing area, and just north of the Eastside Utility boundary.

3.6 PRIVATE UTILITIES WITHIN THE DLC BOUNDARY

3.6.1 ALTO UTILITY

Private & Public Water Systems and Utilities



Alto Utility is located on the eastern slopes of the valley. To the immediate south lies the new subdivision of Copperhill, which is serviced by the Okanagan Lake Water Source. Alto Utilities is the sole water purveyor for the original Clearwater Park Subdivision (and subsequent growth) that was developed in the early 1970s and is now within the District of Lake Country's municipal boundary. The Alto Utility is the largest private water utility within the District and the water source is groundwater. The wells and pumping facilities are located on Lodge Rd. Alto Utility consists of 2 wells, 3 reservoirs, a booster pump station and 2 pressure reducing stations. Alto Utility services water to approximately 450 users.

3.6.2 EASTSIDE UTILITY

Eastside Utility is located at the north end of the municipality. Eastside Utility consists of approximately 160 users.

3.6.3 MOBERLY USERS

The Moberly Users system consists of a lake intake and pump station. The system supplies water to Carr's Landing and operates independently. Moberly consists of approximately 11 users.

3.6.4 KAL PINE

Kal Pine is located on the west side of Kalamalka Lake and services water to approximately 50 users.

3.6.5 PRIVATE WATER SYSTEMS

There are numerous users within the District of Lake Country that have their own private water system. These include water front properties that have lake intakes or properties that have a ground water supply. Most groundwater wells are located in the low lying area south of Wood Lake.

3.7 ANNEX

Table 3.15 – Annual Water Requirements

Current Theoretical Annual Water Requirements					
#	**Zoning / Land Use**	**Irrigation Land ha**	**# of Units / Connections**	**Annual Demand ML**	**Total ML**
1.0 Beaver Lake Water Source					
1.1	Irrigated Grade "A" Land	870		6.90	6,003
1.2	Rural Residential (Grade "A" Land)		750	0.17	128
1.3	Rural Residential		10	1.50	15
1.4	Urban Large Residential		120	0.75	90
1.5	Single Family Residential		520	0.40	208
1.6	Multi-family & Strata		200	0.17	34
1.7	Commercial, Industrial & Institutional		30	0.34	10
Total Theoretical Annual Use for Beaver Lake Water Source					**6,488**
2.0 Okanagan Lake Water Source					
2.1	Irrigated Grade "A" Land	60		6.90	414
2.2	Rural Residential (Grade "A" Land)		35	0.17	6
2.3	Rural Residential		45	1.50	68
2.4	Urban Large Residential		200	0.75	150
2.5	Single Family Residential		748	0.40	299
2.6	Bare Land Strata, Single Family		52	0.17	9
2.7	Multi-family & Strata		750	0.17	128
2.8	Commercial, Industrial & Institutional		60	0.34	20
2.9	City of Kelowna Industrial Area	80		6.90	552
Total Theoretical Annual Use for Okanagan Lake Water Source					**1,645**
3.0 Kalamalka Lake Water Source					
3.1	Irrigated Grade "A" Grade Land	127		6.90	876
3.2	Rural Residential (Grade "A" Land)		65	0.17	11
3.3	Rural Residential		15	1.50	23
3.4	Urban Large Residential		40	0.75	30
3.5	Single Family Residential		164	0.40	66
3.6	Bare Land Strata, Single Family		6	0.17	1
3.7	Multi-Family & Strata		22	0.17	4
3.8	Commercial, Industrial & Institutional		25	0.34	9
Total Theoretical Annual Use for Kalamalka Lake Water Source					**1,019**
4.0 Oyama Lake Water Source					
4.1	Irrigated Grade "A" Land	420		6.90	2,898
4.2	Rural Residential (Grade "A" Land)		185	0.17	31
4.3	Rural Residential		10	1.50	15
4.4	Urban Large Residential		35	0.75	26
4.5	Single Family Residential		25	0.40	10
4.6	Multi-Family & Strata		15	0.17	3
Total Theoretical Annual Use for Oyama Lake Water Source					**2,983**
Total Theoretical Annual Use for All Sources					**12,135**

Notes:

1. The estimated annual irrigation requirements are based on the Irrigation Design Manual prepared by the British Columbia Ministry of Agriculture.
2. The Grade "A" land serviced area includes the irrigated areas within the Rural Residential, Multi-family & Strata, and Commercial, Industrial & Institutional developments.
3. Water use on Urban Large Residential lots (0.12 – 0.25 ha in size) includes irrigation of lawns and gardens.
4. Urban Rural Residential lots are between 0.25 – 0.4 ha in size, and Single Family Residential lots are smaller than 0.12 ha in size.

Table 3.15 shows that the total theoretical annual water use and demand for all sources combined is 12,135 ML per year.

Table 3.16 – Vernon Creek at Outlet of Swalwell Lake Monthly Discharge 1969-1995

Monthly Mean Discharges (m^3/s) for Vernon Creek at Outlet of Swalwell Lake													
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Avg**
1983	0.188	0.219	0.380	0.475	3.710	0.878	0.721	0.889	0.622	0.117	0.117	0.117	0.703
1974	0.017	0.032	0.281	1.290	2.320	2.000	0.771	0.783	0.280	0.109	0.123	0.080	0.674
1969	0.258	0.251	0.324	0.973	2.170	1.090	1.010	0.882	0.467	0.168	0.157	0.150	0.658
1982	0.151	0.178	0.333	0.423	1.860	1.200	1.710	0.759	0.697	0.187	0.150	0.173	0.652
1981	0.291	0.318	0.256	0.185	2.220	1.210	0.852	1.140	0.701	0.191	0.195	0.153	0.643
1991	0.266	0.759	0.397	0.433	2.500	0.589	0.644	0.592	0.369	0.264	0.126	0.102	0.587
1976	0.040	0.040	0.040	0.076	2.310	1.160	0.727	0.875	1.100	0.146	0.171	0.077	0.564
1989	0.055	0.110	0.103	0.688	2.540	0.833	0.642	0.510	0.286	0.263	0.237	0.226	0.541
1994	0.087	0.395	1.120	1.630	1.100	0.418	0.627	0.528	0.294	0.111	0.061	0.054	0.535
1972	0.065	0.063	0.716	0.770	1.050	1.750	0.760	0.771	0.271	0.039	0.046	0.015	0.526
1990	0.171	0.174	0.170	0.166	0.434	2.850	0.827	0.621	0.301	0.174	0.140	0.232	0.522
1986	0.060	0.072	0.297	0.303	2.220	0.983	0.624	0.747	0.362	0.156	0.127	0.123	0.506
1984	0.116	0.128	0.122	0.121	0.991	2.010	1.010	0.739	0.265	0.068	0.242	0.174	0.499
1978	0.122	0.177	0.144	0.377	1.700	1.030	0.754	0.661	0.220	0.159	0.159	0.156	0.472
1995	0.069	0.059	0.067	0.289	2.000	0.725	0.670	0.481	0.378	0.147	0.114	0.316	0.443
1975	0.068	0.069	0.073	0.063	0.742	1.970	0.809	0.882	0.381	0.161	0.047	0.034	0.442
1977	0.089	0.075	0.060	0.493	1.820	0.693	0.783	0.721	0.255	0.046	0.006	0.050	0.424
1979	0.158	0.268	0.259	0.141	1.310	0.698	0.735	0.647	0.264	0.142	0.075	0.076	0.398
1987	0.124	0.120	0.123	0.146	0.705	0.686	0.773	0.639	0.387	0.144	0.059	0.057	0.330
1993	0.151	0.141	0.085	0.087	0.779	0.613	0.614	0.697	0.395	0.148	0.084	0.116	0.326
1985	0.173	0.168	0.163	0.137	0.253	0.708	1.060	0.712	0.185	0.057	0.059	0.058	0.311
1973	0.036	0.044	0.039	0.366	0.345	0.610	0.797	0.738	0.271	0.021	0.012	0.011	0.274
1971	0.079	0.087	0.025	0.005	0.186	0.530	0.770	0.913	0.269	0.125	0.077	0.037	0.259
1970	0.131	0.112	0.093	0.072	0.285	0.590	0.667	0.661	0.170	0.037	0.049	0.064	0.244
1992	0.070	0.073	0.123	0.142	0.447	0.560	0.408	0.561	0.260	0.048	0.028	0.114	0.236
1980	0.066	0.065	0.064	0.069	0.281	0.399	0.573	0.704	0.285	0.116	0.112	0.086	0.235
1988	0.057	0.057	0.054	0.037	0.118	0.421	0.503	0.587	0.337	0.060	0.045	0.046	0.194
Average Dry Year	0.073	0.073	0.066	0.115	0.277	0.518	0.620	0.694	0.265	0.068	0.054	0.060	0.240
Average of 26 yrs	0.117	0.158	0.219	0.369	1.348	1.008	0.772	0.720	0.373	0.126	0.104	0.107	0.452

Note, the recorded results were averaged for each year and arranged in frequency from highest to lowest to determine the percentiles of wet years, normal years and dry years.

Wet Years are based on the largest 25th percentile of average monthly mean discharges.

Normal Years are based on the 25th to 75th percentile to represent the average discharges.

Dry Years are based on the lowest 25th percentile of average monthly mean discharges.

The Vernon Creek at the Outlet of Swalwell Lake mean monthly discharges (08NM022) are shown in Table 3.16 for 1969-1995. The data was collected by Water Survey Canada during 1969 to 1995.

Table 3.17 – Vernon Creek Water Licenses

LICENSE No	WR MAP/ PNT CODE	PURPOSE	QUANTITY	UNITS	FLAG		STATUS		DATES	
					QTY	REDIV	LICENSE	PROCESS	PRIORITY	ISSUE
C021807	82.L.003.2.2 X (PD59041)	Storage-Non Power	625,374.36	MY	T	N	Current	N/A	19520906	
C034636	82.L.004.1.2 A (PD58685)	Irrigation Local Auth	1,299,162.80	MY	T	N	Current	N/A	19681112	
		Waterworks Local Auth	414,830.71	MY	T	N	Current	N/A	19681112	
C056171	82.L.004.1.2 A (PD58685)	Domestic	0.91	MD	T	N	Current	N/A	18981008	
		Irrigation Local Auth	15,702.20	MY	T	N	Current	N/A	18981008	
C059644	82.L.004.1.2 A(PD58685)	Irrigation Local Auth	616,740.00	MY	T	N	Current	N/A	19790124	
C059645	82.L.004.1.2 A(PD58685)	Waterworks Local Auth	618,268.24	MY	T	N	Current	N/A	19781026	
C121792	82.L.004.1.2 A(PD58685)	Power-General	0.77	MS	T	N	Current	N/A	20060329	20080924
C122462	82.L.004.1.2 A(PD58685)	Irrigation Local Auth	5,184,624.80	MY	T	N	Current	N/A	19070823	20070112
		Waterworks Local Auth	82,738.84	MY	T	N	Current	N/A	19070823	20070112
C122463	82.L.004.1.2 A(PD58685)	Waterworks Local Auth	82,966.14	MY	T	N	Current	N/A	19070823	20070112
F006991	82.L.004.1.2 A(PD58685)					Y	Current	N/A	19081019	
F018936	82.L.004.1.1 D(PD58690)	Irrigation Local Auth	616.74	MY	T	N	Current	N/A	18910312	
F070848	82.L.004.1.2 A(PD58685)	Incidental - Domestic	1.14	MD	T	N	Current	N/A	18910312	
		Irrigation Local Auth	61,674.00	MY	T	N	Current	N/A	18910312	
F070849	82.L.004.1.2 A(PD58685)	Incidental - Domestic	1.14	MD	T	N	Current	N/A	18910312	
		Irrigation Local Auth	17,268.72	MY	T	N	Current	N/A	18910312	
F070850	82.L.004.1.2 A(PD58685)	Domestic	1.14	MD	T	N	Current	N/A	18910312	
		Irrigation	32,070.48	MY	T	N	Current	N/A	18910312	
F070851	82.L.004.1.2 A(PD58685)	Incidental - Domestic	1.14	MD	T	N	Current	N/A	18910312	
		Irrigation Local Auth	16,035.24	MY	T	N	Current	N/A	18910312	
F070852	82.L.004.1.2 A(PD58685)	Domestic	1.14	MD	T	N	Current	N/A	18910312	
		Irrigation	29,603.52	MY	T	N	Current	N/A	18910312	
F070853	82.L.004.1.2 A(PD58685)	Domestic	1.14	MD	T	N	Current	N/A	18910312	
		Irrigation	15,418.50	MY	T	N	Current	N/A	18910312	
F070854	82.L.004.1.2 A(PD58685)	Domestic	1.14	MD	T	N	Current	N/A	18910312	
		Irrigation	30,837.00	MY	T	N	Current	N/A	18910312	
F070855	82.L.004.1.2 A(PD58685)	Domestic	1.14	MD	T	N	Current	N/A	18910312	
		Irrigation	29,911.89	MY	T	N	Current	N/A	18910312	
F070856	82.L.004.1.2 A(PD58685)	Domestic	1.14	MD	T	N	Current	N/A	18910312	
		Irrigation	24,052.86	MY	T	N	Current	N/A	18910312	
F070857	82.L.004.1.2 A(PD58685)	Incidental - Domestic	1.14	MD	T	N	Current	N/A	18910312	
		Irrigation Local Auth	13,259.91	MY	T	N	Current	N/A	18910312	
F070858	82.L.004.1.2 A(PD58685)	Domestic	1.14	MD	T	N	Current	N/A	18910312	
		Irrigation	72,158.58	MY	T	N	Current	N/A	18910312	
		Total	**8,662,838.01**	**MY**	**The total does not include storage or power licenses.**					

Table 3.17 shows that the current licenses for the Vernon Creek Water Source total 8,663 ML. There are more licenses for Vernon Creek compared to the other sources. The earliest priority date dates back to 1891.

Table 3.18 – Swalwell Lake Water Licenses

LICENSE No	WR MAP/ POINT CODE	PURPOSE	QUANTITY	UNITS	FLAG		STATUS		DATES	
					QTY	REDIV	LICENSE	PROCESS	PRIORITY	ISSUE
C015025	8467 A (PD58085)	Storage-Non Power	5,146,078.60	MY	T	N	Current	N/A	19410308	
F006991	8467 A (PD58085)	Incidental Domestic	9.09	MD	T	N	Current	N/A	19081019	
		Irrigation Local Auth	678,414.00	MY	T	N	Current	N/A	19081019	
F010425	8467 A (PD58085)	Storage-Non Power	6,784,140.00	MY	T	N	Current	N/A	19070823	
Z123381	8467 A (PD58085)	Storage-Non Power	5,955,241.40	MY	T	Y	Active Appl.	Applic-Cleared	20071210	
		Total	**681,732.58**	**MY**	**The total does not include storage licenses.**					

Table 3.18 shows that the water licenses designated to Swalwell Lake total 681 ML. Almost 96 % of the licenses are designated to irrigation use and the remaining 4 % is for domestic use. The earliest priority date dates back to 1907.

Table 3.19 – Okanagan Lake Water Licenses

LICENSE No	WR MAP/ POINT CODE	PURPOSE	QUANTITY	UNITS	FLAG		STATUS		DATES	
					QTY	REDIV	LICENSE	PROCESS	PRIORITY	ISSUE
C108271	82.L.003.2.2 G (PD59016)	Waterworks Local Auth	2,198,602.80	MY	T	N	Current	N/A	19940614	20030220
C108281	82.L.003.2.2 G (PD59016)	Waterworks Local Auth	8,794,411.10	MY	T	N	Current	N/A	19690623	19940620
C110266	82.L.013.2.3 QQ (PD71481)	Watering	1,850.22	MY	T	N	Current	N/A	19951004	20020409
		Waterworks Local Auth	2,488.98	MY	T	N	Current	N/A	19951004	20020409
Z121654	82.L.003.4.2 (PD79706)	Waterworks Local Auth	803,656.43	MY	T	N	Active Appl.	Applic-Cleared	20060203	
		Total	**10,997,353.10**	**MY**	**The total does not include license Z121654 because it has not yet been adjudicated.**					

Refer to Table 3.19 for the Okanagan Lake water licenses. From the 10,997 ML of water licenses authorized by the District of Lake Country, 100 % is used for domestic waterworks. License number Z121654 was removed from the total because it has not been adjudicated yet. The earliest priority date for the licenses is from 1969. Information from this table was used in Table 3.6 – Okanagan Lake Licensing.

Table 3.20 – Kalamalka Lake Water Licenses

LICENSE No	WR MAP/ POINT CODE	PURPOSE	QUANTITY	UNITS	FLAG		STATUS		DATES	
					QTY	REDIV	LICENSE	PROCESS	PRIORITY	ISSUE
C029574	8469A WW (PD57975)	Storage-Non Power	1,233,480.00	MY	T	N	Current	N/A	19361121	
C109389	82.L.014.1.1 X (PD70638)	Irrigation Local Auth	48,722.46	MY	T	N	Current	N/A	19100927	19950426
C109390	82.L.014.1.1 X (PD70638)	Irrigation Local Auth	342,586.74	MY	T	N	Current	N/A	19260625	19950426
C109391	82.L.014.1.1 X (PD70638)	Waterworks Local Auth	62,224.61	MY	T	N	Current	N/A	19630308	19950426
C109392	82.L.014.1.1 X (PD70638)	Irrigation Local Auth	1,202,396.30	MY	T	N	Current	N/A	19301121	19950426
		Waterworks Local Auth	62,224.61	MY	T	N	Current	N/A	19301121	19950426
		Total	**1,718,154.71**	**MY**	**The total does not include storage licenses**					

There are 1,718 ML of licenses for Kalamalka Lake. This total is divided into 93 % of irrigation purposes and 7 % of domestic purposes. The earliest priority date is 1910. The information from this table is used in Table 3.9 – Kalamalka Lake Licensing.

Table 3.21 – Oyama Creek Water Licenses

LICENSE No	WR MAP/ POINT CODE	PURPOSE	QUANTITY	UNITS	FLAG		STATUS		DATES	
					QTY	REDIV	LICENSE	PROCESS	PRIORITY	ISSUE
C037445	82.L.014.1.2 A (PD58298)	Waterworks Local Auth	82,966.14	MY	T	N	Current	N/A	19710114	
C109328	82.L.014.1.2 A (PD58298)	Waterworks Local Auth	1,159,480.30	MY	T	N	Current	N/A	19950222	20020409
F003659	82.L.014.1.2 A (PD58298)	Domestic	4.55	MD	T	N	Current	N/A	18990227	
		Irrigation Local Auth	139,383.24	MY	T	N	Current	N/A	18990227	
F008819	82.L.014.1.2 A (PD58298)	Domestic	22.73	MD	T	N	Current	N/A	18920723	
		Irrigation Local Auth	2,450,616.40	MY	T	N	Current	N/A	18920723	
F012148	82.L.014.1.2 A (PD58298)	Irrigation Local Auth	11,718.06	MY	T	N	Current	N/A	18920723	
F014777	82.L.014.1.2 A (PD58298)	Irrigation Local Auth	37,004.40	MY	T	N	Current	N/A	18920723	
F021411	8466 A (PD58152)	Storage-Non Power	3,700,440.00	MY	T	N	Current	N/A	19051125	
F038834	8466 A (PD58152)	Storage-Non Power	2,452,158.20	MY	T	N	Current	N/A	19700120	
Z123380	8466 A (PD58152)	Storage-Non Power	3,330,396.00	MY	T	N	Active Appl.	Applic-Cleared	20071210	
		Total	**3,891,124.28**	**MY**	**The total does not include storage licenses.**					

Table 3.21 shows the water licenses for Oyama Creek. The table shows that there are 3891 ML of total water licenses, where 68 % is for irrigation purposes and 32 % is for domestic purposes. The table shows that the earliest priority date was from 1892. Information from this table was used in Table 3.12 – Oyama Creek Licensing.

Table 3.22 – North Oyama Creek Water Licenses

LICENSE No	WR MAP/ POINT CODE	PURPOSE	QUANTITY	UNITS	FLAG		STATUS		DATES	
					QTY	REDIV	LICENSE	PROCESS	PRIORITY	ISSUE
C036362	8466 B (PD58148)	Storage-Non Power	493,392.00	MY	M	N	Current	N/A	19630910	
	8466 C (PD58147)	Storage-Non Power	493,392.00	MY	M	N	Current	N/A	19630910	
C044149	8466 E (PD58146)	Storage-Non Power	493,392.00	MY	T	N	Current	N/A	19710609	
Total			**0**	**MY**	**The total does not include storage licenses**					

Table 3.23 – Crooked Lake Water Licenses

LICENSE No	WR MAP/ POINT CODE	PURPOSE	QUANTITY	UNITS	FLAG		STATUS		DATES	
					QTY	REDIV	LICENSE	PROCESS	PRIORITY	ISSUE
C011623	8467 B (PD58081)	Storage-Non Power	4,933,920.00	MY	T	N	Current	N/A	19330602	
Z123379	8467 B (PD58081)	Storage-Non Power	2,109,250.80	MY	T	N	Active Appl.	Applic-Cleared	20071210	
Total			**0**	**MY**	**The total does not include storage licenses**					

Table 3.22 and 3.23 show the licenses designated to North Oyama Creek and Crooked Lake respectively. Since North Oyama Creek and Crooked Lake Water Sources only have storage licenses, the total licenses calculated for each source is 0 ML.

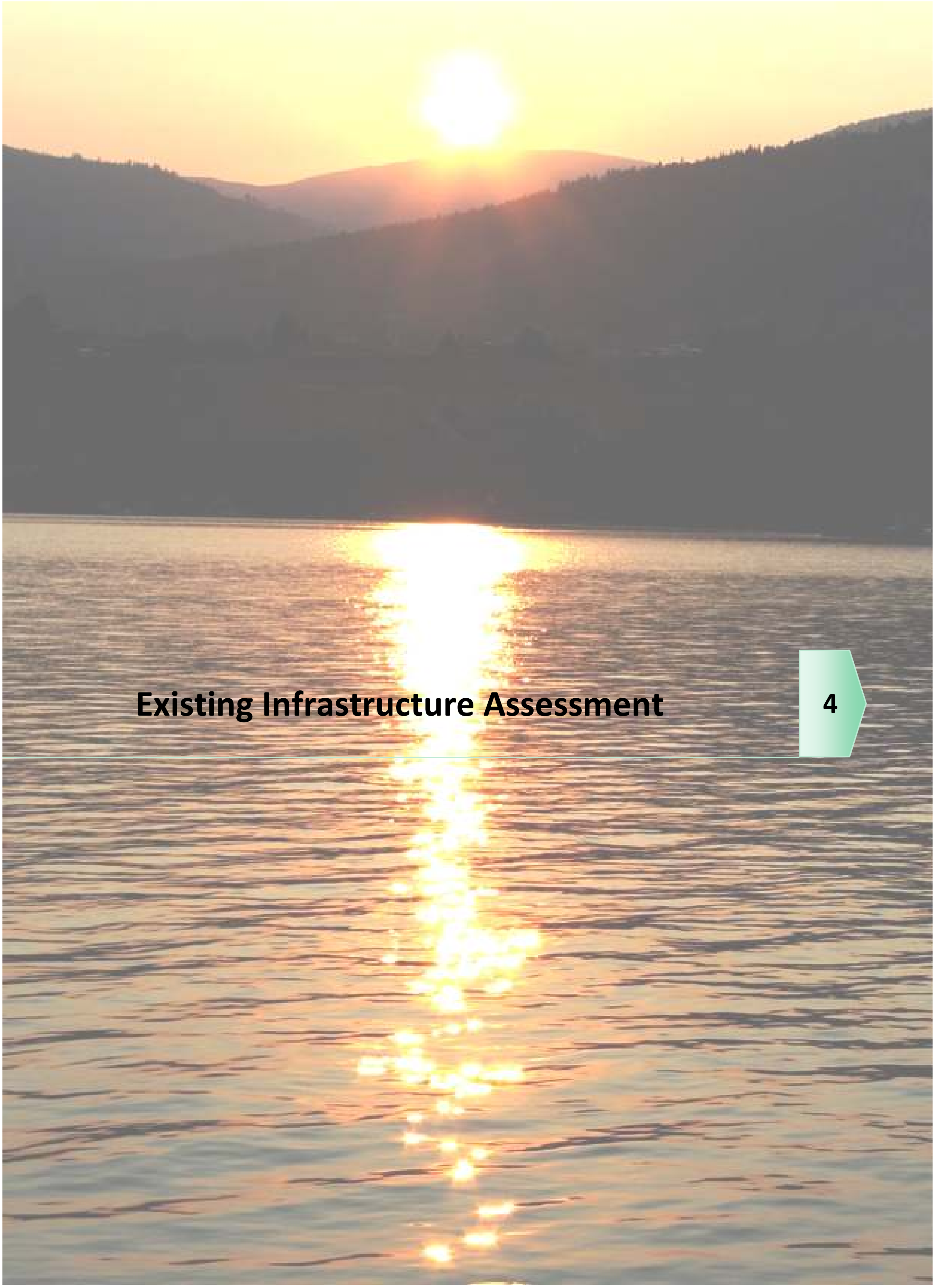
Table 3.24 – Notes for License Tables 3.17-4.23

Unit Abbreviations and Descriptions For the DLC License Tables		
Section of Table	**Abbreviation**	**Description**
License Number	License No.	The Water License Information System (WLIS) assigned a unique seven-character identifier for each license for water diversion and usage.
	Cnnnnnn	The Conditional License authorizes the construction of works or the diversion and use of water before the final license is issued.
	Fnnnnnn	The Final License authorizes the water diversion and use, but does not authorize the construction of additional works or an extension of water use.
	Znnnnnn	The Application Number represents a license application to authorize the construction of works and diversion and use of water.
Water Right Map	WR Map / POD	The Water Rights map was created by the Water Management Branch to reconcile the Point of Diversion (POD) and other features of a license. Examples range from pipelines, dwellings, appurtenant lands, to geographic locations. Licenses can have more than one POD. With reference to the Water Regulation, the POD is the place on the natural channel of a stream where an applicant proposes, or a licensee is authorized, to divert water from the stream. If a POD has more than one license, then there is a shared intake. Use the WR Map field when working with a Water Rights map.
Purpose	-	The Purpose represents the use of water authorized by license. For detailed descriptions of each purpose.
Quantity	-	The Quantity value represents the maximum amount of water that can be diverted for the specified purpose in the license.
Units	MD	m^3/day
	MY	m^3/year
Flag Quantity	T	Total Demand for purpose
Flag Rediversion	Y/N	Water is diverted from one stream into another. The second stream acts as a natural conduit as it moves water closer to the place of use. Water removal from the second stream is a rediversion of water which originated in the first stream. If "Y" is displayed, then the purpose, quantity, and the units are blank. ("Y" = Yes, there is Flag Rediversion) & ("N" = No Flag Rediversion)
License Status	Active Appl	Active Application status is for licenses with "Z-prefix"
	Current	Current Application status is for licenses with "F-prefix" or "C-prefix"
Process Status	N/A	Not Applicable
	Applic-Cleared	Application Cleared
Priority Date	yyyy/mm/dd	The date when the license precedence was established.
Issue Date	yyyy/mm/dd	The date when the license was issued.

Table 3.24 shows the descriptions of the abbreviations used in Tables 3.17 to 3.23. All totals of licenses were converted to MY (m^3/year).

appendix C

EXISTING SYSTEM ASSESSMENT BACKGROUND REPORT (MOULD ENGINEERING)



Existing Infrastructure Assessment

4

DISTRICT OF LAKE COUNTRY
WATER MASTER PLAN

SECTION 4.0 – EXISTING INFRASTRUCTURE ASSESSMENT

TABLE OF CONTENTS

TABLES

FIGURES

4.0 Existing Infrastructure Assessment

The majority of the water works infrastructure within the municipality boundaries of Lake Country was installed under the Agricultural and Rural Development Act (ARDA) in the late 60's and early 70's. Since then, some major changes were made to the systems, some as a result of growth which was largely paid for by developers. The Okanagan Lake pump station and concrete balancing reservoir were constructed in 1970 by Hiram-Walker Distillery and purchased by Lake Country in 1994. In 1996 the District received government funding to improve the water supply in Oyama which resulted in the construction of the Kalamalka Lake pump station and intake plus a balancing reservoir on the western slopes of the valley. Also, the Eldorado Reservoir has been a recent improvement to the Beaver Lake Water Source.

Before the District was amalgamated, it consisted of independent irrigation and improvement districts. While Beaver, Okanagan, Kalamalka and Oyama Lake Water Systems are the largest, there are also private utilities that convey water within the District. The respective water source distribution areas are shown in Figure 3.1. Many studies have been done in Canada and USA to determine the life span of the underground works, including asbestos-cement (AC) pipe. Typically the underground pipe will function as intended for 70 to 100 years, provided that it is installed correctly and the soil conditions do not affect the pipe exterior. The underground infrastructure in the District is approximately half-way to that milestone, and replacement of aging infrastructure is not far from becoming an annual part of the District's operating budget. In addition, many of the watermains installed were intended for irrigation purposes. Today, fire flow has become the driving force behind pipe sizing and much of the 100 mm diameter piping that was installed needs to be replaced.

This section of the *Water Master Plan* discusses the above and below ground infrastructure and outlines their general conditions and functions. Some deficiencies will be discussed as well as operating and maintenance problems. However, no recommendations will be made in this section. For recommendations and capital cost estimates see *Section 10 – Capital Works Projects*.

4.1 *BEAVER LAKE SOURCE INFRASTRUCTURE COMPONENTS*

The Beaver Lake Water Source (BLWS) was previously known as the Winfield Okanagan Centre Water System (WOCWS).

The main components of the Beaver Lake Water Source are:

- Beaver and Crooked Lake Dams and Reservoirs
- Vernon Creek Intake and Spillway
- Eldorado Reservoir
- Camp Rd Reservoir
- Pressure reducing stations, mainlines, and distribution system

4.1.1 BEAVER AND CROOKED LAKE DAMS AND RESERVOIRS

Beaver (Swalwell) and Crooked Lake Dams and Reservoirs are utilized for the purpose of storing watershed run-off. Water storage is discharged through control gates; from Crooked to Beaver and then from Beaver to augment Vernon Creek flows during periods when the water demand exceeds the base creek flow.

The emergency protection plan (EPP), and operations, maintenance and surveillance (OMS) manuals that meet Dam Safety requirements have recently been updated. Dam safety reviews and consequence ratings have also been completed. Based on new dam safety regulations, the dam classifications have been upgraded to extreme consequence for Beaver Lake Dam and high consequence for Crooked Lake Dam.

4.1.1.1 BEAVER LAKE DAM

Dams typically consist of three main components, an impervious earthfill embankment, an outlet gate structure, and a spillway. The Beaver Lake Dam is 7.1 m in height with a crest length and width of 187 m and 3.7 m respectively. The dam was originally constructed around 1907, replaced in 1944, and raised in 1964. The vertical outlet gate tower was constructed in 1944, rehabilitated in 1984, and some leaks were repaired in 2002. The spillway is a 21.3 m wide concrete sill.

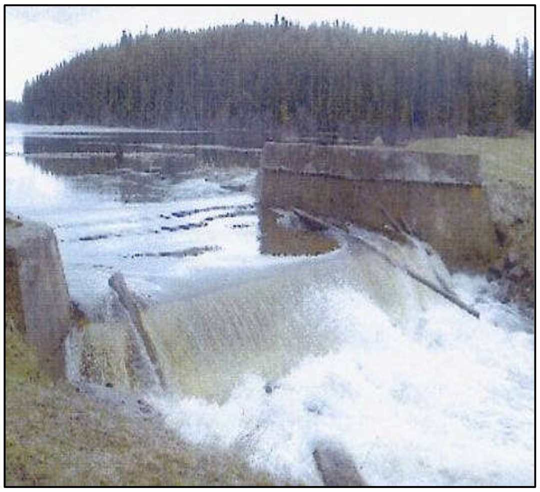
Swalwell (Beaver) Lake Dam Outlet Structure

The dam safety review outlines deficiencies for Beaver Lake Dam facility which include:

a spillway that does not meet current dam safety standards and a deteriorating gate tower and outlet works. Some repair work on the outlet pipe, which was needed immediately, has been completed and is to be followed by regular inspections.

4.1.1.2 Crooked Lake Dam

Crooked Lake Spillway



The Crooked Lake Dam, constructed in 1931, is also an impervious earthfill embankment, 5.2 m in height with a crest length of 226 m. Ancillary works include a 0.6 x 0.6 m reinforced concrete outlet sluice and an 8.6 m wide concrete spillway. A reservoir raising study was performed by Summit Environmental Consulting to compare the environmental impacts with the capital costs, and to analyze the impacts of additional storage around reservoirs in crown leased land regions. The main deficiency on Crooked Lake Dam is material erosion on the downstream side of the spillway.

4.1.2 Vernon Creek Intake

An earth fill dam and concrete spillway have been constructed across Vernon Creek to create a small settling/head pond. A 20 m wide concrete spillway, sloped concrete chute, and energy dissipater allows the creek flows to pass from the pond back down to the creek channel. A new concrete surface has recently been installed over the old surface because has been considerable surface spalling and wear since the initial installation over 40 years ago.

Vernon Creek Intake Screening Building

A concrete block building houses the intake works and screens. Considerable improvements to the building were completed in early spring of 2002 in order to replace the old screens that were submerged approximately 4 m below the pond level. New 20 and 40 mesh inclined screens, with a total area of 12 m², were installed at approximately 0.6 m below the spillway elevation. The intake gates were relocated to the exterior of the building.

The main objectives achieved with the improvements include: reduced screen cleaning maintenance costs, increased screening area to comply with Ministry regulations, and a safe working environment.

4.1.3 RESERVOIRS

4.1.3.1 ELDORADO BALANCING RESERVOIR

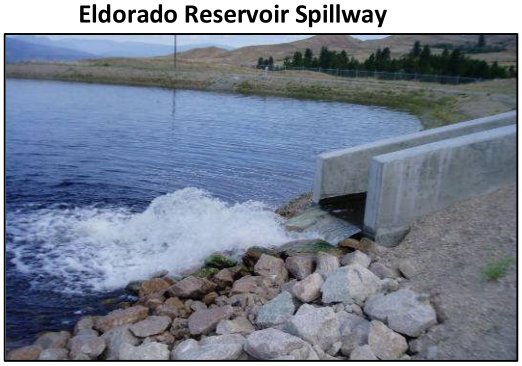
The Eldorado Balancing Reservoir and disinfection facility was fundamental to the removal of PR stations 1 and 2, and the stabilization of mainline pressures. The reservoir is located on a bench above PR 2 at an elevation of approximately 624 m. The mainline pressure was increased by about 14 psi, as the current HGL below PR No. 2 is 617 m. The facility was constructed in 2005 and contains approximately 30,000 m³ (25 ac-ft) of storage.

The large balancing reservoir was required to have sufficient capacity to provide uninterrupted water service. Numerous landslide areas exists immediately upstream of the intake. Some remedial work of the slide areas has been completed, however, large unstable banks remain which will result in further landslides, thereby jeopardizing the water supply.

Eldorado Reservoir

The reservoir is capable of supplying the Winfield area for at least one day during maximum flow conditions. With proper management, the reservoir also reduces operating costs by decreasing the number of manual gate changes required at both the Vernon Creek Intake and Beaver Lake. As well, the volume of mountain storage water discharged past the intake was reduced, as the reservoir can balance the demand fluctuations from the distribution system.

Eldorado Reservoir Spillway



There were noticeable water quality benefits, especially lower turbidity levels as a result of the construction of the Eldorado Reservoir. The reservoir allows high turbidity events in Vernon Creek to be circumvented. The system is equipped with low-level sensors at the reservoir to override the mainline closure during a sustained turbidity event.

In 2009 a hydro generation facility was initiated at the site. The turbine serves as an energy dissipater of the water coming down the pipeline from the intake to the reservoir. Proper management practices have been developed to manage the flow from Vernon Creek intake to satisfy the needs of irrigation, domestic, industrial and most of all the environmental aspects such as fish flows in the creek. A chlorine gas disinfection facility is located in one of the buildings on the site. The site is well suited for future expansion and construction of the water treatment facilities.

4.1.3.2 CAMP ROAD RESERVOIR

Constructed in 1983, the Camp Road Reservoir is located on the hillside behind the works yard. The reservoir is 1500 m³ (400,000 USgal) in size with a high water elevation of 588.4 m. The reservoir is supplied by the mainline pressure from Eldorado Reservoir; however, the hydraulic grade line (HGL) is 29 m higher than the reservoir. This renders the facility ineffective, even when considering pressure losses that occur during peak hour conditions with a fire flow of 60 lps. The purpose of the reservoir is limited to providing a short term backup supply in the event of a mainline break, or to provide control and balancing capacity when operating the booster pump at PR 24. The only immediate concern is that an adequate volume of water be flushed through the piping and reservoir to ensure the water will be fresh when needed. If major repair or maintenance of these works is needed in the future, consideration should be given to abandonment of the installation.

4.1.4 DISTRIBUTION SYSTEM

Excluding the mainlines, the distribution network consists of approximately 40 km of pipe ranging in size from 600 mm to 50 mm diameter. The majority of the distribution piping is asbestos cement (AC), some concrete cylinder (CC), with more recent installations being polyvinyl chloride (PVC), ductile iron (DI) and high-density polyethylene (HDPE). Approximately 7 km of pipe is 100 mm diameter asbestos cement, which is more susceptible to breakage in comparison to larger pipe diameters. There is also some galvanized and PVC piping in the smaller diameters. In general, there have been few leaks considering the high pressures in the system so the piping seems to be in good condition. However, there is corrosion of service connections creating some leaks. In total, there is 6.35 km of 100 mm diameter pipe that needs to be replaced to meet fire flow requirements.

4.1.4.1 VERNON CREEK MAINLINE

The steel mainline conveys water from Eldorado Reservoir down the eastern hillside and along Beaver Lake Road to Highway 97. The 9 mm thick spirally wound steel pipe with a 13 mm thick cement liner on the inside, is between 700 and 800 mm in diameter. From Highway 97 the line continues to the intersection of Chase and Camp Roads. The total length of the mainline from the intake to Chase Road is 9.6 km. Pressures are within the design parameters of the mainline, reaching 250 to 300 psi across the valley bottom. Water velocities are moderate in the mainline reaching 1.0 m/s during an average year (500 lps), and peaking at 1.5 m/s during 1998 (730 lps).

Seaton Road PR Station Tie-in

In 2002 a check of the cathodic protection system on the steel pipeline was conducted by *Southwest Corrosion Control Consultants Ltd*. The check proved that the line was catholically protected and in good shape. However, checking the electrical continuity should be performed on a regular basis to ensure no serious external corrosion problems occur with associated high cost repairs or complete pipe replacement.

In 2008 a tie-in on the mainline was conducted for the Seaton Rd PR Station. A visual inspection showed that the line was in excellent condition. Cathodic protection diodes were installed across the mechanical couplings.

4.1.4.2 PRESSURE REDUCING STATIONS

The elevation change from the Eldorado Reservoir to the service area in the valley creates the need to reduce the pressure within many areas of the distribution system. The pressure zones are created by installing pressure reducing valves at optimal locations in the distribution system.

It is the intent of the District staff to upgrade, rebuild or replace all pressure reducing stations as part of the annual operating budget over the next 20 years. Table 4.1 gives the PRV location, pressures, and hydraulic grade line of the zone. Some of the PR stations are poorly-designed, are showing their age, and are considered to have confined space entry. Also, there are stations located on the edge of busy road and have access hatches and ladders directly above the piping, both of which create a safety concern.

Table 4.1 below shows the 24 PR stations, valve sizes, downstream pressures, and hydraulic grade lines. As outlined in the comments column of the table, some of the PR stations are abandoned, while others need to be removed, reconstructed, or relocated. Also, if pipeline upgrades are completed to improve fire flow capabilities in the District, some pressure reducing valves and/or stations may need to be upgraded as well.

Table 4.1 – PR Stations for Beaver Lake Water Source

PR Stations - Beaver Lake Water Sources							
PR #	**PR Station Name / Location**	**Valve Sizes (in)**	**Ex. D/S Pressure (psi)**	**Ex. D/S HGL (m)**	**New D/S Pressure (psi)**	**New D/S HGL (m)**	**Comments**
1	Upper Range	12, 10, 8, 4					Abandoned
2	Lower Range -Beaver Lake Rd	12, 10, 8, 4, 4					Abandoned
3	Bottom Wood Lake Rds (East)	6, 2	90	486			To be Removed
4	Bottom Wood Lake Rds (West)	6, 2	70	472			To be Removed
5	Kobayashi						Abandoned
	INTERCONNECTION	8	94	533			Proposed Telemetry to Okanagan Lake Reservoir
6	Seaton Rd	8, 2.5	124	554			Supplies Glenmore Road South
7	Shanks Rd	6, 2	92	532			
8	Read Rd	3, 2	60	514			To be Removed
9	Seaton / Dick Rd	4, 2	0	527			
10	Camp & Bond Rd	8, 3	64	577			
11	Bond Rd	8, 6, 3	60	577			Reconstruct
12	McGowan Rd	4, 2	44	559	75	585	To be relocated, larger valve required
13	Brew Rd	4, 2	30	506	25	502	Change after reconfiguration of PR19
14	Hare Rd	4, 2	61	434			
15	6th St	4, 2	58	421			Construct New PR Stn
16	Tyndall Rd	4, 2	40	553			
17	Camp Rd	6, 2	79	484			
18	Davidson Rd	6, 2, 1.5	41	527			
19	Robinson Rd	3, 2	77	506	95		Rebuild & Reconfigure
20	Pretty Rd	4, 2	57	463			
22	Goldie Rd	6, 2	59	492			
23	Carrs Landing Rd	4, 1.5	83	450	60	445	Relocate, larger valve Required
24	INTERCONNECTION Jim Bailey Rd PRV / Booster (100 hp)	10	90	512			Backup to Okanagan Lake Supply Rebuild – New Above Ground Booster Pump Station
		8, 2	82	491			Fire Flow Backup

Figure 4.3 shows the pressure zones within the Beaver Lake Water Source. Pressure zones within the area serviced by the BLWS range from PZ 430 to PZ 620.

4.1.5 HYDRAULIC ANALYSIS

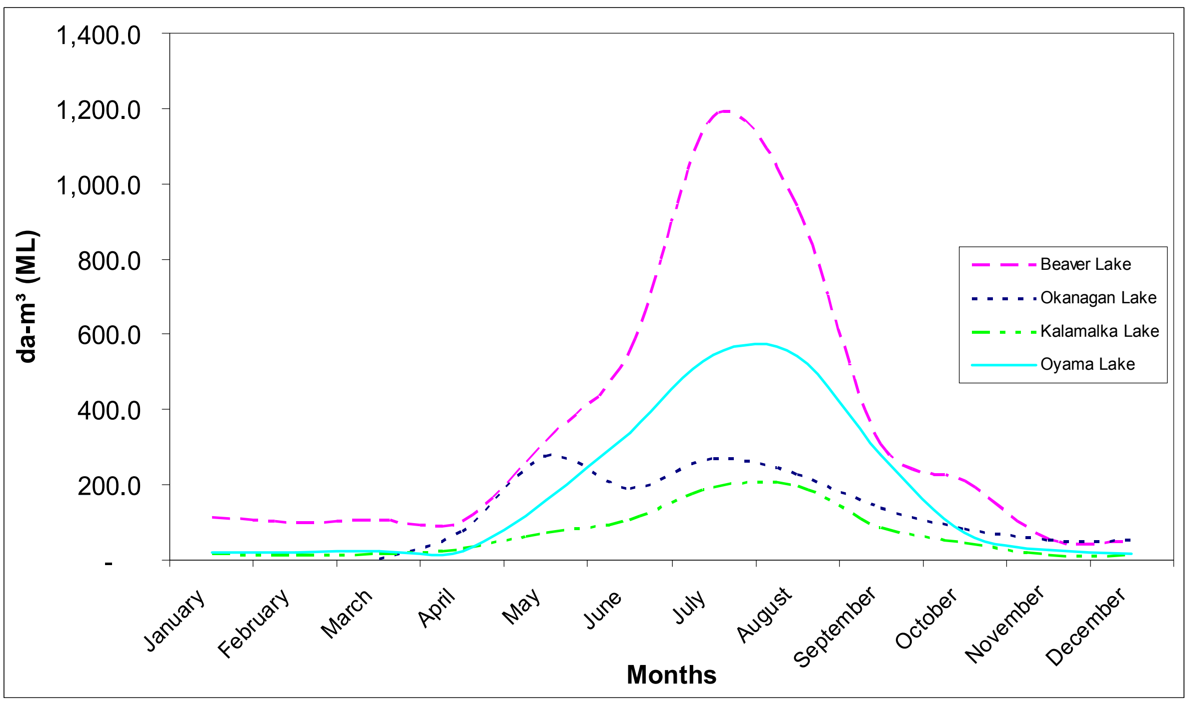
4.1.5.1 MONTHLY WATER USAGE BREAKDOWN FOR 2010

The figure below shows the monthly breakdown of water usage for each source in the year 2010. The comparative graph shows that for all sources, the most usage is in the summer months, between June and August. The least water usage months are in the winter, and are mostly between December and February. Sources with greater agriculture irrigation requirements have greater magnitude peaks.

The figure shows that Beaver Lake has a significantly higher water usage in summer months than any other source. The figure also illustrates that the Beaver Lake usage is consistently higher in all months except for November and December when the usage for Okanagan Lake is marginally more.

Note: Figure 4.1 is referred to for each of the other sources in the appropriate sections.

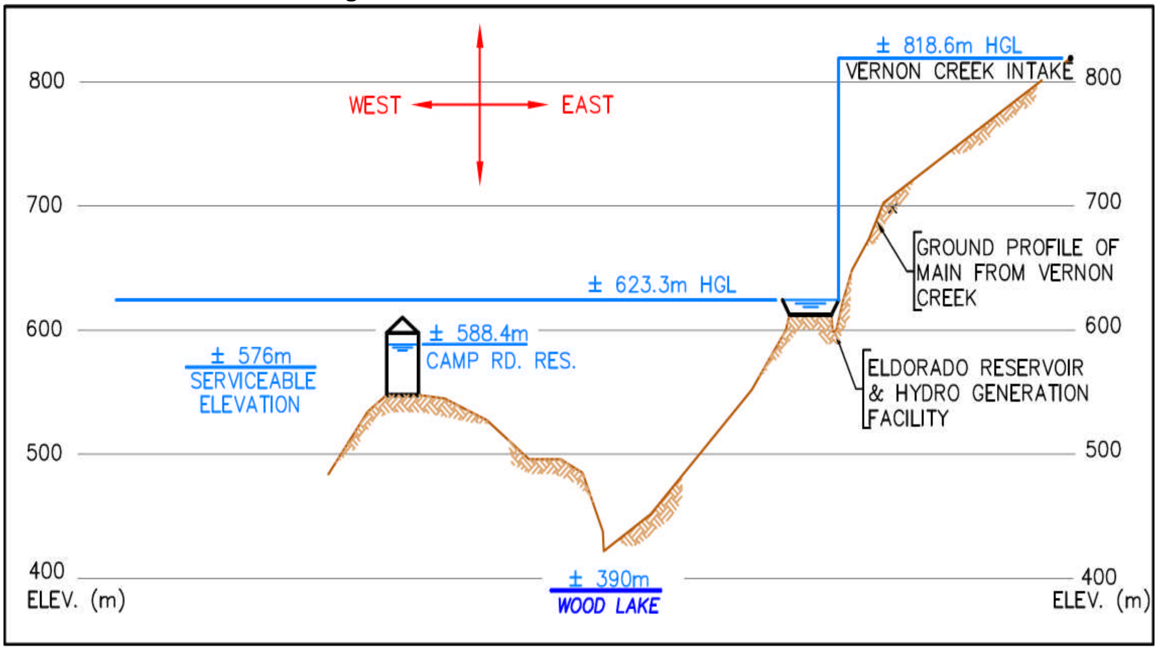
Figure 4.1 – Monthly Water Usage Breakdown for 2010



4.1.5.2 HYDRAULIC GRADE LINE

A cross section of the valley is shown in Figure 4.2 below. The figure shows the Beaver Lake Source hydraulic grade line.

Figure 4.2 – Beaver Lake Water Source Profile



4.1.6 DESIGN PARAMETERS

The criteria used to analyze the water system include both standard design values and values obtained from experience with DLC and other municipalities. Table 4.2 shows the theoretical values for water demand and the design parameters for fire flow, reservoir storage, system pressures, and maximum pipeline PRV velocities. The District of Lake Country bylaw values are shown for comparison. The agricultural water demand is based on the soil duty maps prepared by the Ministry of Agriculture. This design table is applicable for all four major sources.

Table 4.2 – Design Parameters

Design Parameters			
Category	**Imperial Units**	**Metric Units**	**DLC Bylaw**
Theoretical Maximum Day Demand			
Agriculture	5.0-6.5 USgpm/acre	47-61 lpm/ha	6.2 lpm/conn (1.64 USgal/conn)
Rural Residential	3.8 USgpm/conn (0.6-1.0 acre lot)	14.4 lpm/conn (0.25-0.4 ha lot)	
Urban Large Residential	1.9 USgpm/conn (0.3-0.6 acre lot)	7.2 lpm/conn (0.12-0.25 ha lot)	
Single Family Residential	1.6 USgpm/conn (<0.3 acre lot)	6.2 lpm/conn (<0.12 ha lot)	
Bare Land Strata, Single Family	1.4 USgpm/conn	5.2 lpm/conn	
Multi-Family & Strata	1.0 USgpm/unit	3.8 lpm/unit	
Commercial, Industrial & Institutional	10 USgpm/acre	94 lpm/ha	
Theoretical Peak Hour Demand			
Rural Residential	6.0 USgpm/conn (0.6-1.0 acre lot)	22.7 lpm/conn (0.25-0.4 ha lot)	10.4 lpm/conn (2.75 Usgal/conn)
Urban Large Residential	3.0 USgpm/conn (0.3-0.6 acre lot)	11.4 lpm/conn (0.12-0.25 ha lot)	
Single Family Residential	2.4 USgpm/conn (<0.3 acre/lot)	6.2 lpm/conn (<0.1 ha lot)	
Bare Land Strata, Single Family	2.24 USgpm/conn	8.32 lpm/conn	
Multi-Family & Strata	1.6 USgpm/unit	6.0 lpm/unit	
Commercial, Industrial & Institutional	16.0 USgal/acre	150 lpm/ha	
Annual Use			
Agriculture	2.26 ac-ft/acre	6.9 ML/ha	
Rural Residential	0.14 ac-ft/conn	0.17 ML/conn	
Rural Residential (with "A" Grade Land)	1.22 ac-ft/conn	1.5 ML/conn	
Urban Large Residential	0.61 ac-ft/conn	0.75 ML/conn	
Single Family Residential	0.32 ac-ft/conn	0.4 ML/conn	
Bare Land Strata, Single Family	0.14 ac-ft/conn	0.17 ML/conn	
Multi-Family	0.14 ac-ft/conn	0.17 ML/conn	
Commercial, Industrial & Institutional	0.28 ac-ft/conn	0.34 ML/conn	
Fire Flow			
All Buildings	Fire Underwriters Survey Guidelines		Fire Underwriters Survey Guidelines
Minimum Rural Residential	950 USgpm	60 lps	
Reservoir Storage			
Fire Flow	Largest Fire Flow x Duration		
Balancing	25% of Residential Maximum Day Demand		
Emergency	25% of a) & b)		
System Pressures			
Maximum	140 psi	965 kPa	1000 kPa
Minimum at Probable Bldg Main Floor during Peak Hour Demand	36 psi	248 kPa	250 kPa
Minimum at Hydrant During Fire	20 psi	138 kPa	140 kPa
Maximum Pipeline Velocity			
Peak Hour	6.5 ft/s	2.0 m/s	2.0 m/s
Peak Day Plus Fire Flow	13 ft/s	4.0 m/s	4.0 m/s
Maximum PRV Velocities			
Peak Hour	20 ft/s	6.0 m/s	
Peak Day Plus Fire Flow	25 ft/s	7.6 m/s	

4.1.6.1 MAXIMUM DAY & PEAK HOUR DEMANDS

Maximum day flow calculations are used to determine the size of future expansion of the water supply system. The resulting facilities will be utilized to near capacity daily during the high demand in the summer months.

In comparison to the other sources, Beaver Lake has the largest design peak hour demand, with a magnitude of 710 lps. Based on the distribution system computer model, the design maximum day demand for Beaver Lake is 595 lps.

More recent flow data, including actual max day flow, was not available from the District and has not been analyzed. This data should be analyzed when the computer model of the distribution systems is updated. When it is analyzed, consideration needs to be given to whether or not the summer months would be considered among the hottest and driest on record. According to the Environment Canada records, the hottest and longest summer occurred in 1998.

4.1.6.2 Distribution System Computer Model

The *Waterworks* software for AutoCAD R14 was used to develop a computer model to analyze the hydraulics of the distribution system. As outlined in the Assessment Response Plan completed in 2004, the model was calibrated using actual flow and pressure data to obtain accurate results. A scaling factor of 75% was used to reduce the values from a theoretical demand to a design peak hour demand. An accurate computer model is a useful tool to extensively analyze the existing water system and to determine the growth impact on the system.

The distribution piping is generally well sized to supply the current peak hour demand, with only one pipeline on Hare Road (150 mm AC) where velocities exceed the design parameters during peak flow. A large amount of the hydrants are located on or downstream of the small diameter (100 mm) pipe. The computer model was previously used (2004) to determine the available flow at every hydrant on the system, and numerous hydrants cannot supply the minimum fire flow of 60 lps. Upgrading pipelines to supply minimum fire flows would also require upgrading of some pressure reducing valves and/or stations in the system.

Many PR stations are not optimally placed or operated, which results in several high and low pressure areas. High pressures areas include Pow, Oceola, Robinson, Lang, and Goldie Roads. The low-pressure areas are on Long Road and the south end of Cemetery Road. The hydraulic grade line of the Eldorado Reservoir (623 m) is higher than the downstream setting of the former PR 2 (617 m), which benefits properties in the upper lands supplied by this system.

The majority of the distribution system computer model has been updated to existing conditions, including the addition of pipes, nodes and demands for specific newer developments. However, further work is required to completely update the model and it is recommended that the computer modeling software is upgraded.

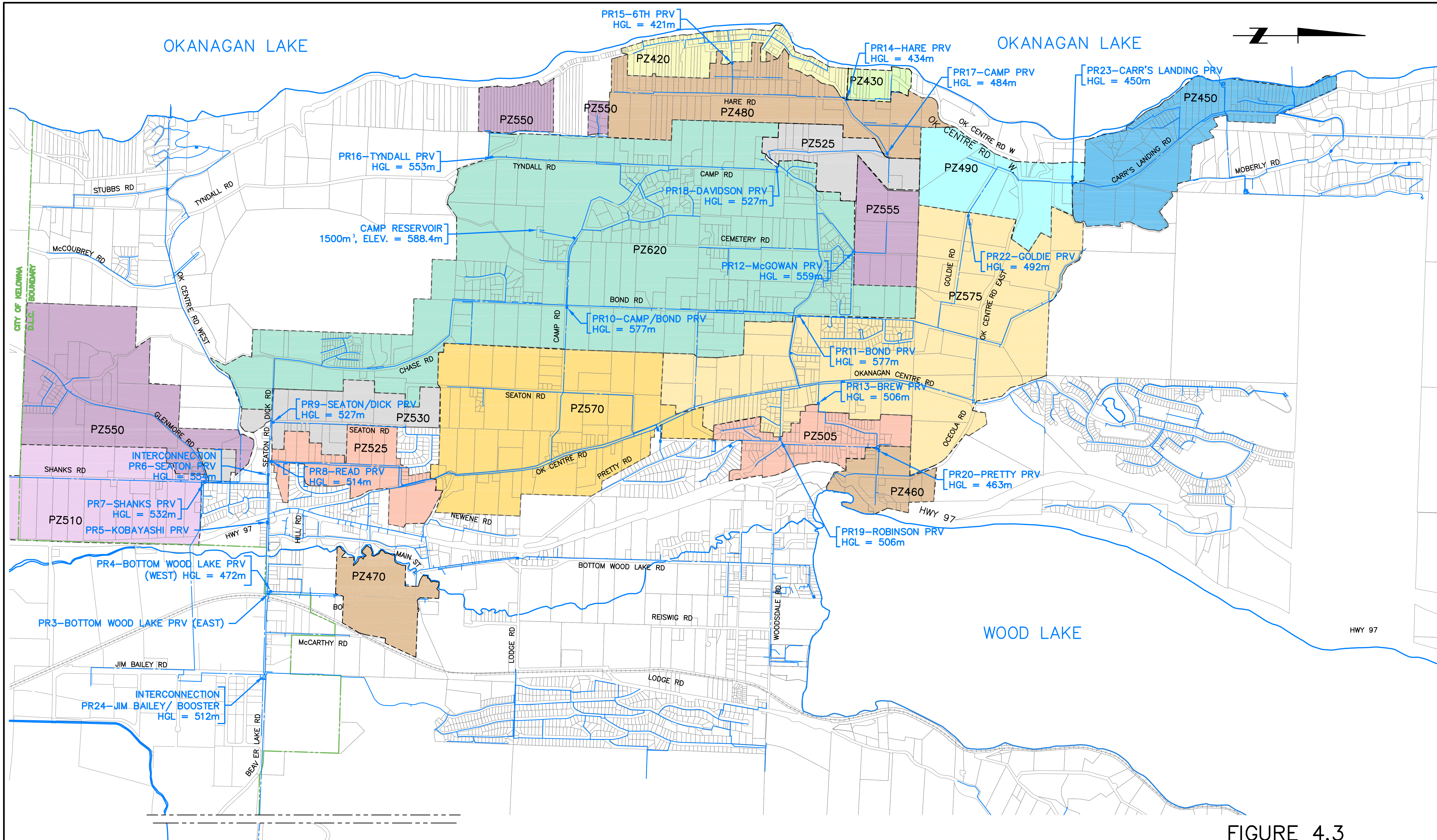


FIGURE 4.3

DISTRICT OF LAKE COUNTRY
WATER MASTER PLAN
BEAVER LAKE WATER SOURCE
DISTRIBUTION AREAS

SCALE: NTS

DEC. 2011

LAKE COUNTRY
LIFE. THE OKANAGAN WAY.

Mould Engineering

4.2 OKANAGAN LAKE SOURCE INFRASTRUCTURE COMPONENTS

The Okanagan Lake Intake Assessment report was completed by Larratt Aquatic in July 2010*.* The report determined the current and future water risks and hazards and provides recommendations to minimize the impacts of the intake. The Okanagan Lake Intake assessment identifies the existing and future threats and hazards in the drinking water and provides recommendations to limit the potentially detrimental impacts on the intake. The report also outlines the need to develop a source protection plan for mid-North Basin Okanagan Lake and a water treatment and system protection plan. An Intake Protection Zone is necessary to protect the unrestrained development along the shoreline. The District plans to apply for a License of Occupation over the Intake Protection Zone and closely monitor the water quality of the lake to meet the IHA filtration deferral standards.

In summary, the Okanagan Lake Water Source (OLWS) consists of the following components:

- Okanagan Lake pump station and intake
- Okanagan Lake Balancing Reservoir
- An 850 mm diameter steel pipe extending a total of 5 km from the Okanagan Lake reservoir to Jim Bailey Road
- The two reservoirs at the Lakes Development
- Increasing the number of pressure reducing stations
- Distribution system

4.2.1 PUMP STATIONS

Costs associated with pumping water from the lake, HGL 340 m to the reservoir at HGL 536 m make Okanagan Lake water more costly than gravity systems such as Beaver and Oyama Lake sources. However, because of the superior water quality, the distribution of Okanagan Lake water to the urban areas in Winfield has increased.

4.2.1.1 OKANAGAN LAKE PUMP STATION

The Okanagan Lake Pump Station, built in 1970 for the Hiram-Walker Distillery, is located near the south-western boundary of Lake Country. The intake is approximately 40 m from the lakeshore. Although the depth of the intake provides sufficient protection from surface contaminants, the relative closeness to shore exposes the intake to shoreline activities, seiches and diluted plumes from various creeks. The intake screens are located at the inlet to the wet well and do not meet current *Ministry of Water, Land and Air Protection* standards. The screens are scheduled to be replaced.

The pump station wet well is fed by a 1200 mm diameter pipe with the intake situated 31 m below the lake surface which is typically below the thermocline zone. The pumping facility consists of three 750 hp pumps and motors. The third pump, which has been upgraded from 350 hp to 750 hp, was designed to be on standby for emergency purposes and to meet fire flow regulations. The design pumping rate is 464 lps (7350 USgpm) with two 750 hp units operating. Generally the building is in good condition but due its age it needs upgrading such as improved lighting, painting, etc.

An on-site sodium hypochlorite generation disinfection system was installed at the pump station in 2010 to replace the original sodium hypochlorite tote system.

4.2.1.2 JIM BAILEY RD BOOSTER PUMP STATION

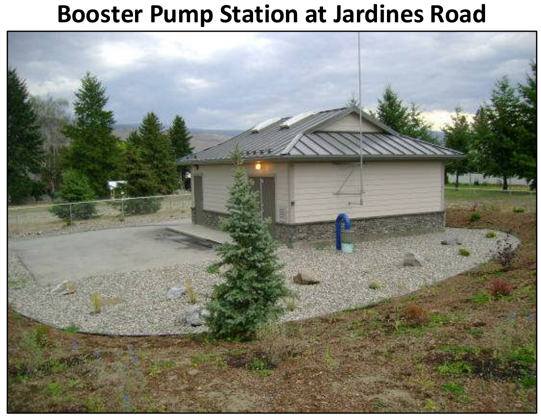
The Jim Bailey Rd Booster Pump Station, also known as PR24 Booster Pump Station, was originally installed to supply the Beaver Lake Source with Okanagan lake water during the intake screen improvements at Vernon Creek. This facility is slated for major improvements.

Jim Bailey Booster Pump Station

A single booster pump was installed inside the existing underground chamber which was originally designed to house a pressure reducing station. The electrical cabinets and variable frequency drive required for the pump were also installed in the chamber which limits the space available for operators.

4.2.1.3 JARDINES RD BOOSTER PUMP STATION

Booster Pump Station at Jardines Road



Okanagan Lake water is supplied to *The Lakes* development via a 450 mm diameter PVC line from the Okanagan Mainline at Glenmore Rd, along Okanagan Centre Rd E into the booster pump station at Jardines Rd. The pump station contains two 75 hp horizontal centrifugal pumps (one is back up) with variable speed drives capable of pumping 60 lps up to the Lower Lakes Reservoir, HGL 584 m.

The pump station also contains a pipeline on the suction side of the pumps to supply water down to Pretty/Roberts Rd. There is also a back-up supply to the downstream side of booster pumps, from the Beaver Lake Water Source at Camp/Bond Road (PR 10).

4.2.1.4 LOWER LAKES BOOSTER PUMP STATION

Lower Lakes Booster Pump Station

The infrastructure associated with *The Lakes* development located on the northern end of Winfield was mostly constructed between 2003 and 2005. Two booster pumps are located inside of the Lower Lakes Reservoir valve house to pump water up to the Upper Lakes Reservoir.

These two reservoirs provide a balancing source of drinking water and fire flow for *The Lakes* area as well as Ponderosa. Some minor improvements are scheduled for the facility. Sodium hypochlorite is injected into the pump discharge line to boost the residual chlorine required in the system at the Upper Lakes reservoir.

4.2.2 RESERVOIRS

The Okanagan Lake Water Source is a pumped system and requires reservoirs to control fluctuations in demand and provide fire flow storage. There are three reservoirs on this source; Okanagan Lake Reservoir and the Lower and Upper Lakes Reservoirs.

4.2.2.1 OKANAGAN LAKE RESERVOIR

A 2270 m^3 (600,000 USgal) reservoir situated near McCoubrey Road, with a high water elevation of 536.4 m, is used for controlling starting and stopping of the pumps at the Okanagan Lake Pump Station as well as balancing the fluctuations in demand and storing fire flow. Future expansion of this facility is planned. Since it is over 40 years old, it needs to be inspected, with a leakage test, and cleaned.

4.2.2.2 LOWER & UPPER LAKES RESERVOIRS

Both reservoirs were built by The Lakes Development to supply domestic and fire flow water to the residences of the development on the north end of Winfield. The reservoirs are at HGL 584 m and HGL 641.5 m respectively. The Lower Lakes Reservoir has a capacity of 4,000 m^3 and the Upper Lakes Reservoir 1,500 m^3.

The Lakes Development

Water is supplied to the Lower Lakes Reservoir through a 300 PVC watermain along Okanagan Centre Rd E. from the Jardines Booster Pump Station. From the Lower Lakes Reservoir water is boosted up to the Upper Lakes Reservoir. Both reservoirs are fairly new and should not require any capital investment in the near future.

4.2.3 DISTRIBUTION SYSTEM

The Okanagan Lake water distribution system was formerly an integral part of the Winfield Okanagan Centre Water System. Although the Okanagan Lake Water System (OLWS) is interconnected with the Beaver Lake Water System at several locations, the OLWS is essentially a separate system. Excluding the mainlines, the distribution network consists of approximately 37 km of pipe ranging in size from 450 mm to 50 mm diameter. The majority of the distribution piping is asbestos cement (AC), with more recent installations being polyvinyl chloride (PVC), ductile iron (DI) and high-density polyethylene (HDPE). Approximately 3 km of pipe is 100 mm diameter asbestos cement, which is more susceptible to breakage in comparison to larger pipe diameters. In order to meet fire flow requirements, 1.93 km of 100 mm diameter pipe needs to be replaced.

4.2.3.1 OKANAGAN LAKE MAINLINE

Okanagan Lake Mainline

The mainline, constructed at the same time as the reservoir and pump station, is an 850 mm diameter steel pipe, with a total length of 4.9 km. It extends from the Okanagan Lake Pump Station to the Okanagan Lake Reservoir, then to Jim Bailey Road and the decommissioned Hiram-Walker Distillery.

In 2008, a visual inspection was made of the interior of the line during a tie-in on Glenmore Rd. There was no visible corrosion and the interior was in good shape. An assessment of the cathodic protection system on the steel pipeline was conducted by *Southwest Corrosion Control Consultants Ltd*. The assessment results confirmed that the line was in good condition and catholically protected.

In 2008, a 3 km long PVC branch line, 450 mm in diameter, was installed from Glenmore Rd along Read Rd and Okanagan Centre Rd E. to provide water to the Jardines Road booster pump station, which then supplies to Okanagan Lake water to The Lakes Development.

4.2.3.2 PRESSURE REDUCING STATIONS

Table 4.3 lists the pressure reducing stations associated with the OLWS. The Taiji Ct PR has been identified as obsolete and could be removed from the system to avoid unnecessary maintenance, as pressures would not exceed the maximum allowed in the Bylaw if it were removed.

Table 4.3 – PR Stations for Okanagan Lake Water Source

PR Stations - Okanagan Lake Water Source							
PR #	**PR Station Name / Location**	**Valve Sizes (in)**	**Ex. D/S Pressure (psi)**	**Ex. D/S HGL (m)**	**New D/S Pressure (psi)**	**New D/S HGL (m)**	**Comments**
21	Jardines Rd Booster Pump Station	4	35	527			PR in Pump Station is backup to supply from Okanagan Lake Reservoir. Remove Old PR21 Chamber.
24	INTERCONNECTION Jim Bailey Rd PRV / Booster (100 hp)	10	120	512			Backup to Okanagan Lake Supply Rebuild - New Above Ground Booster Pump Stn
		8, 2	90	491			TOWN CENTRE SUPPLY
26	Taiji Ct	8, 2	78	462	Open		To be Removed
29	Pretty / Roberts Rd	6, 2	62	487			
	INTERCONNECTION Seaton PR Stn						
5		10, 3	40	496			Supplies Town Centre
	Lower Ponderosa PRV					470	Setting to be Verified
	Upper Ponderosa PRV					514	Setting to be Verified

PR Station on Roberts Road during Construction

A new pressure reducing station on Roberts Rd was constructed in 2010 as part of the incorporation of the Woodsdale utilities system into the DLC water systems. The valve chamber was located in the embankment below Pretty Rd. and access is through a ground level door eliminating manholes and confined space entry.

The highest pressure zone (PZ) within the OLWS is based on high water elevation of the Okanagan Reservoir (HGL 536.4 m), and are shown in Figure 4.5. Pressures in Town Centre and Bottom Wood Lake Road area are PZ460 and PZ490, while the Pretty/Roberts Road area and Copperhill are both at a higher elevation is PZ530. The Lakes Development and Ponderosa have their own pressure zones, PZ640 and PZ580, created by the high water elevation of the upper reservoir at HGL 641.5 m and the lower reservoir is at HGL 584 m.

4.2.4 HYDRAULIC ANALYSIS

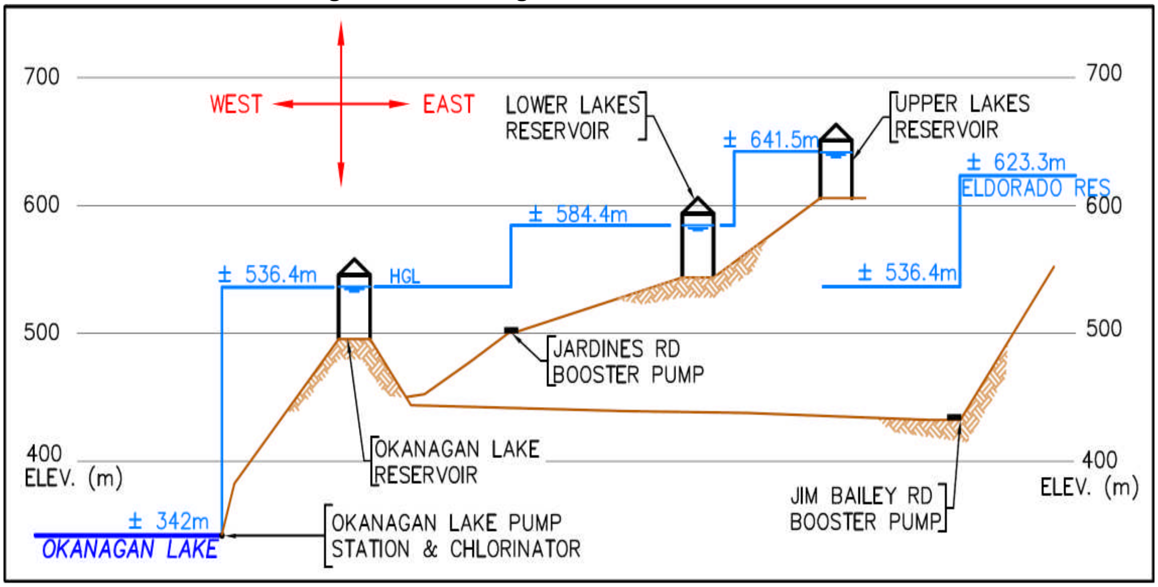
4.2.4.1 MONTHLY WATER USAGE BREAKDOWN FOR 2010

Refer to Figure 4.1 for the monthly water usage breakdown for 2010 for OLWS. The figure shows that OLWS usage peaks between May and August, where the most usage occurs in the middle of May. Although the usage is low in the winter months, the water usage for OLWS in November and December is higher than that of any other source.

4.2.4.2 HYDRAULIC GRADE LINE

The hydraulics of the Okanagan Lake Water Source is shown in Figure 4.4, which is an East/ West section of the valley looking north. The hydraulic grade lines shown in the figure take into consideration the distribution system losses.

Figure 4.4 – Okanagan Lake Water Source Profile



4.2.5 DESIGN PARAMETERS

The design parameters for the Okanagan Lake Water Source are the same as shown in Table 4.2. The data in the table pertains to all major sources within the District of Lake Country.

4.2.5.1 MAXIMUM DAY & PEAK HOUR DEMANDS

The design maximum day demand based on the computer model is 200 lps. This value does not include the full use for the City of Kelowna. The design peak hour demand is 320 lps, which is 1.6 times the maximum day demand. These values are based on the distribution system computer model. Recent actual max day data was not available from the District, but should be analyzed and compared to the design values.

4.2.5.1.1 *CITY OF KELOWNA BULK WATER AGREEMENT*

Included in the Okanagan Lake Water Source service area is the supply to City of Kelowna Industrial Park. The District and the City have two agreements regarding the metering and supply to two different areas of the Industrial Park:

- The District must supply potable water at maximum day flow rate of 21 lps plus a fire flow of 190 lps for 3 hrs to the 20 ha parcel southeast of the intersection of Jim Bailey Road and Beaver Lake Road.
- The District must supply a maximum daily flow rate of 98 lps plus a fire flow of 227 lps for 3 hrs to parcels farther south along the east side of Jim Bailey Road, with a combined water allocation of 60 ha.

The agreements allow the combined maximum daily flow rate of 119 lps to be supplied through either the pressure reduced Beaver Lake Source or the pumped Okanagan Lake Source. Since Okanagan Lake reservoir is not large enough to solely meet the fire flow duration requirements, pressure reduced interconnects from the Beaver Lake Water Source are provided.

4.2.5.2 DISTRIBUTION SYSTEM COMPUTER MODEL

The *Waterworks* software was used to develop a computer model for the Okanagan Lake Water Source. The computer model was calibrated in 2004, and a scaling factor of 75% was used to reduce the demands from a theoretical value to a design peak hour demand.

The distribution piping is generally well sized to supply the current peak hour demand, with the exception of The Lakes development. System upgrades are required in order to supply the current number of approved units as well as ‘full build-out’ to this development. In general, the majority of the off-site works required for the Lakes are on the Beaver Lake Water Source; the specific details of which are addressed in several reviews of this development and are not included in this report.

A considerable portion of the hydrants are located on or downstream of small diameter (100 mm) pipe. The computer model was previously used (2004) to determine the available flow at every hydrant on the system, and numerous hydrants cannot supply the minimum fire flow of 60 lps. Upgrading pipelines to supply minimum fire flows would also require upgrading of some pressure reducing valves and/or stations in the system. The majority of the distribution system computer model has been updated to existing conditions, including the addition of pipes, nodes and demands for specific newer developments. However, further works is required to completely update the model and it is recommended that the computer modeling software is upgraded.

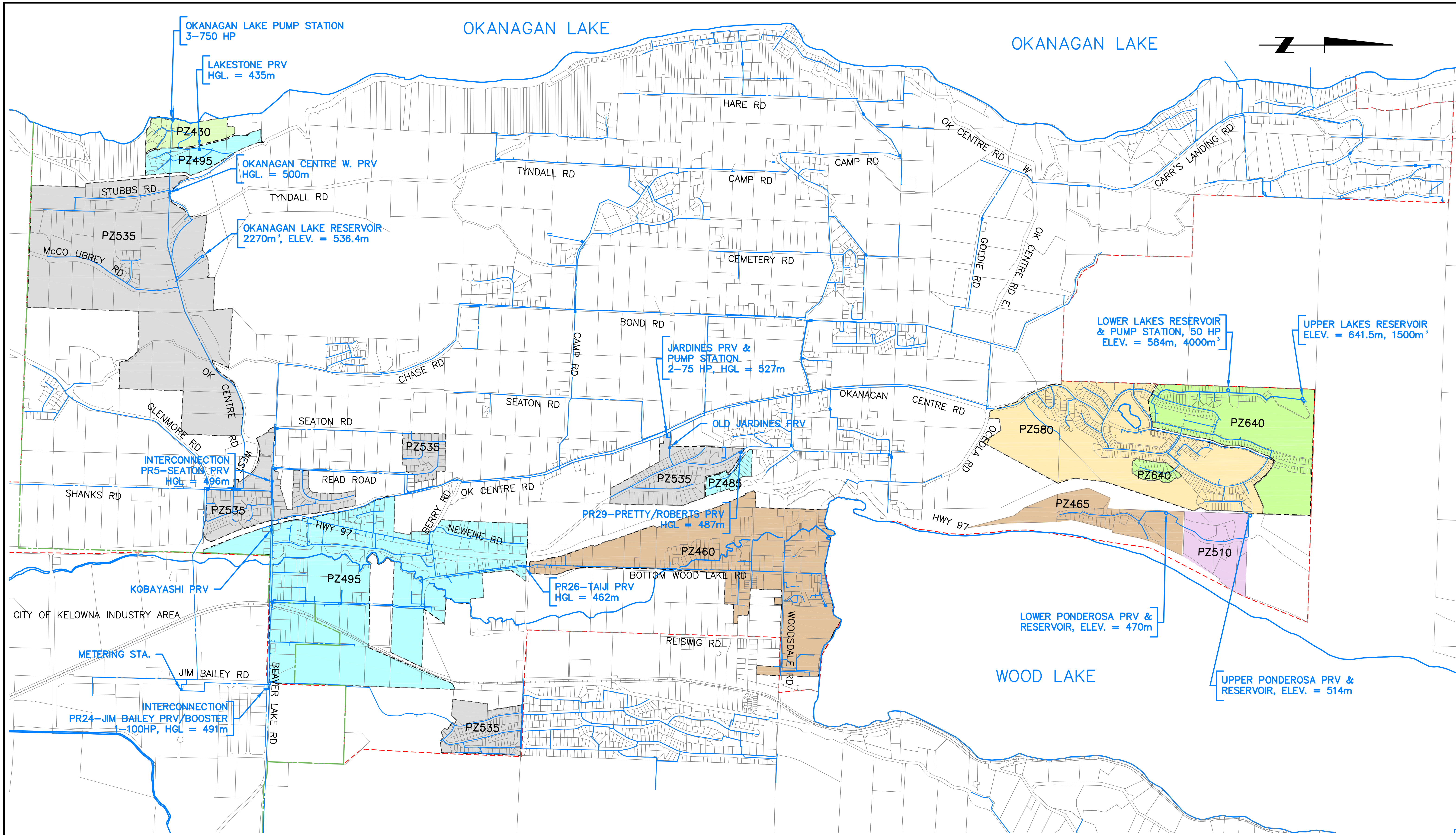


FIGURE 4.5

DISTRICT OF LAKE COUNTRY
WATER MASTER PLAN
OKANAGAN LAKE WATER SOURCE
DISTRIBUTION AREAS

SCALE: NTS

DEC. 2011

4.3 *KALAMALKA LAKE SOURCE INFRASTRUCTURE COMPONENTS*

The Kalamalka Lake Water Source was previously known as the Oyama Water System and before that the Oyama Irrigation District.

Generally the Kalamalka Lake Water System (KLWS) consists of the following components:

- Lake intake
- Pump station
- Balancing reservoir
- Distribution system

Upgrading has resulted in a system that is generally in good condition and capable of supplying both irrigated and domestic services, in addition to some surplus capacity.

4.3.1 KALAMALKA LAKE & INTAKE

South Kalamalka Lake

The South Kalamalka Lake Intake Assessment report was completed by Larratt Aquatic on July 2010. The report determined the current and future water risks and hazards and provided recommendations to minimize the impacts of the intake. Water current studies and hazard assessments were conducted near the intake to determine the fall rates of particulate contaminants.

The research results were based on a two hour travel time of water currents to the intake, and the information was used to define the proposed Intake Protection Zone. The South Kalamalka Lake Intake assessment plan suggests that it is necessary to make major expenditure improvements to the Kalamalka Lake water system to facilitate growth. Data collection results support the decision to extend the intake to meet the IHA requirements. The District plans to provide source protection for Kalamalka Lake by developing a Comprehensive Emergency Plan, preparing a water system and treatment plan, and obtaining an Intake Protection Zone License for Occupation. The raw water sample line on the intake will be replaced and the water quality monitoring standards will be improved to conform to the Interior Health Authority standards.

The lake itself is not under the jurisdiction of the District and therefore development along the shoreline would be difficult to control. The intake is screened and located at

22 m below the lake surface which is typically below the thermocline zone. One of the recommendations that resulted from the *Source to Tap Assessment of the South Kalamalka Lake Intake Report produced by Larratt Aquatics* is to extend and lower the intake line depth from 22 m to 30 m. A wide range of human activities, natural and weather related, influence the quality of water at the south end of the lake. For instance, turbulences are more intense on the south end of the lake than they are at the north end of the lake because of the shape of the lake basin.

4.3.2 PUMP STATIONS

The Kalamalka Lake Water Source is a pumped water source. Costs associated with pumping water up from the lake to the reservoir at HGL 474.5 m make Kalamalka Lake water more costly than gravity systems such as Beaver and Oyama Lake sources. However, because of the superior water quality, it is ideal to continue distribution of Kalamalka Lake water to the areas in Oyama for domestic and irrigation, and as a future source of water to the Oyama Lake Water source during spring freshet.

4.3.2.1 KALAMALKA LAKE PUMP STATION

Kalamalka Lake Pump Station on Trask Road

The Kalamalka Lake pump station, constructed in 1995, is located on Trask Road. Water is supplied to the pumps through an 800 mm diameter HDPE intake line that extends 440 m into the lake from the lakeshore.

The pumping capacity of the pump station is 268 lps with two 125 hp and one 50 hp pumps running. The third 125 hp pump is considered a standby pump.

The current form of disinfection at the pump station is Sodium Hypochlorite. The injection point is located within the 800 mm diameter intake pipe near the screens. This makes the intake pipe the principal contact chamber, which is necessary as the first service is located 45 m from the pump station.

Ultra Violet (UV) disinfection units are scheduled to be installed at the Kalamalka Lake pump station (part of the Building Canada Fund Project) and will be capable of treating full pumping capacity of the pump station. The timeline for the installation is scheduled for completion by 2013.

4.3.2.2 BOOSTER PUMP STATIONS AT KALAMALKA LAKE RESERVOIR

The pumping facilities in the upper pressure zone were originally designed to supply a HGL 530 m. The combination of these improvements allows the distribution system to supply higher lands and the system can now supply 310 kPa (45 psi). Both pumping facilities are in need of major reconstruction. The pumps are located below ground in a confined space facility.

4.3.3 KALAMALKA LAKE RESERVOIR

There is only one reservoir in the KLWS; Kalamalka Lake Reservoir located on the western slopes above Oyama. The Kalamalka Lake Reservoir was constructed at the same time as the Kalamalka Lake Pump Station and has a high water level of 474.5 m. The reservoir is supplied through a PVC watermain, which ranges in size between 300 mm to 400 mm, along Oyama Rd from the Kalamalka Lake Pump Station. Some minor improvements are scheduled at the reservoir; otherwise the infrastructure is likely in good condition, but needs to be inspected as it is 17 years old.

4.3.4 DISTRIBUTION SYSTEM

The Kalamalka Lake Water Source consists of approximately 13.5 km of watermain. Like other systems, the majority of the underground distribution system was installed during the late 60's under the ARDA program. Although the system is functioning as intended with very little service interruptions, there are areas within the system that need improvement. Some areas were developed for residential use and 100 mm AC lines were installed. These lines have been identified and are scheduled for replacement.

Prior to the pump station and reservoir improvements, the Oyama area was supplied by well water. The well water had a high concentration of iron which caused build-up in many of the lines and led to reduced pipeline capacities. Once the new infrastructure was in place, the lines were flushed for an extended period of time with softer Kalamalka Lake water. This process seemed to reduce the iron build up in the pipes. However, due to water quality complaints, the flushing did not last long so crustations and reduced pipe diameters most likely still exist.

The system is currently interconnected with the Oyama Lake Water Source through an underground pressure reducing valve chamber located on Oyama Rd. This one directional supply is used for emergency situations or during major fires. However, a new interconnection is scheduled to be constructed as part of the *Building Canada Infrastructure* program and will be located in the future booster pump station at Sawmill Rd.

With the exception of the interconnect, there are no pressure reducing stations in the Kalamalka Lake Water Source distribution system. More than 3.57 km of 100 mm diameter pipe needs to be replaced in order to meet fire flow requirements.

4.3.4.1 KALAMALKA LAKE MAINLINE

The 1.5 km long mainline from the Kalamalka Lake pump station, west to Highway 97, has a pipe diameter that ranges between 400 mm and 350 mm. To the east of Trask Road, the mainline diameter reduces down to 200 mm which creates a flow restriction in the system that will feed the planned booster pump station at Sawmill Rd.

4.3.4.2 PRESSURE REDUCING STATIONS

The following table shows the pressure reducing stations in Kalamalka Lake.

Table 4.4 – PR Stations for Kalamalka Lake

PR Stations - Kalamalka Lake Water Source						
PR Station Name / Location	Valve Sizes (mm)	Ex. D/S Pressure (psi)	Ex. D/S HGL (m)	New D/S Pressure (psi)	New D/S HGL (m)	Comments
Oyama Road Interconnect PRV & Meter Chamber	150	100	470	62	471	To be relocated to Sawmill Road Booster Pump Station

There are only two pressure zones in the Kalamalka Lake Water Source, refer to Figure 4.6. The zones are governed by the location of the reservoir at HGL 474.5 m, as well as the 50 hp irrigation booster pump and the 0.5 hp domestic pump, which supply the upper zone.

4.3.5 HYDRAULIC ANALYSIS

While the existing system can supply to the 480 m contour, the system could supply more water if the booster pump was moved to the valve chamber at the new reservoir. Moving the pump to this location would reduce headlosses and increase pumping rates. The valve chamber at the new reservoir was designed to accommodate the booster pump when funds become available to make the change.

4.3.5.1 MONTHLY WATER USAGE BREAKDOWN FOR 2010

Refer to Figure 4.1 for the monthly water usage breakdown for 2010 for Kalamalka Lake. The figure shows that Kalamalka Lake consistently has the lowest water use throughout the year, and the peak usage occurs in August.

4.3.6 DESIGN PARAMETERS

The design parameters for the Kalamalka Lake Water Source are the same as shown in Table 4.2.

4.3.6.1 MAXIMUM DAY & PEAK HOUR DEMANDS

The design maximum day demand for the Kalamalka Lake source is 115 lps. This value, which was determined using the distribution system computer model, is 11 lps more than the actual maximum day demand. The design peak hour demand for Kalamalka Lake is 1.3 times more than the design maximum day demand, with a value of 150 lps.

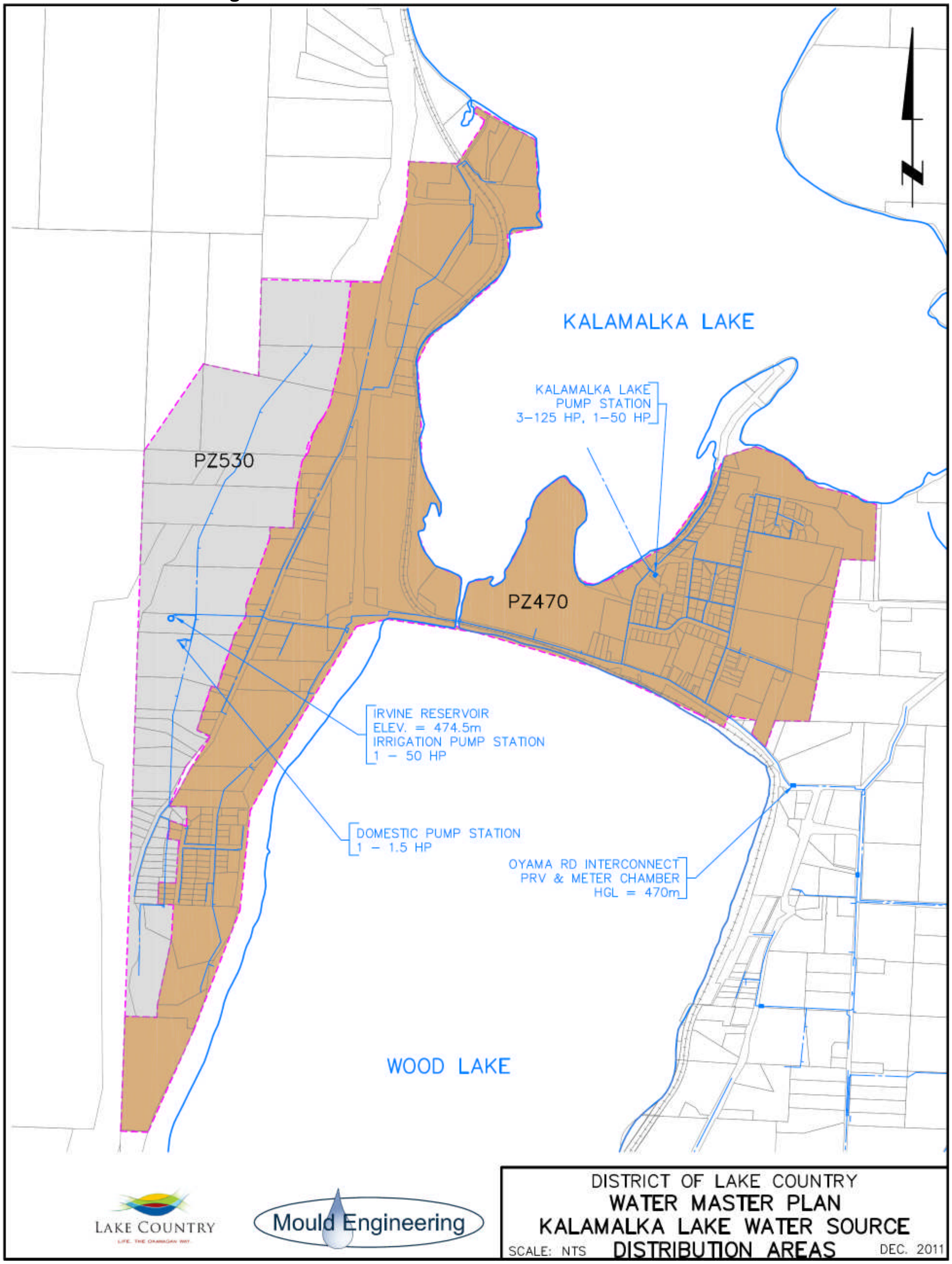
4.3.6.2 DISTRIBUTION SYSTEM COMPUTER MODEL

The distribution system was analyzed with the assistance of the *Waterworks* Computer Model Program. The theoretical demand values were reduced by 85% to represent the design peak hour demand. The analysis of the existing system revealed the distribution piping is generally well sized to supply the current peak hour demand. There are no areas where the minimum pressure criteria cannot be met and no pipelines where maximum velocities are reached under peak hour demand.

A considerable portion of the hydrants are located on or downstream of small diameter (100 mm) pipe. The computer model was previously used to determine the available flow at every hydrant on the system, and numerous hydrants cannot supply the minimum fire flow of 60 lps. Upgrading pipelines to supply minimum fire flows would also require upgrading of some pressure reducing valves and/or stations in the system.

The majority of the distribution system computer model has been updated to existing conditions, including the addition of pipes, nodes and demands for specific newer developments. The Middle Bench Road/Todd Road pipeline, installed in 2010, as well as the proposed Sawmill Road Booster Station, have also been added to the model. However, further works is required to completely update the system demands and it is recommended that the computer modeling data is upgraded.

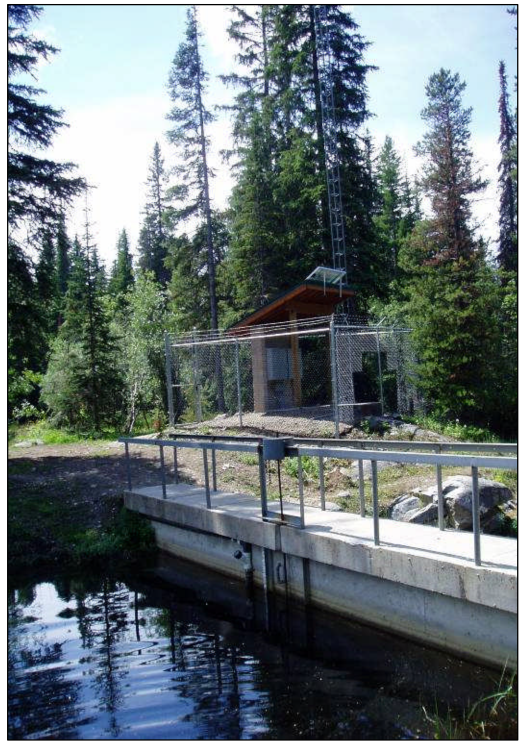
Figure 4.6 – Kalamalka Lake Water Source Pressure Zones



4.4 *OYAMA LAKE SOURCE INFRASTRUCTURE COMPONENTS*

The Oyama Lake Water Source (OWS) was previously known as the Wood Lake Water System and before that the Wood Lake Irrigation District.

Oyama Concrete Dam



The main components of the Oyama Lake Water Source are:

- Oyama and Damer Lake Dams and Reservoirs;
- Oyama Creek Intake, screening building and balancing tank;
- Todd Road Chlorinator; and
- Pressure reducing stations, mainlines and distribution system.

4.4.1 OYAMA AND DAMER LAKE DAMS AND RESERVOIRS

Oyama and Damer Lake Dams and Reservoirs are utilized for the purpose of storing watershed runoff. Water storage is released through control gates and into Oyama Creek when the water demand exceeds the base creek flow.

The operations, maintenance and surveillance (OMS) manuals, and emergency protection plan (EPP) that meet Dam Safety requirements have recently been updated. Dam safety reviews and consequence ratings have also been completed for both Oyama and Damer Lake Dams.

4.4.1.1 OYAMA LAKE DAMS

The Oyama Lake Reservoir is impounded by three separate structures: a concrete core earthfill dam on the Oyama Creek outlet; a concrete dam on the outlet channel; and a concrete spillway to Oyama Creek. At full pool, water also spills into Clark Creek.

The Dam on the Oyama Creek outlet was originally a ‘dirt and timber’ dam constructed around 1908. The Dam was upgraded and rebuilt several times and replaced some time before 1951 with a concrete core earthfill dam. Additional improvements were completed in 1951, and major upgrades were done in 1968 bringing the structure to its current state.

The Dam is 4.0 m in height with a crest length and width of 40 m and 3.7 m respectively. Improvements were made in 2005 to automate the releases into Oyama Creek via telemetry.

In the event of failure, the Dam was classified by the Ministry of Environment as 'High Consequence'. The Dam Safety review outlines improvements required to the Dam and ancillary works.

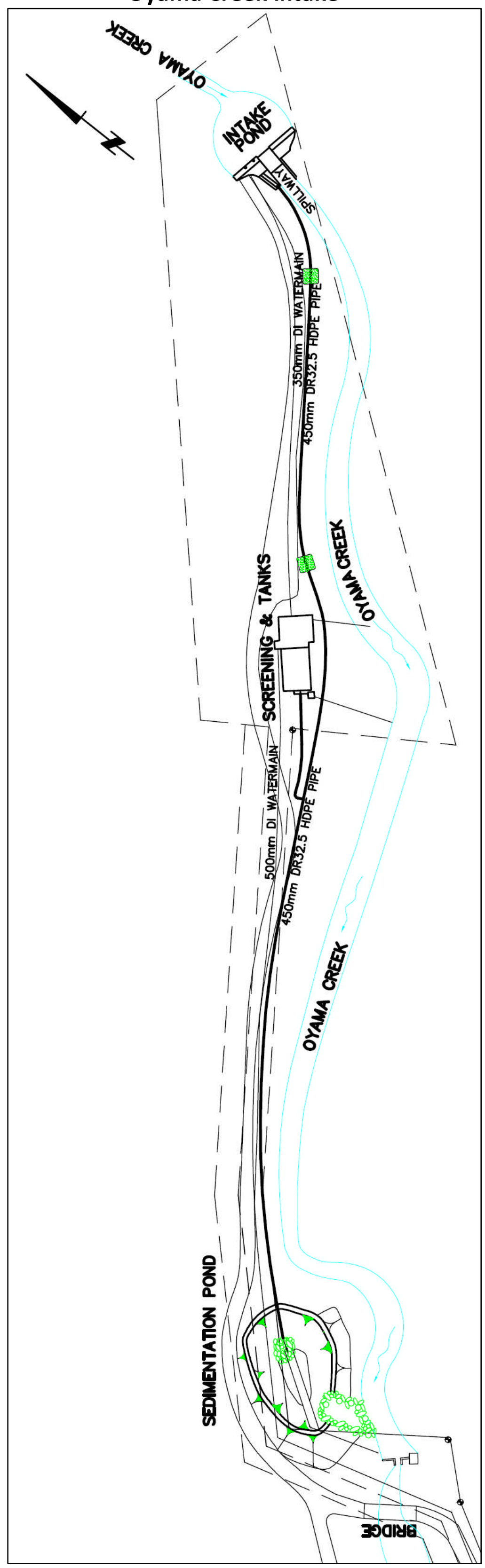
4.4.1.2 DAMER LAKE DAM

The Damer Lake Dam was originally a log crib and rock fill dam constructed in 1931. In 1968, this dam was removed and replaced with an erthfill dam with a clay core, which is the current dam. The Dam is 4.0 m high at its highest point and has a crest length and width of 50 m and 3.5 m respectively. Ancillary works include a 600 mm outlet pipe with sluice gate and a 1.7 m wide spillway.

In the event of failure, the Dam was classified by the Ministry of Environment as 'High Consequence'. The Dam Safety Review outlines improvements required to the Dam and ancillary works.

4.4.2 OYAMA CREEK INTAKE & SCREENING FACILITIES

Oyama Creek Intake



The Oyama Creek Intake facilities are located at elevation 613 m on property owned by the District. The intake facility consists of a concrete dam with a sluice gate and a 350 mm mainline to a screening building. The creek flows down into Kalamalka Lake.

The screening building is equipped with fish screens that meet Ministry requirements. Water passes through these screens before entering the balancing tank and then the 500 mm PVC mainline to the distribution system.

In 1997, a sedimentation pond was constructed to allow the intake pond to be cleaned without flushing sediment down the Creek. Minor mechanical improvements were also made in 2005 in conjunction with the automation of the Oyama Lake gate.

The building will be replaced, insulated and supplied with power and lighting. It is anticipated that the new screening building may incorporate the proposed relocation of the chlorine gas disinfection facilities.

4.4.3 PUMP STATIONS

Currently there is only one pump station in the Oyama Water Source; the Talbot Road Pump Station which supplies a few properties on the south end of Talbot Road, a t HGL 670 m. The pump station was originally constructed in 1991 with 5 Hp and ½ Hp pumps. The pumps were recently re-built and the station is scheduled for improvements. A booster pump station at Sawmill Rd is scheduled to be built in 2012 as part of the *Building Canada Infrastructure* program.

4.4.4 RESERVOIR

Currently the Oyama Water Source has a small balancing tank; however, a larger balancing reservoir will be built at the Oyama Creek Intake as part of the Oyama/Kalamalka Lake Water Source Supply and Quality Improvement project. The reservoir was first proposed in the capital works program of 1998 -2008. The reservoir is part of the *Building Canada Infrastructure* program approved to improve the water quality and supply to the OWS residents.

4.4.5 DISTRIBUTION SYSTEM

The underground water lines and pressure reducing stations were installed under the ARDA program during the 1960s and '70s. Excluding the mainline, the distribution network consists of approximately 15 km of pipe ranging in size from 400 mm to 50 mm in diameter. The distribution piping consists of asbestos cement (AC), polyvinyl chloride (PVC), ductile iron (DI), and high density polyethylene (HDPE) pipelines.

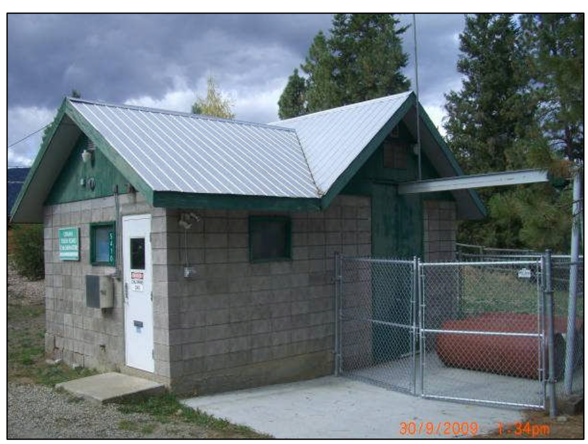
In general, the system operates with very few problems, with the exception of occasional line breaks and pressure fluctuations. Also, there is a section of 100 mm AC line on Talbot Road that causes a flow restriction in the line and needs to be replaced. Approximately 3.5 km of 100 mm diameter pipe needs to be replaced to meet fire flow requirements.

4.4.5.1 OYAMA CREEK MAINLINE

The 500 mm ductile iron mainline runs from the screening building at the intake, past the chlorination facility on Todd Road, down to the distribution system, at a distance of 4.0 km.

4.4.5.2 TODD ROAD CHLORINATOR

Chlorination Facility on Todd Road



The Todd Rd chlorination facility was constructed during the 1970s. The chlorination point is on the 500 mm mainline, just upstream of the first users. The facility also houses some water quality monitoring equipment.

Once the new reservoir and chlorination facilities have been constructed at the Oyama Creek Intake, the Todd Rd facility will be demolished.

4.4.5.3 PRESSURE REDUCING STATIONS

The OWS contains 10 pressure reducing stations as shown in Table 4.5. PR No. 2 on Middle Bench Rd. is slated to be reconfigured once the Sawmill Road Booster Pump Station is constructed.

Table 4.5 – PR Stations for Oyama Lake Water Source

PR Stations - Oyama Lake Water Source						
PR #	**PR Station Name / Location**	**Valve Sizes (in)**	**Ex. D/S Pressure (psi)**	**Ex. D/S HGL (m)**	**New D/S Pressure (psi)**	**New D/S HGL (m)**
1	Todd Rd	4	67	544		
2	Middle Bench / Todd Rd	4	50	496		
3	Oyama Rd	1	50	474		
4	Middle Bench Rd	2	55	541		
5	Allison Rd	4	55	526		
6	Oyama / Broadwater Rd	4	50	492		
7	Towgood Rd	4	85	559		
8	Trewhitt Rd	3	68	561		
9	Middle Bench / Towgood Rd					

Refer to Figure 4.7 for the Pressure Zone map for Oyama Lake.

4.4.6 HYDRAULIC ANALYSIS

4.4.6.1 MONTHLY WATER USAGE BREAKDOWN FOR 2010

Refer to Figure 4.1 for the monthly water usage breakdown for 2010 for Oyama Lake Water Source. The figure shows that the usage peaks in the summer months, where the most usage occurs in July. The peak usage in July is approximately 50 % of the peak usage for Beaver Lake Water Source for the same month.

4.4.7 DESIGN PARAMETERS

The design parameters for the Oyama Lake Water Source are the same as shown in Table 4.2.

4.4.7.1 MAXIMUM DAY & PEAK HOUR DEMAND

The design maximum day demand for Oyama Lake, which was determined using the distribution system computer model, is 285 lps. This design value is conservative, as the actual maximum day is 255 lps. The design peak hour demand for Oyama Lake is 340 lps, which is 1.2 times the design maximum day demand.

4.4.7.2 DISTRIBUTION SYSTEM COMPUTER MODEL

The distribution system was analyzed with the assistance of the *Waterworks* Computer Program. A scaling factor of 80% was used to reduce the demands from theoretical to a design peak hour demand.

The analysis of the existing system at peak hour demand indicated that the minimum pressure criteria is being met for all irrigated land. The critical lots for minimum pressures are at the south end of the system on Oyama Road and Trewhitt Road East. The water pressure to properties in these areas is slightly above the minimum, and therefore additional irrigated land must be accompanied by distribution system upgrading to ensure that users are not adversely affected. There are no single sections of pipeline where losses are particularly high so there is no easy remedy to reducing system headlosses.

The minimum pressure of 250 kPa (36 psi) at the service connection is being met for all lots being supplied with domestic water but some homes on larger lots may not receive 250 kPa at the main floor of the residence. Properties that rise considerably in elevation from the service connection to the home site may have pressure below the minimum. The District has taken the position that where landowners want to construct above the highest elevation that can be supplied with minimum pressure they must provide their own facilities to boost the water pressure to acceptable levels. The future Sawmill Road Booster Station, when operating, will assist low pressure areas as it will reduce the headlosses in the mainline from the intake to PR 1.

A considerable portion of the hydrants are located on or downstream of small diameter (100 mm) pipe. The computer model was previously used to determine the available flow at every hydrant on the system, and numerous hydrants cannot supply the minimum fire flow of 60 lps. Upgrading pipelines to supply minimum fire flows would also require upgrading of some pressure reducing valves and/or stations in the system.

The analysis also indicated that some of the pressure reducing valves (PR 1, 3, 4, 5 and 8) are approaching maximum velocities and replacement of these valves and associated piping will be necessary if significant areas of new lands are irrigated downstream of the stations.

Pressure in a few areas of the mainline and distribution system exceeds 860 kPa (140 psi), the generally accepted maximum for distribution systems. This is not a particularly desirable situation but the topography of the Wood Lake area makes it difficult to avoid high pressures.

The distribution system computer model has not been updated to existing conditions, although there have been minimal changes to the system since the previous revision. Further works is required to update the model and it is recommended that the computer modeling data is upgraded.

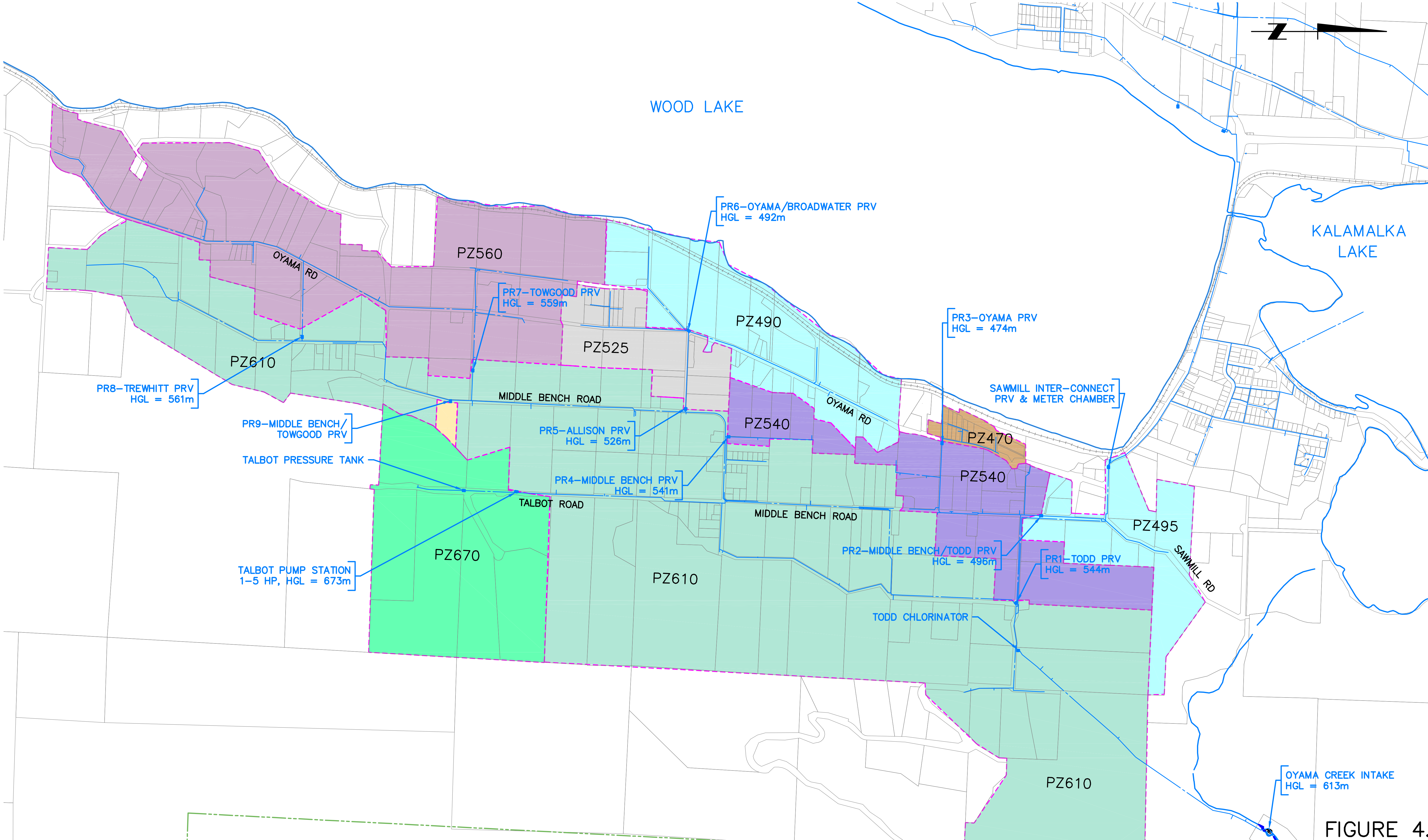


FIGURE 4.7

LAKE COUNTRY
LIFE. THE OKANAGAN WAY.

Mould Engineering

DISTRICT OF LAKE COUNTRY
WATER MASTER PLAN
OYAMA LAKE WATER SOURCE
DISTRIBUTION AREAS

SCALE: NTS

DEC. 2011

4.5 ANNEX

4.5.1 BEAVER LAKE SOURCE – DISTRIBUTION SYSTEM COMPUTER MODEL

4.5.1.1 COMPUTER MODEL DATA

The results for the distribution system computer model for the Beaver Lake Source are shown below. The existing system analysis is 75% of theoretical peak hour.

Input						Output			Input
Pipe	Up	Down	Len m	Diam mm	Rough	Flow l/s	Velocity m/s	HeadLoss m	Status
1	1	2	2182.2	780.0	115.0	710.4	1.487	6.43	Open
2	2	3	10.0	300.0	110.0	710.4	10.05	68.89	Open
3	3	4	1044.1	780.0	115.0	710.4	1.487	3.076	Open
4	4	5	536.5	780.0	115.0	710.4	1.487	1.581	Open
5	5	6	10.0	300.0	80.0	710.4	10.05	122.2	Open
6	6	7	1614.5	780.0	115.0	710.4	1.487	4.757	Open
14	7	14	561.6	780.0	115.0	710.4	1.487	1.655	Open
16	14	16	10.0	150.0	100.0	6.47	0.3662	138.5	Open
18	16	17	245.0	200.0	130.0	6.47	0.206	7.24e-002	Open
19	17	19	250.0	200.0	130.0	4.95	0.1576	4.499e-002	Open
34	14	33	464.8	780.0	115.0	703.9	1.473	1.346	Open
53	33	50	238.3	780.0	115.0	703.9	1.473	0.6903	Open
54	50	51	10.0	150.0	100.0	88.57	5.013	54.46	Open
55	51	52	387.6	300.0	130.0	87.05	1.232	1.958	Open
56	52	53	10.0	150.0	100.0	54.28	3.072	20.04	Open
63	53	60	162.9	250.0	130.0	51.87	1.057	0.7666	Open
64	60	61	280.0	250.0	130.0	45.21	0.9211	1.022	Open
65	61	62	484.1	200.0	130.0	30.43	0.9687	2.516	Open
66	62	63	265.8	150.0	130.0	18.16	1.028	2.156	Open
67	63	64	289.9	100.0	130.0	8.47	1.079	4.126	Open
68	64	65	179.5	100.0	130.0	2.0	0.2547	0.1764	Open
69	52	66	475.0	250.0	130.0	32.77	0.6677	0.9551	Open
70	66	67	681.1	250.0	130.0	20.53	0.4183	0.5761	Open
71	67	68	133.5	150.0	140.0	6.05	0.3424	0.1233	Open
72	68	69	96.1	150.0	140.0	5.56	0.3147	7.591e-002	Open
73	69	70	177.5	150.0	140.0	1.68	9.508e-002	1.528e-002	Open
74	67	71	186.4	50.0	140.0	2.41	1.228	6.598	Open
75	67	72	138.2	150.0	130.0	1.78	0.1007	1.519e-002	Open
76	72	73	164.7	150.0	140.0	0.89	5.037e-002	4.373e-003	Open
98	50	95	148.0	730.0	115.0	615.3	1.47	0.4615	Open
99	95	96	258.4	730.0	115.0	592.3	1.415	0.7508	Open
100	96	97	411.1	680.0	115.0	572.3	1.576	1.584	Open
101	97	240	320.0	680.0	115.0	566.1	1.559	1.208	Open
102	98	99	801.4	680.0	115.0	553.2	1.523	2.899	Open
103	95	100	10.0	75.0	100.0	23.02	5.211	93.69	Open
104	100	101	177.3	150.0	130.0	18.49	1.046	1.487	Open
106	101	103	176.1	150.0	130.0	18.49	1.046	1.477	Open
107	103	104	472.7	100.0	130.0	10.69	1.361	10.35	Open
108	96	105	10.0	100.0	100.0	19.97	2.543	80.21	Open
109	105	106	398.2	200.0	130.0	12.67	0.4033	0.4085	Open
110	106	107	446.1	100.0	130.0	1.95	0.2483	0.4184	Open
115	111	112	257.5	100.0	130.0	4.33	0.5514	1.058	Open
117	113	114	188.4	100.0	130.0	-8.29	-1.056	2.577	Open
118	114	115	493.4	150.0	130.0	-22.83	-1.292	6.114	Open
119	115	116	461.5	250.0	130.0	-41.75	-0.8506	1.453	Open
120	116	117	329.2	200.0	130.0	19.07	0.6071	0.7201	Open
121	117	118	183.7	150.0	130.0	6.04	0.3418	0.194	Open
122	118	119	82.4	100.0	130.0	2.3	0.2929	0.1049	Open
123	116	120	462.4	250.0	130.0	35.45	0.7223	1.075	Open
124	120	121	246.6	200.0	130.0	25.11	0.7994	0.8978	Open
125	121	122	109.7	150.0	130.0	1.3	7.358e-002	6.741e-003	Open
126	122	115	435.5	150.0	130.0	-6.5	-0.3679	0.5269	Open

PIPE TABLE

Pipe	Up	Down	Len m	Diam mm	Rough	Flow l/s	Velocity m/s	HeadLoss m	Status
127	121	123	185.0	200.0	130.0	19.45	0.6192	0.4197	Open
134	123	130	238.0	150.0	130.0	10.54	0.5965	0.7049	Open
135	130	131	341.0	100.0	130.0	6.01	0.7653	2.571	Open
137	132	133	431.3	100.0	130.0	-3.55	-0.452	1.227	Open
138	133	134	130.0	100.0	130.0	-7.67	-0.9767	1.54	Open
139	134	135	339.6	150.0	140.0	-13.06	-0.7391	1.304	Open
140	135	136	10.0	200.0	100.0	196.9	6.267	19.56	Open
141	136	137	278.4	250.0	130.0	76.47	1.558	2.688	Open
142	137	138	235.6	250.0	130.0	68.35	1.393	1.848	Open
143	138	139	121.8	200.0	130.0	31.44	1.001	0.6725	Open
144	139	140	163.2	150.0	130.0	11.21	0.6344	0.5418	Open
145	140	141	277.0	100.0	130.0	5.44	0.6927	1.737	Open
146	139	142	227.2	150.0	130.0	18.82	1.065	1.969	Open
147	142	143	94.5	150.0	130.0	15.0	0.8491	0.5382	Open
148	143	144	10.0	75.0	100.0	15.0	3.396	62.33	Open
149	144	145	139.5	150.0	130.0	5.22	0.2954	0.1125	Open
150	145	146	182.2	150.0	130.0	2.98	0.1687	5.202e-002	Open
151	144	147	243.1	150.0	140.0	3.2	0.1811	6.903e-002	Open
152	144	148	360.5	150.0	130.0	2.963	0.1677	0.1018	Open
153	138	149	112.2	200.0	140.0	32.74	1.042	0.582	Open
154	149	150	125.2	200.0	140.0	14.0	0.4456	0.1346	Open
155	150	151	10.0	100.0	100.0	14.0	1.782	64.34	Open
156	151	152	246.0	200.0	140.0	14.0	0.4456	0.2645	Open
157	152	153	340.8	200.0	140.0	12.14	0.3864	0.2814	Open
158	153	148	270.1	150.0	130.0	1.097	6.207e-002	1.204e-002	Open
159	153	154	10.0	100.0	100.0	8.06	1.026	42.47	Open
160	154	155	178.8	200.0	140.0	7.33	0.2333	5.804e-002	Open
161	155	156	305.9	100.0	140.0	1.27	0.1617	0.113	Open
162	149	157	400.3	150.0	130.0	11.48	0.6497	1.389	Open
163	136	158	260.0	400.0	130.0	119.0	0.9468	0.5769	Open
164	158	159	60.2	400.0	130.0	109.8	0.8738	0.1151	Open
165	159	162	240.0	400.0	130.0	101.6	0.8087	0.3977	Open
166	159	160	134.6	150.0	130.0	7.63	0.4318	0.2192	Open
167	160	161	126.6	150.0	130.0	5.81	0.3288	0.1245	Open
168	161	162	208.6	150.0	130.0	2.83	0.1602	5.413e-002	Open
169	162	164	200.3	400.0	130.0	95.32	0.7586	0.2948	Open
170	162	163	168.1	150.0	130.0	4.364	0.247	9.725e-002	Open
171	163	164	276.5	100.0	130.0	1.684	0.2144	0.1976	Open
172	164	165	164.2	400.0	130.0	92.73	0.738	0.2297	Open
173	165	166	258.9	200.0	130.0	26.43	0.8414	1.036	Open
174	166	167	426.9	200.0	140.0	7.01	0.2232	0.1276	Open
175	166	168	169.0	200.0	130.0	17.36	0.5526	0.3106	Open
176	168	169	655.4	150.0	130.0	12.27	0.6944	2.572	Open
177	165	170	829.7	300.0	130.0	61.77	0.874	2.22	Open
178	170	171	10.0	150.0	100.0	43.26	2.448	80.37	Open
179	171	172	351.6	250.0	130.0	43.26	0.8814	1.182	Open
180	172	173	547.6	200.0	130.0	31.78	1.012	3.084	Open
181	173	174	10.0	100.0	100.0	23.16	2.949	37.36	Open
182	174	175	177.1	200.0	130.0	23.16	0.7373	0.5551	Open
183	175	176	600.6	150.0	130.0	20.57	1.164	6.136	Open
184	176	177	140.7	100.0	130.0	6.27	0.7984	1.147	Open
185	177	178	240.4	100.0	130.0	6.27	0.7984	1.96	Open
186	176	179	200.8	150.0	130.0	11.62	0.6576	0.7124	Open
187	179	180	549.1	100.0	130.0	8.5	1.082	7.867	Open
188	180	181	141.6	100.0	130.0	3.41	0.4342	0.3738	Open
189	99	182	273.1	680.0	115.0	541.0	1.49	0.9478	Open
190	182	183	324.1	150.0	130.0	1.52	8.602e-002	2.66e-002	Open
191	182	184	427.6	150.0	130.0	7.3	0.4131	0.6415	Open
192	182	185	394.5	680.0	115.0	524.8	1.445	1.295	Open
193	185	186	10.0	200.0	100.0	107.6	3.424	20.69	Open
194	186	116	553.1	400.0	130.0	104.5	0.8313	0.9645	Open
195	185	187	844.2	600.0	130.0	331.9	1.174	1.738	Open
196	187	135	617.2	600.0	130.0	322.6	1.141	1.206	Open

PIPE TABLE

Pipe	Up	Down	Len m	Diam mm	Rough	Flow l/s	Velocity m/s	HeadLoss m	Status
197	185	188	278.6	400.0	130.0	67.4	0.5364	0.2158	Open
198	188	189	160.0	150.0	140.0	2.68	0.1517	3.272e-002	Open
199	188	190	159.4	400.0	130.0	51.24	0.4078	7.433e-002	Open
200	190	191	236.8	400.0	130.0	0.0	0.0	0.0	Open
201	227	192	420.0	400.0	130.0	42.24	0.3362	0.137	Open
202	192	193	381.2	400.0	140.0	18.57	0.1478	2.366e-002	Open
203	193	194	670.6	300.0	140.0	5.92	8.376e-002	2.034e-002	Open
204	194	195	10.0	100.0	100.0	5.92	0.7538	45.03	Open
205	195	196	552.7	200.0	140.0	5.92	0.1885	0.1208	Open
206	192	197	92.3	400.0	130.0	19.55	0.1556	7.225e-003	Open
207	198	197	275.4	150.0	130.0	-4.392	-0.2486	0.1612	Open
208	198	199	225.3	150.0	130.0	-2.468	-0.1397	4.537e-002	Open
209	198	200	194.9	150.0	130.0	3.24	0.1834	6.496e-002	Open
210	197	201	260.7	150.0	130.0	15.15	0.8576	1.512	Open
211	193	201	466.5	150.0	130.0	11.0	0.6227	1.496	Open
212	201	202	346.4	150.0	130.0	21.39	1.21	3.803	Open
213	202	203	376.9	150.0	130.0	14.73	0.8334	2.074	Open
214	203	204	10.0	150.0	100.0	82.14	4.649	63.47	Open
215	203	205	443.7	300.0	130.0	-76.16	-1.077	1.75	Open
216	205	206	352.6	200.0	130.0	10.62	0.3381	0.2609	Open
217	206	207	10.0	100.0	100.0	8.56	1.09	32.85	Open
218	206	208	471.5	150.0	140.0	2.06	0.1166	5.923e-002	Open
219	205	209	232.9	300.0	130.0	-94.66	-1.339	1.374	Open
220	209	135	483.5	350.0	130.0	-111.3	-1.157	1.816	Open
221	209	210	146.0	150.0	140.0	11.29	0.6389	0.4281	Open
222	210	211	442.0	150.0	140.0	2.0	0.1132	5.257e-002	Open
223	204	212	894.7	250.0	130.0	75.96	1.548	8.534	Open
224	212	213	10.0	150.0	100.0	64.27	3.637	34.75	Open
225	213	214	256.1	250.0	130.0	63.0	1.284	1.728	Open
226	214	215	190.5	200.0	130.0	57.08	1.817	3.173	Open
227	215	216	10.0	100.0	100.0	3.47	0.4419	44.25	Open
228	216	217	296.4	150.0	140.0	1.95	0.1104	3.364e-002	Open
229	215	218	396.0	200.0	130.0	49.9	1.589	5.143	Open
230	218	219	345.8	150.0	130.0	45.0	2.547	15.05	Open
231	219	220	374.9	100.0	130.0	8.781	1.118	5.704	Open
232	220	221	227.9	150.0	130.0	4.583	0.2594	0.1444	Open
233	219	222	191.2	150.0	130.0	31.89	1.805	4.399	Open
234	222	223	10.0	100.0	100.0	28.72	3.656	32.77	Open
235	223	224	136.5	150.0	130.0	28.15	1.593	2.492	Open
236	229	225	400.0	100.0	130.0	7.562	0.9629	4.615	Open
237	224	226	589.0	100.0	130.0	10.01	1.275	11.42	Open
238	190	227	130.0	400.0	130.0	51.24	0.4078	6.062e-002	Open
239	199	227	135.0	150.0	140.0	-8.998	-0.5092	0.2601	Open
240	240	98	360.0	680.0	115.0	554.1	1.526	1.306	Open
241	240	241	120.0	200.0	140.0	5.049	0.1607	1.953e-002	Open
242	241	242	73.0	200.0	140.0	4.045	0.1288	7.881e-003	Open
243	242	243	95.9	200.0	140.0	2.886	9.187e-002	5.542e-003	Open
244	224	228	125.0	150.0	140.0	5.658	0.3202	0.102	Open
245	228	229	185.0	200.0	140.0	5.658	0.1801	3.717e-002	Open
246	224	229	155.0	100.0	130.0	1.904	0.2425	0.1391	Open
1000	1	2	2126.9	1.e	10.0	8.523e-012	1.085e-004	6.43	Open
1001	104	111	2.0	100.0	130.0	5.6	0.7131	1.323e-002	Open

NODE TABLE

<--- Input			<--- Output		<-Input->
Node	Elevation m	Demand l/s	Pressure psi	HGL m	Status
1	819.3	0.0	5.723e-002	819.3	Open
2	702.5	0.0	156.8	812.9	Open
3	702.5	0.0	58.97	744.0	Open
4	616.3	0.0	177.0	740.9	Open
5	551.7	0.0	266.5	739.3	Open
6	551.7	0.0	92.91	617.1	Open
7	433.0	0.0	254.7	612.3	Open
14	423.0	0.0	266.6	610.7	Open
16	423.0	0.0	69.93	472.2	Open
17	422.5	1.52	70.54	472.1	Open
19	423.0	4.95	69.76	472.1	Open
33	438.0	0.0	243.4	609.3	Open
50	467.0	0.0	201.2	608.6	Open
51	467.0	1.52	123.9	554.2	Open
52	467.5	0.0	120.4	552.2	Open
53	467.5	2.41	91.9	532.2	Open
60	466.0	6.66	92.94	531.4	Open
61	461.0	14.78	98.59	530.4	Open
62	458.0	12.27	99.28	527.9	Open
63	459.0	9.69	94.8	525.7	Open
64	467.0	6.47	77.58	521.6	Open
65	484.5	2.0	52.47	521.4	Open
66	472.0	12.24	112.6	551.3	Open
67	487.0	10.29	90.5	550.7	Open
68	487.0	0.49	90.32	550.6	Open
69	492.0	3.88	83.11	550.5	Open
70	495.0	1.68	78.83	550.5	Open
71	513.0	2.41	44.2	544.1	Open
72	497.0	0.89	76.27	550.7	Open
73	503.0	0.89	67.74	550.7	Open
95	472.3	0.0	193.0	608.2	Open
96	478.0	0.0	183.9	607.4	Open
97	502.0	6.27	147.5	605.8	Open
98	507.0	0.923	136.9	603.3	Open
99	525.0	12.27	107.2	600.4	Open
100	472.3	4.53	59.95	514.5	Open
101	475.0	0.0	54.0	513.0	Open
103	480.0	7.8	44.8	511.5	Open
104	477.0	5.09	34.36	501.2	Open
105	478.0	7.3	69.93	527.2	Open
106	478.0	10.72	69.35	526.8	Open
107	481.0	1.95	64.5	526.4	Open
111	477.0	1.27	34.34	501.2	Open
112	455.0	4.33	64.08	500.1	Open
113	472.0	8.29	134.1	566.4	Open
114	479.0	14.54	127.8	569.0	Open
115	491.0	12.42	119.5	575.1	Open
116	500.0	8.18	108.7	576.5	Open
117	497.0	13.03	112.0	575.8	Open
118	492.0	3.74	118.8	575.6	Open
119	487.0	2.3	125.8	575.5	Open
120	504.0	10.34	101.5	575.5	Open
121	498.0	4.36	108.8	574.6	Open
122	493.0	7.8	115.9	574.6	Open
123	502.0	8.91	102.5	574.1	Open
130	501.0	4.53	102.9	573.4	Open
131	518.0	6.01	75.12	570.9	Open
132	518.0	3.55	104.0	591.2	Open
133	541.0	4.12	73.04	592.4	Open
134	541.0	5.39	75.23	593.9	Open

NODE TABLE

<------- Input		------->	<------- Output	------->	<-Input->
Node	Elevation m	Demand l/s	Pressure psi	HGL m	Status
135	533.5	1.44	87.73	595.2	Open
136	533.5	1.41	59.95	575.7	Open
137	518.0	8.12	78.15	573.0	Open
138	495.0	4.17	108.2	571.1	Open
139	495.0	1.41	107.2	570.5	Open
140	498.0	5.77	102.2	569.9	Open
141	499.0	5.44	98.32	568.2	Open
142	466.0	3.82	145.6	568.5	Open
143	451.5	0.0	165.5	568.0	Open
144	451.5	3.62	76.92	505.6	Open
145	445.0	2.24	85.99	505.5	Open
146	467.0	2.98	54.67	505.5	Open
147	420.0	3.2	121.6	505.6	Open
148	436.0	4.06	98.79	505.5	Open
149	495.0	7.26	107.4	570.6	Open
150	485.0	0.0	121.4	570.4	Open
151	485.0	0.0	29.99	506.1	Open
152	457.0	1.86	69.38	505.8	Open
153	423.0	2.98	117.3	505.5	Open
154	423.0	0.73	56.95	463.1	Open
155	404.5	6.06	83.14	463.0	Open
156	395.0	1.27	96.47	462.9	Open
157	479.0	11.48	128.1	569.2	Open
158	536.0	9.18	55.58	575.1	Open
159	530.0	0.54	63.94	575.0	Open
160	520.0	1.82	77.83	574.8	Open
161	515.0	2.98	84.76	574.6	Open
162	513.0	4.77	87.52	574.6	Open
163	506.0	2.68	97.32	574.5	Open
164	500.0	4.27	105.6	574.3	Open
165	487.0	4.53	123.7	574.1	Open
166	467.0	2.06	150.6	573.0	Open
167	467.0	7.01	150.5	572.9	Open
168	475.5	5.09	138.1	572.7	Open
169	463.0	12.27	152.2	570.2	Open
170	450.0	18.51	173.1	571.8	Open
171	450.0	0.0	58.95	491.5	Open
172	404.0	11.48	122.6	490.3	Open
173	391.5	8.62	136.0	487.2	Open
174	391.5	0.0	82.91	449.9	Open
175	404.5	2.59	63.66	449.3	Open
176	402.5	2.68	57.78	443.2	Open
177	375.0	0.0	95.21	442.0	Open
178	356.0	6.27	119.4	440.1	Open
179	398.0	3.12	63.16	442.5	Open
180	385.5	5.09	69.74	434.6	Open
181	377.5	3.41	80.57	434.2	Open
182	529.5	7.3	99.43	599.5	Open
183	529.0	1.52	100.1	599.5	Open
184	552.0	7.3	66.56	598.8	Open
185	532.5	17.98	93.33	598.2	Open
186	532.5	3.12	63.95	577.5	Open
187	541.0	9.26	78.79	596.4	Open
188	548.0	13.48	71.01	598.0	Open
189	564.0	2.68	48.24	597.9	Open
190	553.0	0.0	63.8	597.9	Open
191	588.4	0.0	13.53	597.9	Open
192	546.5	4.12	72.75	597.7	Open
193	528.0	1.65	99.0	597.7	Open
194	524.5	0.0	103.9	597.7	Open
195	524.5	0.0	39.98	552.6	Open
196	492.0	5.92	85.97	552.5	Open
197	537.0	0.0	86.24	597.7	Open

NODE TABLE

Node	Elevation m	Demand l/s	Pressure psi	HGL m	Status
	<------ Input	------>	<------ Output	------>	<-Input->
198	550.0	3.62	67.54	597.5	Open
199	554.0	6.53	61.93	597.6	Open
200	557.0	3.24	57.51	597.5	Open
201	529.0	4.77	95.45	596.2	Open
202	518.5	6.66	105.0	592.4	Open
203	498.0	8.74	131.1	590.3	Open
204	498.0	6.18	40.98	526.8	Open
205	532.0	7.88	85.33	592.0	Open
206	528.0	0.0	90.64	591.8	Open
207	528.0	8.56	43.97	558.9	Open
208	530.0	2.06	87.71	591.7	Open
209	548.5	5.33	63.85	593.4	Open
210	547.0	9.29	65.37	593.0	Open
211	555.0	2.0	53.93	592.9	Open
212	428.0	11.69	128.3	518.3	Open
213	428.0	1.27	78.92	483.5	Open
214	409.0	5.92	103.5	481.8	Open
215	391.5	3.708	123.8	478.6	Open
216	391.5	1.52	60.94	434.4	Open
217	382.5	1.95	73.68	434.4	Open
218	417.5	4.905	79.57	473.5	Open
219	415.5	4.33	61.02	458.4	Open
220	420.0	4.198	46.53	452.7	Open
221	425.0	4.583	39.22	452.6	Open
222	380.5	3.172	104.5	454.0	Open
223	380.5	0.569	57.94	421.3	Open
224	349.5	10.574	98.43	418.8	Open
225	343.0	7.562	100.9	414.0	Open
226	353.0	10.01	77.24	407.4	Open
227	554.0	0.0	62.3	597.8	Open
228	0.0	0.0	594.7	418.7	Open
229	0.0	0.0	594.6	418.6	Open
240	494.8	6.868	156.0	604.6	Open
241	505.0	1.004	141.5	604.6	Open
242	511.2	1.159	132.7	604.6	Open
243	519.0	2.886	121.6	604.6	Open

PUMPED SOURCES TABLE

Input			Output		Input
Node	Pumps	OpCurve	%Estimate	%Actual	Inflow l/s	Status

--- No data available ---

FIXED GRADE SOURCES TABLE

Input			Output		Input
Node	Top of Water m	%Estimate	%Actual	Inflow l/s	Status
1	819.3	0.75	1.0	-710.4	Open

BOOST TABLE

Input			Output	Input
Pipe	Pumps	OpCurve	Boost m	Status

--- No data available ---

REDUCING (PRV) TABLE

Input					Output		Input
Pipe	Source	Pressure psi	OpenK m	CKV	PRVLoss psi	CKVState	Status
2	1	59.0	0.0	Yes	65.53	Open	Open
5	1	93.0	0.0	Yes	116.2	Open	Open
16	1	70.0	0.0	Yes	138.4	Open	Open
54	1	124.0	0.0	Yes	51.98	Open	Open
103	1	60.0	0.0	Yes	87.71	Open	Open
108	1	70.0	0.0	Yes	79.08	Open	Open
193	1	64.0	0.0	Yes	19.81	Open	Open
140	1	60.0	0.0	Yes	16.88	Open	Open
155	1	30.0	0.0	Yes	63.75	Open	Open
148	1	77.0	0.0	Yes	59.62	Open	Open
159	1	57.0	0.0	Yes	42.26	Open	Open
178	1	59.0	0.0	Yes	79.71	Open	Open
181	1	83.0	0.0	Yes	35.87	Open	Open
217	1	44.0	0.0	Yes	32.62	Open	Open
204	1	40.0	0.0	Yes	44.91	Open	Open
214	1	41.0	0.0	Yes	61.32	Open	Open
224	1	79.0	0.0	Yes	33.38	Open	Open
227	1	61.0	0.0	Yes	44.21	Open	Open
234	1	58.0	0.0	Yes	30.55	Open	Open
56	1	92.0	0.0	Yes	19.04	Open	Open

Pump3
<--------- Input --------->

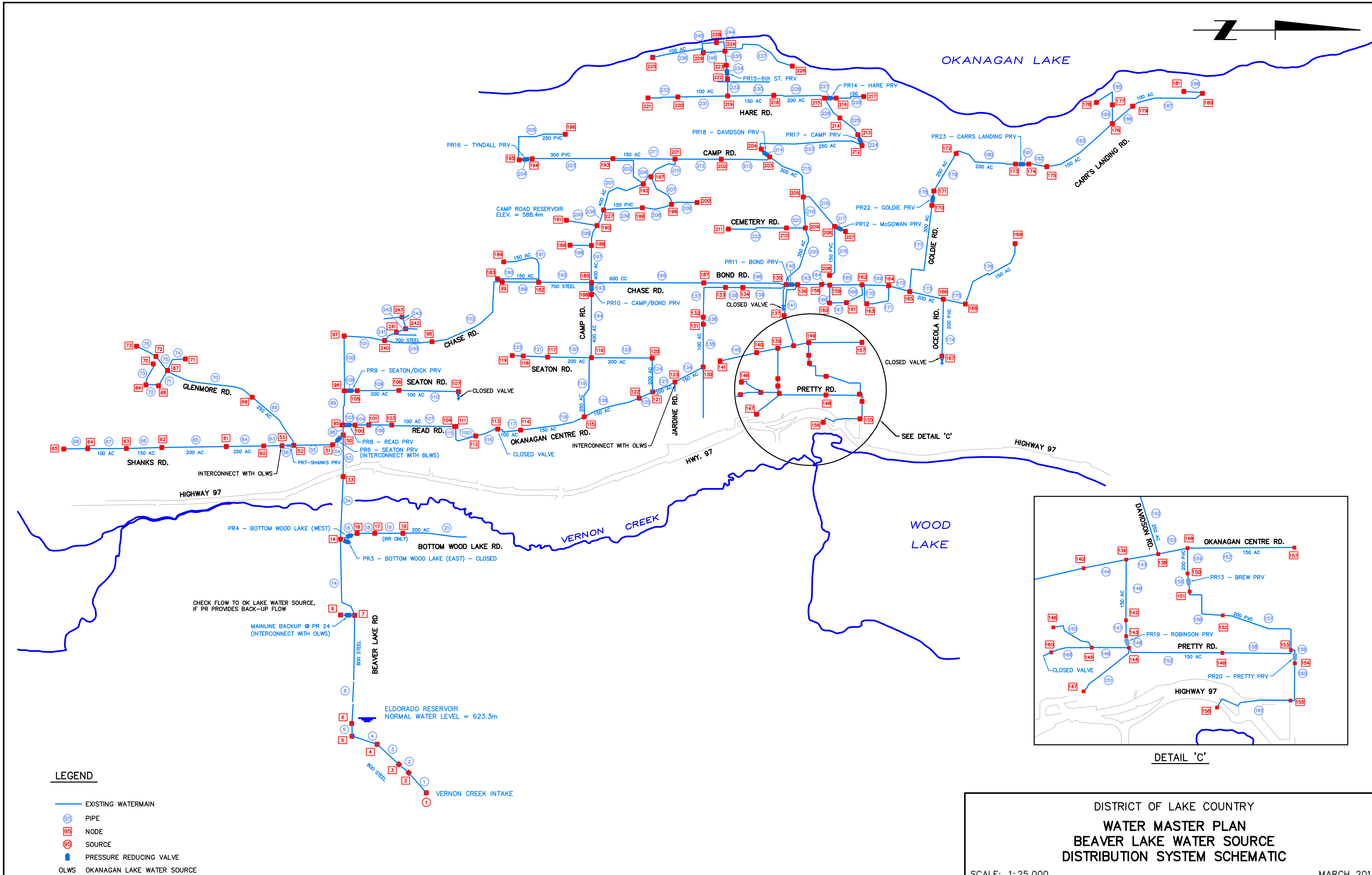
Flow	**Head**
l/s	**m**
0.0	260.6
15.8	244.4
31.5	232.7
47.3	223.3
63.1	218.5
78.9	211.5
94.6	202.1
110.4	188.1
142.0	153.4
173.5	95.8

Pump2
<--------- Input --------->

Flow	**Head**
l/s	**m**
0.0	292.6
126.2	237.7
189.3	216.4
220.8	201.2
252.4	179.2
283.9	154.4
315.5	126.5

Pump1
<--------- Input --------->

Flow	**Head**
l/s	**m**
0.0	292.6
126.2	237.7
189.3	216.4
220.8	201.2
252.4	179.2
283.9	154.4
315.5	126.5



DISTRICT OF LAKE COUNTRY

WATER MASTER PLAN
BEAVER LAKE WATER SOURCE
DISTRIBUTION SYSTEM SCHEMATIC

SCALE: 1:25,000

MARCH 2012

4.5.2 OKANAGAN LAKE SOURCE – DISTRIBUTION SYSTEM COMPUTER MODEL

4.5.2.1 COMPUTER MODEL DATA

The results for the distribution system computer model for the Okanagan Lake Source are shown below. The existing system analysis is 75% of theoretical peak hour.

PIPE TABLE

Input						Output			Input
Pipe	Up	Down	Len m	Diam mm	Rough	Flow l/s	Velocity m/s	HeadLoss m	Status
9	9	10	388.8	250.0	140.0	8.26	0.1683	5.311e-002	Open
10	9	11	292.4	250.0	140.0	0.0	0.0	0.0	Open
11	11	12	524.4	250.0	140.0	8.29	0.1689	7.211e-002	Open
12	11	13	146.5	250.0	140.0	-9.56	-0.1948	2.623e-002	Open
13	13	15	103.8	200.0	140.0	-9.94	-0.3164	5.923e-002	Open
17	15	18	495.0	200.0	130.0	-12.18	-0.3877	0.472	Open
18	400	401	10.0	200.0	140.0	76.0	2.419	36.78	Open
20	18	20	585.0	250.0	130.0	-15.59	-0.3176	0.2972	Open
22	20	21	236.4	250.0	130.0	-21.82	-0.4446	0.2238	Open
23	21	22	59.9	250.0	130.0	18.12	0.3692	4.02e-002	Open
24	22	23	506.8	100.0	130.0	3.82	0.4864	1.651	Open
25	22	24	513.3	300.0	130.0	8.38	0.1186	3.399e-002	Open
26	24	25	10.0	200.0	100.0	5.35	0.1703	32.54	Open
27	25	26	922.0	300.0	130.0	5.18	7.329e-002	2.505e-002	Open
28	26	27	527.5	300.0	130.0	5.01	7.088e-002	1.347e-002	Open
29	27	28	197.1	300.0	130.0	2.42	3.424e-002	1.309e-003	Open
30	28	29	213.9	250.0	130.0	0.38	7.742e-003	1.12e-004	Open
31	28	30	252.6	200.0	130.0	1.87	5.953e-002	7.495e-003	Open
32	30	31	207.4	150.0	130.0	0.54	3.056e-002	2.504e-003	Open
33	28	32	198.4	250.0	130.0	0.17	3.464e-003	2.341e-005	Open
36	34	35	220.0	200.0	140.0	20.16	0.6418	0.4651	Open
37	34	36	118.8	300.0	120.0	-23.78	-0.3365	6.296e-002	Open
38	36	37	221.2	300.0	140.0	50.95	0.7208	0.3612	Open
39	37	38	195.4	150.0	130.0	5.735	0.3246	0.1875	Open
40	37	39	43.6	300.0	140.0	41.33	0.5848	4.834e-002	Open
41	39	40	391.2	300.0	140.0	37.13	0.5253	0.3556	Open
42	40	41	365.2	300.0	140.0	35.67	0.5046	0.3081	Open
43	41	42	71.3	250.0	140.0	23.4	0.4767	6.696e-002	Open
44	42	21	144.9	250.0	140.0	39.94	0.8137	0.3664	Open
45	42	43	247.0	200.0	140.0	-16.54	-0.5267	0.362	Open
46	41	44	104.2	200.0	140.0	5.74	0.1827	2.151e-002	Open
47	44	45	254.7	100.0	130.0	5.74	0.7309	1.764	Open
48	45	46	356.3	150.0	140.0	3.88	0.2196	0.1446	Open
49	39	47	413.7	100.0	130.0	1.965	0.2502	0.3934	Open
50	47	48	68.4	100.0	130.0	-3.536e-002	-4.503e-003	3.822e-005	Open
51	48	40	139.0	150.0	140.0	-3.125	-0.1769	3.778e-002	Open
52	47	49	195.3	100.0	130.0	2.0	0.2547	0.192	Open
58	53	55	197.0	150.0	130.0	-2.41	-0.1364	3.796e-002	Open
59	55	56	173.8	150.0	130.0	-5.0	-0.283	0.1294	Open
60	56	57	130.1	150.0	130.0	-8.584	-0.4858	0.2635	Open
61	56	58	144.7	100.0	130.0	2.734	0.3481	0.2537	Open
62	58	59	122.1	150.0	130.0	1.554	8.795e-002	1.044e-002	Open
77	74	75	695.0	850.0	115.0	-34.46	-6.073e-002	4.965e-003	Open
78	75	76	52.1	300.0	100.0	61.62	0.8718	0.2256	Open
79	76	77	10.0	200.0	100.0	61.62	1.962	0.312	Open
80	75	78	71.0	850.0	115.0	-96.08	-0.1693	3.387e-003	Open
81	77	9	673.7	300.0	140.0	30.22	0.4276	0.4183	Open
82	78	79	766.4	850.0	115.0	-103.6	-0.1826	4.202e-002	Open
83	79	80	736.7	850.0	115.0	-103.6	-0.1826	4.04e-002	Open
84	80	81	285.5	850.0	115.0	-281.2	-0.4957	9.954e-002	Open
85	81	82	614.0	850.0	115.0	-281.2	-0.4957	0.2141	Open
86	82	83	496.4	850.0	115.0	-281.7	-0.4964	0.1735	Open
87	83	84	342.3	200.0	130.0	5.403	0.172	7.245e-002	Open
88	84	85	145.5	150.0	140.0	1.135	6.423e-002	6.061e-003	Open

PIPE TABLE

Pipe	Up	Down	Len m	Diam mm	Rough	Flow l/s	Velocity m/s	HeadLoss m	Status
	<---------------- Input				---------------->	<-------------------- Output		---------------->	<-Input->
89	84	86	387.9	200.0	130.0	1.184	3.769e-002	4.937e-003	Open
90	83	87	69.3	850.0	115.0	-287.1	-0.5059	2.509e-002	Open
91	87	88	213.5	825.0	110.0	-192.6	-0.3604	4.637e-002	Open
92	87	89	409.4	850.0	115.0	-100.0	-0.1763	2.104e-002	Open
93	89	90	149.0	850.0	115.0	-101.0	-0.178	7.795e-003	Open
94	90	91	196.1	200.0	140.0	4.311	0.1372	2.382e-002	Open
95	91	92	491.7	200.0	140.0	3.695	0.1176	4.489e-002	Open
96	90	93	99.1	850.0	115.0	-105.3	-0.1856	5.602e-003	Open
97	93	94	342.9	850.0	115.0	-105.5	-0.186	1.947e-002	Open
105	101	102	333.9	150.0	130.0	2.98	0.1687	9.532e-002	Open
111	107	108	107.9	150.0	130.0	0.0	0.0	0.0	Open
112	108	109	185.6	150.0	130.0	1.84	0.1041	2.17e-002	Open
113	108	110	97.3	150.0	130.0	-3.4	-0.1924	3.546e-002	Open
114	110	111	366.9	150.0	130.0	-7.37	-0.4171	0.5602	Open
119	115	116	461.5	250.0	130.0	7.759	0.1581	6.44e-002	Open
123	116	120	462.4	250.0	130.0	7.759	0.1581	6.452e-002	Open
124	120	121	246.6	200.0	130.0	7.759	0.247	0.102	Open
125	121	122	109.7	450.0	140.0	-71.41	-0.449	4.647e-002	Open
127	121	123	184.8	450.0	140.0	79.17	0.4978	9.475e-002	Open
130	123	126	215.0	150.0	130.0	17.77	1.006	1.675	Open
131	126	127	290.0	150.0	130.0	10.36	0.5863	0.8319	Open
132	127	128	406.0	150.0	130.0	5.92	0.335	0.4132	Open
133	126	129	87.3	150.0	130.0	6.56	0.3713	0.1074	Open
134	408	130	270.0	300.0	140.0	61.4	0.8687	0.6229	Open
135	130	131	341.0	100.0	130.0	0.0	0.0	0.0	Open
142	137	138	235.6	250.0	130.0	0.0	0.0	0.0	Open
143	138	139	121.8	300.0	140.0	-61.4	-0.8687	0.281	Open
144	139	140	163.2	300.0	140.0	-61.4	-0.8687	0.3765	Open
145	140	141	277.0	300.0	140.0	-61.4	-0.8687	0.6391	Open
153	138	149	112.2	300.0	140.0	61.4	0.8687	0.2589	Open
162	149	157	400.3	300.0	140.0	61.4	0.8687	0.9235	Open
163	129	158	135.2	150.0	130.0	4.39	0.2484	7.911e-002	Open
164	158	159	230.0	200.0	140.0	4.39	0.1398	2.889e-002	Open
167	159	161	10.0	150.0	110.0	2.55	0.1443	40.44	Open
168	161	162	195.0	150.0	140.0	2.55	0.1443	3.637e-002	Open
180	9	180	662.5	400.0	140.0	14.46	0.1151	2.588e-002	Open
181	180	181	667.5	400.0	140.0	14.46	0.1151	2.607e-002	Open
182	181	182	218.9	400.0	140.0	4.679	3.724e-002	1.058e-003	Open
183	182	183	216.1	200.0	140.0	3.119	9.929e-002	1.442e-002	Open
184	181	187	122.2	200.0	140.0	9.782	0.3114	6.769e-002	Open
185	187	184	142.9	200.0	140.0	9.073	0.2888	6.886e-002	Open
186	184	185	372.8	200.0	140.0	2.497	7.949e-002	1.648e-002	Open
187	184	186	133.4	200.0	140.0	3.741	0.1191	1.246e-002	Open
188	186	185	358.9	200.0	140.0	1.189	3.785e-002	4.013e-003	Open
191	87	191	434.0	350.0	140.0	4.688	4.873e-002	4.034e-003	Open
192	191	192	250.0	350.0	140.0	4.688	4.873e-002	2.324e-003	Open
193	192	193	10.0	300.0	110.0	4.688	6.633e-002	35.13	Open
194	193	194	539.0	350.0	140.0	4.688	4.873e-002	5.01e-003	Open
195	194	195	84.3	350.0	140.0	4.688	4.873e-002	7.84e-004	Open
196	195	196	87.0	350.0	140.0	2.414	2.509e-002	2.366e-004	Open
197	196	197	10.0	300.0	110.0	2.414	3.415e-002	64.86	Open
198	197	198	276.0	350.0	140.0	2.414	2.509e-002	7.505e-004	Open
199	198	199	168.4	200.0	140.0	2.414	7.685e-002	6.992e-003	Open
200	199	200	55.6	200.0	140.0	1.135	3.613e-002	5.709e-004	Open
201	199	201	128.9	200.0	140.0	0.995	3.168e-002	1.037e-003	Open
202	195	202	290.3	200.0	140.0	2.274	7.239e-002	1.079e-002	Open
203	202	203	96.1	200.0	140.0	0.853	2.715e-002	5.811e-004	Open
204	202	204	115.4	200.0	140.0	1.421	4.524e-002	1.796e-003	Open
240	167	228	263.6	300.0	140.0	61.4	0.8687	0.6082	Open
241	228	229	370.0	300.0	140.0	61.4	0.8687	0.8536	Open
242	229	230	235.6	300.0	140.0	57.81	0.8179	0.4861	Open
243	230	231	196.2	200.0	140.0	10.98	0.3495	0.1346	Open

PIPE TABLE

<---- Input						----><---- Output		----><-Input->
Pipe	Up	Down	Len m	Diam mm	Rough	Flow l/s	Velocity m/s	HeadLoss m	Status
244	231	232	371.2	200.0	140.0	6.066	0.1931	8.486e-002	Open
245	232	239	429.5	200.0	140.0	6.36	0.2025	0.1072	Open
246	239	240	99.5	200.0	140.0	5.481	0.1745	1.885e-002	Open
247	239	241	348.6	200.0	140.0	-3.279	-0.1044	2.55e-002	Open
248	241	234	594.0	200.0	140.0	-5.169	-0.1645	0.101	Open
249	234	232	128.5	200.0	140.0	4.831	0.1538	1.927e-002	Open
250	234	233	174.8	200.0	140.0	-10.94	-0.3484	0.1192	Open
251	233	235	290.0	250.0	140.0	-12.08	-0.2461	8.008e-002	Open
252	235	237	213.1	300.0	140.0	0.4707	6.66e-003	5.949e-005	Open
253	230	237	75.2	300.0	140.0	3.687	5.217e-002	9.493e-004	Open
254	233	236	187.2	250.0	140.0	0.0	0.0	0.0	Open
255	237	238	154.6	150.0	140.0	2.457	0.1391	2.693e-002	Open
256	235	242	143.0	300.0	140.0	-14.82	-0.2096	2.373e-002	Open
257	242	243	473.4	300.0	140.0	-14.82	-0.2096	7.852e-002	Open
258	244	245	229.2	250.0	140.0	13.6	0.2772	7.889e-002	Open
259	245	246	251.3	200.0	140.0	13.6	0.4331	0.2564	Open
260	246	247	90.8	200.0	140.0	13.6	0.4331	9.265e-002	Open
261	247	248	90.0	200.0	140.0	11.15	0.3549	6.353e-002	Open
262	248	249	292.5	200.0	140.0	8.505	0.2708	0.125	Open
263	249	252	376.8	150.0	140.0	2.329	0.1318	5.944e-002	Open
264	250	251	120.6	150.0	140.0	2.207	0.1249	1.722e-002	Open
265	249	250	389.8	200.0	140.0	2.207	7.024e-002	1.37e-002	Open
266	251	254	393.9	150.0	140.0	0.0	0.0	0.0	Open
267	252	253	482.2	150.0	140.0	4.536	0.2567	0.2613	Open
268	252	251	199.8	150.0	140.0	-2.207	-0.1249	2.852e-002	Open
270	35	38	74.0	300.0	140.0	19.67	0.2783	2.075e-002	Open
271	38	270	433.0	300.0	140.0	24.92	0.3525	0.188	Open
272	40	270	96.0	200.0	140.0	-6.963	-0.2217	2.834e-002	Open
273	270	43	175.0	300.0	140.0	17.95	0.254	4.142e-002	Open
400	157	167	614.7	300.0	140.0	61.4	0.8687	1.418	Open
401	80	57	15.0	200.0	140.0	9.764	0.3108	8.28e-003	Open
402	80	400	260.0	450.0	140.0	167.9	1.056	0.5364	Open
403	400	101	287.0	450.0	140.0	92.61	0.5823	0.1967	Open
404	400	59	112.0	200.0	140.0	-0.704	-2.241e-002	4.746e-004	Open
405	401	402	125.0	400.0	140.0	76.0	0.6049	0.1055	Open
406	402	36	135.0	300.0	140.0	76.0	1.075	0.4624	Open
407	101	103	176.1	450.0	140.0	86.54	0.5442	0.1065	Open
408	103	104	472.7	450.0	140.0	86.54	0.5442	0.2858	Open
409	111	112	257.5	450.0	140.0	79.17	0.4978	0.132	Open
410	112	113	178.9	450.0	140.0	79.17	0.4978	9.173e-002	Open
411	113	114	188.4	450.0	140.0	79.17	0.4978	9.66e-002	Open
412	114	115	493.4	450.0	140.0	79.17	0.4978	0.253	Open
413	122	115	435.5	450.0	140.0	-71.41	-0.449	0.1845	Open
414	123	408	10.0	300.0	130.0	61.4	0.8687	58.57	Open
415	130	141	138.4	300.0	140.0	61.4	0.8687	0.3194	Open
1001	104	111	2.0	100.0	130.0	86.54	11.02	2.106	Open
1002	1000	94	10.0	600.0	100.0	0.0	0.0	0.0	Open

NODE TABLE

<------ Input		------><------	Output ------>		<-Input->
Node	Elevation m	Demand l/s	Pressure psi	HGL m	Status
9	433.0	7.5	141.8	532.8	Open
10	442.0	8.26	128.9	532.7	Open
11	428.0	1.27	92.88	493.4	Open
12	418.0	8.29	107.0	493.3	Open
13	426.5	0.38	95.04	493.4	Open
15	423.0	2.24	100.1	493.5	Open
18	423.0	3.41	100.8	493.9	Open
20	414.6	6.23	113.1	494.2	Open
21	410.0	0.0	120.0	494.4	Open
22	408.0	5.92	122.8	494.4	Open
23	407.0	3.82	121.8	492.8	Open
24	407.0	3.03	124.1	494.4	Open
25	407.0	0.17	77.92	461.8	Open
26	396.0	0.17	93.51	461.8	Open
27	394.0	2.59	96.33	461.8	Open
28	394.0	0.0	96.33	461.8	Open
29	394.0	0.38	96.33	461.8	Open
30	393.0	1.33	97.74	461.8	Open
31	393.0	0.54	97.73	461.8	Open
32	394.0	0.17	96.33	461.8	Open
34	438.0	3.62	82.26	495.9	Open
35	435.1	0.49	85.72	495.4	Open
36	436.0	1.27	85.19	496.0	Open
37	440.0	3.88	78.99	495.6	Open
38	428.0	0.49	95.77	495.4	Open
39	440.0	2.24	78.92	495.5	Open
40	428.0	5.3	95.46	495.2	Open
41	422.0	6.53	103.5	494.9	Open
42	420.0	0.0	106.3	494.8	Open
43	419.4	1.41	107.7	495.2	Open
44	433.0	0.0	87.89	494.9	Open
45	434.0	1.86	83.97	493.1	Open
46	428.0	3.88	92.28	493.0	Open
47	445.0	0.0	71.26	495.2	Open
48	435.0	3.09	85.47	495.2	Open
49	455.0	2.0	56.79	495.0	Open
53	467.5	2.41	93.64	533.4	Open
55	456.0	2.59	110.0	533.4	Open
56	458.0	0.85	107.4	533.6	Open
57	468.5	1.18	92.83	533.8	Open
58	458.0	1.18	107.0	533.3	Open
59	455.0	0.85	111.3	533.3	Open
74	439.0	34.46	134.6	533.8	Open
75	438.0	0.0	136.0	533.8	Open
76	443.0	0.0	128.6	533.5	Open
77	443.0	31.4	128.2	533.2	Open
78	437.0	7.5	137.5	533.8	Open
79	425.0	0.0	154.6	533.8	Open
80	465.0	0.0	97.81	533.8	Open
81	493.0	0.0	58.18	533.9	Open
82	500.0	0.41	48.55	534.2	Open
83	497.0	0.0	53.05	534.3	Open
84	525.0	3.084	13.18	534.3	Open
85	516.0	1.135	25.96	534.3	Open
86	525.0	1.184	13.18	534.3	Open
87	497.0	0.89	53.09	534.4	Open
88	534.4	0.0	3.733e-002	534.4	Open
89	465.0	0.971	98.57	534.4	Open
90	445.0	0.0	127.0	534.4	Open
91	435.0	0.616	141.2	534.4	Open
92	475.0	3.695	84.28	534.3	Open
93	421.0	0.24	161.1	534.4	Open

NODE TABLE

Node	Elevation m	Demand l/s	Pressure psi	HGL m	Status
	<---------- Input	---------->	<---------- Output	---------->	<-Input->
94	342.0	0.0	273.3	534.4	Open
101	475.0	3.09	82.57	533.1	Open
102	460.0	2.98	103.7	533.0	Open
103	480.0	0.0	75.31	533.0	Open
104	477.0	0.0	79.17	532.7	Open
107	481.0	0.0	69.65	530.0	Open
108	485.0	1.56	63.97	530.0	Open
109	486.0	1.84	62.52	530.0	Open
110	481.0	3.97	69.7	530.1	Open
111	477.0	0.0	76.18	530.6	Open
112	455.0	0.0	107.2	530.5	Open
113	472.0	0.0	82.96	530.4	Open
114	479.0	0.0	72.88	530.3	Open
115	491.0	0.0	55.48	530.0	Open
116	500.0	0.0	42.61	530.0	Open
120	504.0	0.0	36.83	529.9	Open
121	498.0	0.0	45.21	529.8	Open
122	493.0	0.0	52.38	529.9	Open
123	502.0	0.0	39.39	529.7	Open
126	478.0	0.85	71.1	528.0	Open
127	472.0	4.44	78.44	527.2	Open
128	452.0	5.92	106.3	526.8	Open
129	483.0	2.17	63.85	527.9	Open
130	501.0	0.0	123.1	587.7	Open
131	518.0	0.0	98.98	587.7	Open
137	518.0	0.0	96.69	586.0	Open
138	495.0	0.0	129.4	586.0	Open
139	495.0	0.0	129.8	586.3	Open
140	498.0	0.0	126.0	586.7	Open
141	499.0	0.0	125.5	587.3	Open
149	495.0	0.0	129.0	585.8	Open
157	479.0	0.0	150.4	584.9	Open
158	470.0	0.0	82.2	527.8	Open
159	446.2	1.84	116.0	527.8	Open
161	445.2	0.0	59.95	487.4	Open
162	437.0	2.55	71.54	487.3	Open
167	467.0	0.0	165.4	583.4	Open
180	425.1	0.0	153.0	532.8	Open
181	459.3	0.0	104.4	532.7	Open
182	452.6	1.56	113.9	532.7	Open
183	443.5	3.119	126.8	532.7	Open
184	473.0	2.835	84.7	532.6	Open
185	457.0	3.686	107.4	532.6	Open
186	482.7	2.552	70.91	532.6	Open
187	469.2	0.709	90.2	532.7	Open
191	483.5	0.0	72.26	534.3	Open
192	450.0	0.0	119.8	534.3	Open
193	450.0	0.0	69.93	499.2	Open
194	419.2	0.0	113.7	499.2	Open
195	409.2	0.0	127.9	499.2	Open
196	399.2	0.0	142.1	499.2	Open
197	399.2	0.0	49.96	434.4	Open
198	375.8	0.0	83.19	434.4	Open
199	363.4	0.284	100.8	434.3	Open
200	357.0	1.135	109.9	434.3	Open
201	375.8	0.995	83.18	434.3	Open
202	400.2	0.0	140.6	499.2	Open
203	407.9	0.853	129.7	499.2	Open
204	389.3	1.421	156.1	499.2	Open
228	483.5	0.0	141.1	582.8	Open
229	525.2	3.592	80.69	582.0	Open
230	532.3	43.14	69.92	581.5	Open
231	528.7	4.914	74.84	581.4	Open

NODE TABLE

<------------------ Input	-----------------	><----------- Output	------------>	<-Input->
Node	Elevation m	Demand l/s	Pressure psi	HGL m	Status
232	540.0	4.536	58.67	581.3	Open
233	541.0	1.134	57.44	581.4	Open
234	542.8	0.945	54.72	581.3	Open
235	542.3	2.268	55.71	581.5	Open
236	545.4	0.0	51.2	581.4	Open
237	538.1	1.701	61.68	581.5	Open
238	545.8	2.457	50.7	581.5	Open
239	541.5	4.158	56.39	581.2	Open
240	532.5	5.481	69.14	581.2	Open
241	550.0	1.89	44.35	581.2	Open
242	558.1	0.0	33.31	581.5	Open
243	581.6	0.0	4.063e-002	581.6	Open
244	641.5	0.0	4.481e-002	641.5	Open
245	595.3	0.0	65.55	641.4	Open
246	0.0	0.0	910.7	641.2	Open
247	578.1	2.457	89.48	641.1	Open
248	577.3	2.642	90.53	641.0	Open
249	558.1	3.969	117.6	640.9	Open
250	549.8	0.0	129.4	640.9	Open
251	548.5	0.0	131.2	640.9	Open
252	0.0	0.0	910.2	640.8	Open
253	557.0	4.536	118.7	640.6	Open
254	550.0	0.0	129.1	640.9	Open
270	425.0	0.0	99.76	495.2	Open
400	468.4	0.0	92.22	533.3	Open
401	468.4	0.0	39.98	496.5	Open
402	464.5	0.0	45.37	496.4	Open
408	0.0	0.0	835.6	588.3	Open
1000	342.0	0.0	273.3	534.4	Open

PUMPED SOURCES TABLE

Input				Output		Input
Node	Pumps	OpCurve	%Estimate	%Actual	Inflow l/s	Status
1000	2	Pump1	0.85	0.0	0.0	Closec
94	1	Pump3	0.1	0.3232	-105.5	Open

FIXED GRADE SOURCES TABLE

Input			Output		Input
Node	Top of Water m	%Estimate	%Actual	Inflow l/s	Status
88	534.4	0.25	0.5898	-192.6	Oper
244	641.5	0.1	4.166e-002	-13.6	Oper
243	581.6	0.1	4.537e-002	-14.82	Oper

BOOST TABLE

Input			Output	Input
Pipe	Pumps	OpCurve	Boost m	Status
414	1	Jardine	58.6	Open

REDUCING (PRV) TABLE

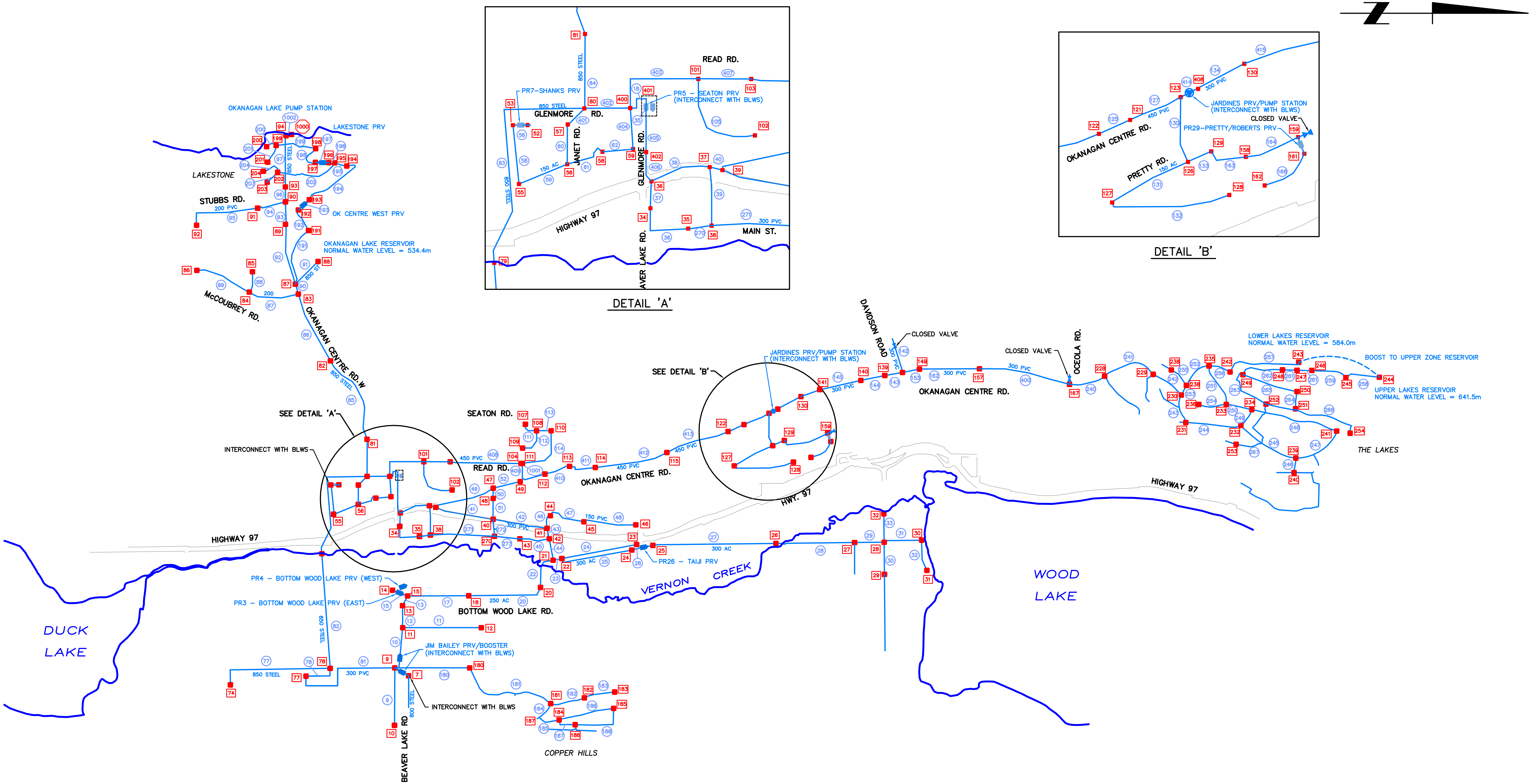
Input					Output		Input
Pipe	Source	Pressure psi	OpenK m	CKV	PRVLoss psi	CKVState	Status
26	88	78.0	0.0	Yes	32.53	Open	Open
10	88	90.0	0.0	Yes	40.87	Closed	Open
18	88	40.0	0.0	Yes	36.54	Open	Open
193	88	70.0	0.0	Yes	35.13	Open	Open
197	88	50.0	0.0	Yes	64.86	Open	Open
167	88	60.0	0.0	Yes	40.43	Open	Open

Jardine <--------- Input --------->	
Flow l/s	**Head m**
0.0	200.0
20.0	120.0
35.0	100.0
50.0	80.0
60.0	60.0
70.0	50.0
80.0	40.0

Pump3 <--------- Input --------->	
Flow l/s	**Head m**
0.0	260.6
15.8	244.4
31.5	232.7
47.3	223.3
63.1	218.5
78.9	211.5
94.6	202.1
110.4	188.1
142.0	153.4
173.5	95.8

Pump2 <--------- Input --------->	
Flow l/s	**Head m**
0.0	292.6
126.2	237.7
189.3	216.4
220.8	201.2
252.4	179.2
283.9	154.4
315.5	126.5

Pump1 <--------- Input --------->	
Flow l/s	**Head m**
0.0	292.6
126.2	237.7
189.3	216.4
220.8	201.2
252.4	179.2
283.9	154.4
315.5	126.5



LEGEND

- EXISTING WATERMAIN
- 95 PIPE
- 95 NODE
- 95 SOURCE
- PRESSURE REDUCING VALVE
- BLWS BEAVER LAKE WATER SOURCE

DISTRICT OF LAKE COUNTRY

WATER MASTER PLAN
OKANAGAN LAKE WATER SOURCE
DISTRIBUTION SYSTEM SCHEMATIC

SCALE: 1:25,000

MARCH 2012

4.5.3 KALAMALKA LAKE SOURCE – DISTRIBUTION SYSTEM COMPUTER MODEL

4.5.3.1 COMPUTER MODEL DATA

The results for the distribution system computer model for the Kalamalka Lake Source are shown below. The existing system analysis is 85% of theoretical peak hour.

PIPE TABLE

Input						Output			Input	
Pipe	UpNode	DnNode	Length	Diameter	Roughness	Flow	Velocity	HeadLoss	Status	
			ft	in		US gpm	ft/sec	ft	Open	
1	1	2	60	16	140	2023.73	3.23	0.12		
2	2	46	737	16	120	2023.73	3.23	2.00		
3	45	3	1936	14	140	1427.88	2.98	3.97		
4	4	5	787	8	120	398.03	2.54	3.08		
5	5	6	715	8	120	359.78	2.30	2.32		
6	6	7	800	4	120	22.10	0.56	0.43		
7	6	8	164	8	120	299.43	1.91	0.38		
8	8	58	341	4	120	43.62	1.11	0.65		
9	46	9	705	4	120	105.17	2.69	6.85		
10	8	59	312	6	120	200.56	2.28	1.39		
11	55	12	360	6	120	50.15	0.57	0.12		
12	12	13	978	4	120	15.30	0.39	0.27		
13	11	14	433	6	120	164.05	1.86	1.33		
14	14	15	910	4	120	17.58	0.45	0.32		
15	47	54	886	8	120	370.60	2.37	3.03		
16	54	16	656	8	120	370.60	2.37	2.25		
17	16	17	1660	6	120	212.50	2.41	8.24		
18	17	18	380	4	120	51.00	1.30	0.97		
19	18	19	656	4	120	28.05	0.72	0.55		
20	17	20	262	4	120	10.20	0.26	0.03		
21	17	21	460	6	120	107.10	1.22	0.64		
22	21	22	1378	4	120	24.65	0.63	0.91		
23	47	23	656	12	50	1007.13	2.86	10.05		
24	23	24	360	12	50	962.08	2.73	5.06		
25	24	25	1214	4	120	10.20	0.26	0.16		
26	24	26	1982	8	120	396.10	2.53	7.68		
27	26	27	2343	8	120	300.90	1.92	5.45		
28	27	28	1332	6	120	196.35	2.23	5.71		
29	28	29	630	6	120	68.85	0.78	0.39		
30	29	30	505	4	120	68.85	1.76	2.24		
31	24	44	800	10	50	488.63	2.00	7.80		
32	52	32	40	12	120	-319.72	-0.91	0.01		Booster
33	31	33	1266	6	120	201.45	2.29	5.69		
34	33	34	690	4	120	148.75	3.80	12.75		
35	34	35	1214	4	120	29.75	0.76	1.14		
36	34	36	1230	4	120	61.20	1.56	4.39		
37	10	37	1290	8	120	418.20	2.67	5.53		
38	37	38	1263	8	120	284.75	1.82	2.65		
39	38	39	951	6	120	110.50	1.25	1.41		
40	41	1	100	8	120	0.00	0.00	0.00		Equivalent
41	42	1	100	8	120	2023.73	12.92	7.94		Equivalent
43	44	52	240	12	140	488.63	1.39	0.14		
44	45	4	260	10	120	413.33	1.69	0.37		
45	46	45	486	16	140	1854.80	2.96	0.84		
46	10	31	318	8	120	300.05	1.92	0.74		
47	48	3	903	14	140	-1387.93	-2.89	1.76		
48	47	48	712	16	50	-1387.93	-2.21	4.86		
49	49	5	1378	12	140	0.00	0.00	0.00		
50	50	49	100	12	140	0.00	0.00	0.00		
51	14	51	720	6	140	64.87	0.74	0.30		
52	51	15	207	6	140	32.57	0.37	0.02		
53	52	53	100	6	120	808.35	9.17	174.11		Equivalent
54	53	10	207	8	140	808.35	5.16	2.26		
55	40	54	100	6	120	0.00	0.00	0.00		
56	11	56	292	6	120	-32.34	-0.37	0.04		
57	55	56	286	6	140	-65.45	-0.74	0.12		

PIPE TABLE

Pipe	UpNode	DnNode	Length ft	Diameter in	Roughness	Flow US gpm	Velocity ft/sec	HeadLoss ft	Status Open
58	56	57	461	8	140	-97.79	-0.62	0.10	
59	57	58	262	4	120	-107.99	-2.76	2.67	
60	58	9	199	4	120	-64.37	-1.64	0.78	
61	59	11	466	6	120	200.56	2.28	2.08	
400	50	400	875	12	140	0.00	0.00	0.00	
401	400	401	30	8	110	0.00	0.00	0.00	
402	401	402	2790	14	130	0.00	0.00	0.00	
403	402	403	5660	20	140	0.00	0.00	0.00	

Peak demand Ratio= 0.85

NODE TABLE

<---------- Input ---------><----- Output ----><--- Optional ---><-Input->,<---- Extra ---->

Node	Elevation ft	Demand US gpm	Pressure psi	HGL ft	XCoord	YCoord	Status ON	Average Demand	
1	1295	0.00	127.10	1588.59				0.00	
2	1293	0.00	127.91	1588.47				0.00	
3	1296	39.95	123.66	1581.66	470	735		47.00	
4	1298	15.30	124.36	1585.26	865	670		18.00	
5	1292	38.25	125.62	1582.18	1010	615		45.00	
6	1355	38.25	97.34	1579.87	1050	720		45.00	
7	1303	22.10	119.67	1579.43	1140	690		26.00	
8	1365	55.25	92.85	1579.49	1050	744		65.00	
9	1345	40.80	101.57	1579.62	975	770		48.00	
10	1510	90.10	92.57	1723.84	890	810		106.00	
11	1433	68.85	61.91	1576.02	1080	865		81.00	
12	1312	34.85	114.21	1575.82	970	920		41.00	
13	1303	15.30	117.99	1575.55	1035	1050		18.00	
14	1424	81.60	65.23	1574.69	1090	932		96.00	
15	1405	50.15	73.32	1574.37	1132	950		59.00	
16	1312	158.10	111.58	1569.76	254	503		186.00	
17	1309	44.20	109.32	1561.52	154	315		52.00	
18	1355	22.95	88.98	1560.55	100	315		27.00	
19	1381	28.05	77.49	1560.00	90	215		33.00	
20	1296	10.20	114.93	1561.49	200	308		12.00	
21	1335	82.45	97.78	1560.88	152	245		97.00	
22	1312	24.65	107.34	1559.97	132	45		29.00	
23	1365	45.05	86.58	1564.99	275	720		53.00	
24	1398	67.15	70.10	1559.93	220	734		79.00	
25	1401	10.20	68.73	1559.77	150	540		12.00	
26	1388	95.20	71.10	1552.25	330	1020		112.00	
27	1335	104.55	91.69	1546.80	465	1310		123.00	
28	1362	127.50	77.53	1541.09	570	1480		150.00	
29	1319	0.00	95.97	1540.70	540	1570		0.00	
30	1362	68.85	76.39	1538.46	610	1520		81.00	
31	1493	98.60	99.61	1723.10	90	680		116.00	
32	1552	0.00	0.00	1552.00	50	695		0.00	Reservoir
33	1445	52.70	117.93	1717.41	70	492		62.00	
34	1421	57.80	122.80	1704.66	70	390		68.00	
35	1453	29.75	108.45	1703.52	7	210		35.00	
36	1398	61.20	130.85	1700.27	69	200		72.00	
37	1530	133.45	81.52	1718.31	120	935		157.00	
38	1547	174.25	73.01	1715.66	205	1114		205.00	
39	1500	110.50	92.75	1714.25	290	1225		130.00	
40	1291	0.00	121.65	1572.01	308	594		0.00	25 Hp
41	1293	0.00	127.96	1588.59				0.00	50 Hp
42	1293	0.00	131.40	1596.53				0.00	125 Hp
44	1510	0.00	18.24	1552.13	80	695		0.00	
45	1289	13.60	128.41	1585.63				16.00	
46	1290	63.75	128.34	1586.47				75.00	
47	1287	10.20	124.69	1575.04	365	707		12.00	
48	1295	0.00	123.33	1579.90	350	730		0.00	
49	1312	0.00	116.96	1582.18				0.00	
50	1312	0.00	116.96	1582.18				0.00	
51	1380	32.30	84.15	1574.39				38.00	
52	1537	0.00	6.49	1551.99				0.00	Up Booster
53	1537	0.00	81.86	1726.09				0.00	Dn Booster
54	1291	0.00	121.65	1572.01				0.00	
55	1381	15.30	84.39	1575.94				18.00	
56	1384	0.00	83.14	1576.06					
57	1367	10.20	90.55	1576.16				12.00	
58	1353	0.00	97.77	1578.84					
59	1394	0.00	79.70	1578.10					
400	1394	0.00	81.47	1582.18				0.00	U/S Booste
401	1394	0.00	81.47	1582.18					D/S Booste
402	1626	0.00	-18.97	1582.18				0.00	PR #1
403	2011	0.00	-185.63	1582.18					WL Intake

INFLOW TABLE

<---------- Input ----------					<------ Output ------>	<-Input->
Node	Pumps	OpCurve	%Estimate	%Actual	Inflow US gpm	Status ON
32	1	RESERVOIR		0.14	-319.72	
40	1	25 Hp		0.00	0.00	no
41	1	KALPUMP1		0.00	0.00	no
42	2	KALPUMP2		0.86	-2023.73	
50	1	WOODLAKE		0.00	0.00	no
403	1	RESERVOIR		0.00	0.00	no

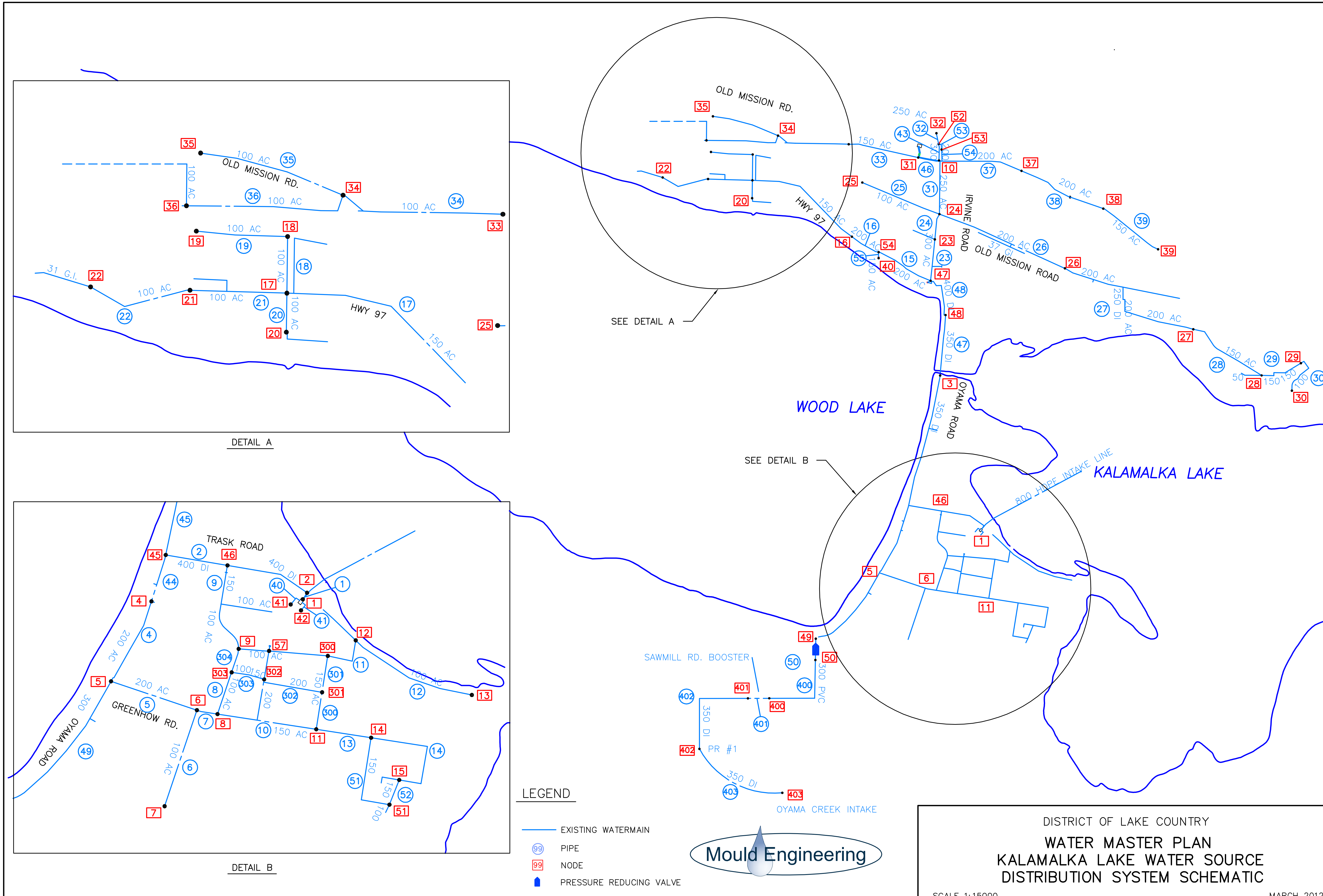
BOOST TABLE

<----- - Input ------>			< Output >	<-Input->
Pipe	Pumps	OpCurve	Boost ft	Status ON
53	1	BOOSTER	180.00	
401	1	SAWMILL	0.00	no

RESERVOIR <------- Input ------> Flow US gpm	Head ft	25 Hp <------- Input -------> Flow US gpm	Head ft	BOOSTER <------- Input -------> Flow US gpm	Head ft
0	0	0	380	0	180
500	0	100	323	300	180
1500	0	150	278	600	180
3500	0	200	240	900	180
5500	0	250	194	1000	180
7000	0	300	133	1200	180
				1500	80

KALPUMP1 <------- Input -------> Flow US gpm	Head ft	KALPUMP2 <------- Input -------> Flow US gpm	Head ft
0	369	0	398
150	345	260	375
300	327	560	352
450	295	860	326
600	263	1160	282
		1460	222

WOODLAKE <------- Input -------> Flow US gpm	Head ft	SAWMILL <------- Input -------> Flow US gpm	Head ft
0	315	0	540
200	312	100	538
500	306	400	535
1000	295	820	520
1500	280	1060	503
2000	250	1310	475
		1600	440
		1800	413



OLD MISSION RD.
HWY 97
IRVINE ROAD
OLD MISSION ROAD
OYAMA ROAD
WOOD LAKE
KALAMALKA LAKE
800 HDPE INTAKE LINE
SEE DETAIL A
SEE DETAIL B
SAWMILL RD. BOOSTER
PR #1
OYAMA CREEK INTAKE
DETAIL A
TRASK ROAD
GREENHOW RD.
OYAMA ROAD
DETAIL B
LEGEND
EXISTING WATERMAIN
PIPE
NODE
PRESSURE REDUCING VALVE
Mould Engineering
DISTRICT OF LAKE COUNTRY
WATER MASTER PLAN
KALAMALKA LAKE WATER SOURCE
DISTRIBUTION SYSTEM SCHEMATIC
SCALE 1:15000
MARCH 2012

4.5.4 OYAMA LAKE SOURCE – DISTRIBUTION SYSTEM COMPUTER MODEL

4.5.4.1 COMPUTER MODEL DATA

The results for the distribution system computer model for the Oyama Lake Source are shown below. The existing system analysis is 80% of theoretical peak hour.

PIPE TABLE

<-------------------- Input					----------------->	<---------- Output		----------->	<-Input->	<Extra>
Pipe	UpNode	DnNode	Length ft	Diameter in	Roughness	Flow USgpm	Velocity ft/s	HeadLoss ft	Status Open	I.D. Label
1	1	2	3700	20	140	5422.34	5.54	15.80		
2	2	3	1800	20	140	5297.54	5.41	7.36		
3	3	4	57	14	100	5297.54	11.04	2.47		ORIFICE
4	4	5	607	4	130	52.00	1.33	1.38		
5	4	6	100	20	140	5190.74	5.30	0.39		
6	6	7	30	4	130	799.06	20.40	200.43		PRV #1
7	7	8	1350	10	130	706.82	2.89	4.44		
8	8	66	255	6	130	240.98	2.73	1.38		
9	9	10	1050	6	130	203.86	2.31	4.16		
10	10	11	1050	4	130	106.45	2.72	9.00		
11	8	12	790	4	130	0.00	0.00	0.00		
12	8	13	656	6	130	322.72	3.66	6.09		
13	13	14	705	6	130	221.68	2.52	3.26		
14	14	15	525	6	130	186.64	2.12	1.77		
15	15	67	525	4	130	70.56	1.80	2.10		
16	6	17	1920	20	140	4308.00	4.40	5.35		
17	17	18	1345	20	140	3865.40	3.95	3.07		
18	18	19	1280	20	140	3701.40	3.78	2.69		
19	17	20	1460	8	140	231.88	1.48	1.58		
20	20	21	1476	8	140	211.88	1.35	1.35		
21	19	22	1312	20	140	3557.40	3.63	2.57		
22	21	22	820	4	130	92.36	2.36	5.40		
23	22	23	1200	4	130	86.16	2.20	6.95		
24	23	24	1960	6	140	27.04	0.31	0.16		
25	24	25	72	6	140	27.04	0.31	244.04		BOOSTER
26	25	26	1590	6	140	27.04	0.31	0.13		
27	22	27	1000	20	140	3384.88	3.46	1.78		
28	27	28	730	4	130	39.44	1.01	1.00		
29	68	29	515	6	130	229.44	2.60	2.54		
30	29	30	837	4	130	127.68	3.26	10.05		
31	27	31	805	20	140	3061.28	3.13	1.19		
32	31	32	30	4	130	766.08	19.56	243.45		PRV #5
33	32	33	1215	10	130	724.96	2.96	4.19		
34	33	34	1296	4	130	97.36	2.49	9.42		
35	34	35	305	4	130	97.36	2.49	2.22		
36	33	36	30	4	130	521.60	13.32	106.34		PRV #6
37	36	37	705	8	130	317.60	2.03	1.56		
38	37	38	1476	6	130	242.96	2.76	8.09		
39	38	39	770	4	130	109.92	2.81	7.00		
40	36	40	1020	6	130	155.76	1.77	2.46		
41	40	41	525	6	130	16.88	0.19	0.02		
42	31	42	820	16	130	2233.60	3.56	2.30		
43	42	43	1525	16	130	2093.52	3.34	3.80		
44	43	44	1017	14	130	1797.52	3.75	3.66		
45	44	69	460	8	130	589.66	3.76	3.21		
46	45	46	910	8	130	589.66	3.76	6.35		
47	46	47	665	4	130	52.08	1.33	1.52		
48	46	48	750	6	130	141.18	1.60	1.51		
49	46	49	640	6	130	194.48	2.21	2.32		
50	49	50	690	6	130	147.04	1.67	1.49		
51	50	51	690	4	130	64.24	1.64	2.32		

PIPE TABLE

Pipe	UpNode	DnNode	Length ft	Diameter in	Roughness	Flow USgpm	Velocity ft/s	HeadLoss ft	Status Open	I.D. Label
52	44	52	345	10	130	1086.34	4.44	2.52		
53	52	53	1050	10	130	1059.14	4.33	7.31		
54	53	54	960	10	130	991.54	4.05	5.92		
55	54	55	890	10	130	917.94	3.75	4.75		
56	55	56	1170	8	130	245.52	1.57	1.61		
57	56	57	855	6	130	140.48	1.59	1.70		
58	55	58	30	3	130	533.54	24.22	98.19		PRV #8
59	58	59	1210	6	130	379.70	4.31	15.17		
60	59	64	655	4	130	-48.38	-1.24	0.44		
61	59	60	820	6	130	346.96	3.94	8.70		
62	60	61	790	6	140	230.24	2.61	3.42		
63	61	62	1295	6	140	91.84	1.04	1.02		
64	62	63	1285	6	140	27.20	0.31	0.11		
65	48	65	630	8	140	48.38	0.31	0.04		
66	65	64	890	8	140	48.38	0.31	0.05		
67	66	9	30	4	130	240.98	6.15	151.39		PRV #2
68	67	16	30	1	130	70.56	18.45	211.55		PRV #3
69	27	68	30	2	130	229.44	23.43	195.64		PRV #4
70	69	45	30	4	130	589.66	15.06	122.27		PRV #7

Peak demand Ratio= 0.80

NODE TABLE

<---------- Input	--------->		<----- Output	---->	<--- Optional	--->	<-Input->,	<---- Extra	---->
Node	Elevation ft	Demand USgpm	Pressure psi	HGL ft	XCoord	YCoord	Status ON	Average Demand	
1	2011	0.00	0.00	2011.00				0.00	INTAKE
2	1755	124.80	103.98	1995.20				156.00	
3	1671	0.00	137.16	1987.84				0.00	GAUGE
4	1663	54.80	139.55	1985.37				68.50	
5	1696	52.00	124.67	1983.99				65.00	
6	1634	83.68	151.94	1984.98				104.60	
7	1630	92.24	66.91	1784.55				115.30	
8	1526	143.12	110.00	1780.11				178.90	
9	1512	37.12	49.93	1627.34				46.40	
10	1378	97.41	106.14	1623.18				121.76	
11	1322	106.45	126.48	1614.18				133.06	
12	1421	0.00	155.46	1780.11				0.00	
13	1575	101.04	86.16	1774.02				126.30	
14	1618	35.04	66.13	1770.76				43.80	
15	1532	116.08	102.59	1768.99				145.10	
16	1440	70.56	49.93	1555.34				88.20	
17	1740	210.72	103.73	1979.62				263.40	
18	1667	164.00	134.01	1976.55				205.00	
19	1719	144.00	110.33	1973.86				180.00	
20	1752	20.00	97.86	1978.05				25.00	
21	1836	119.52	60.91	1976.70				149.40	
22	1749	178.72	96.23	1971.29				223.40	
23	1840	59.12	53.83	1964.34				73.90	
24	1880	0.00	36.44	1964.18				0.00	
25	1880	0.00	142.08	2208.22				0.00	
26	2034	27.04	75.36	2208.09				33.80	
27	1647	54.72	139.61	1969.51				68.40	
28	1661	39.44	133.12	1968.51				49.30	
29	1647	101.76	53.82	1771.33				127.20	
30	1581	127.68	78.04	1761.28				159.60	
31	1614	61.60	153.38	1968.32				77.00	
32	1598	41.12	54.92	1724.87				51.40	
33	1499	106.00	95.96	1720.68				132.50	
34	1595	0.00	50.33	1711.26				0.00	
35	1552	97.36	67.99	1709.05				121.70	
36	1499	48.24	49.93	1614.34				60.30	
37	1476	74.64	59.21	1612.77				93.30	
38	1421	133.04	79.51	1604.68				166.30	
39	1417	109.92	78.21	1597.67				137.40	
40	1437	138.88	75.71	1611.88				173.60	
41	1362	16.88	108.16	1611.86				21.10	
42	1654	140.08	135.07	1966.01				175.10	
43	1683	296.00	120.87	1962.21				370.00	
44	1657	121.52	130.54	1958.55				151.90	
45	1637	0.00	84.88	1833.07				0.00	
46	1624	201.92	87.76	1826.72				252.40	
47	1641	52.08	79.74	1825.21				65.10	
48	1607	92.80	94.47	1825.22				116.00	
49	1575	47.44	107.97	1824.40				59.30	
50	1552	82.80	117.28	1822.91				103.50	
51	1542	64.24	120.60	1820.58				80.30	
52	1673	27.20	122.52	1956.03				34.00	
53	1703	67.60	106.37	1948.72				84.50	
54	1627	73.60	136.71	1942.81				92.00	
55	1683	138.88	110.41	1938.05				173.60	
56	1723	105.04	92.40	1936.44				131.30	
57	1731	140.48	88.20	1934.74				175.60	
58	1683	153.84	67.90	1839.86				192.30	
59	1591	81.12	101.16	1824.69				101.40	

NODE TABLE

<---------- Input		--------->	<----- Output	---->	<--- Optional	--->	<-Input->	<---- Extra ---->
Node	Elevation ft	Demand USgpm	Pressure psi	HGL ft	XCoord	YCoord	Status ON	Average Demand
60	1619	116.72	85.28	1815.99				145.90
61	1656	138.40	67.78	1812.57				173.00
62	1685	64.64	54.78	1811.55				80.80
63	1652	27.20	69.02	1811.44				34.00
64	1585	0.00	103.95	1825.13				0.00
65	1582	0.00	105.27	1825.18				0.00
66	1515	0.00	114.17	1778.73				0.00
67	1443	0.00	140.21	1766.89				0.00
68	1647	0.00	54.92	1773.87				0.00
69	1637	0.00	137.81	1955.34				

INFLOW TABLE

Node	Pumps	OpCurve	%Estimate	%Actual	Inflow USgpm	Status ON
1	0	INTAKE		1.00	-5422.34	

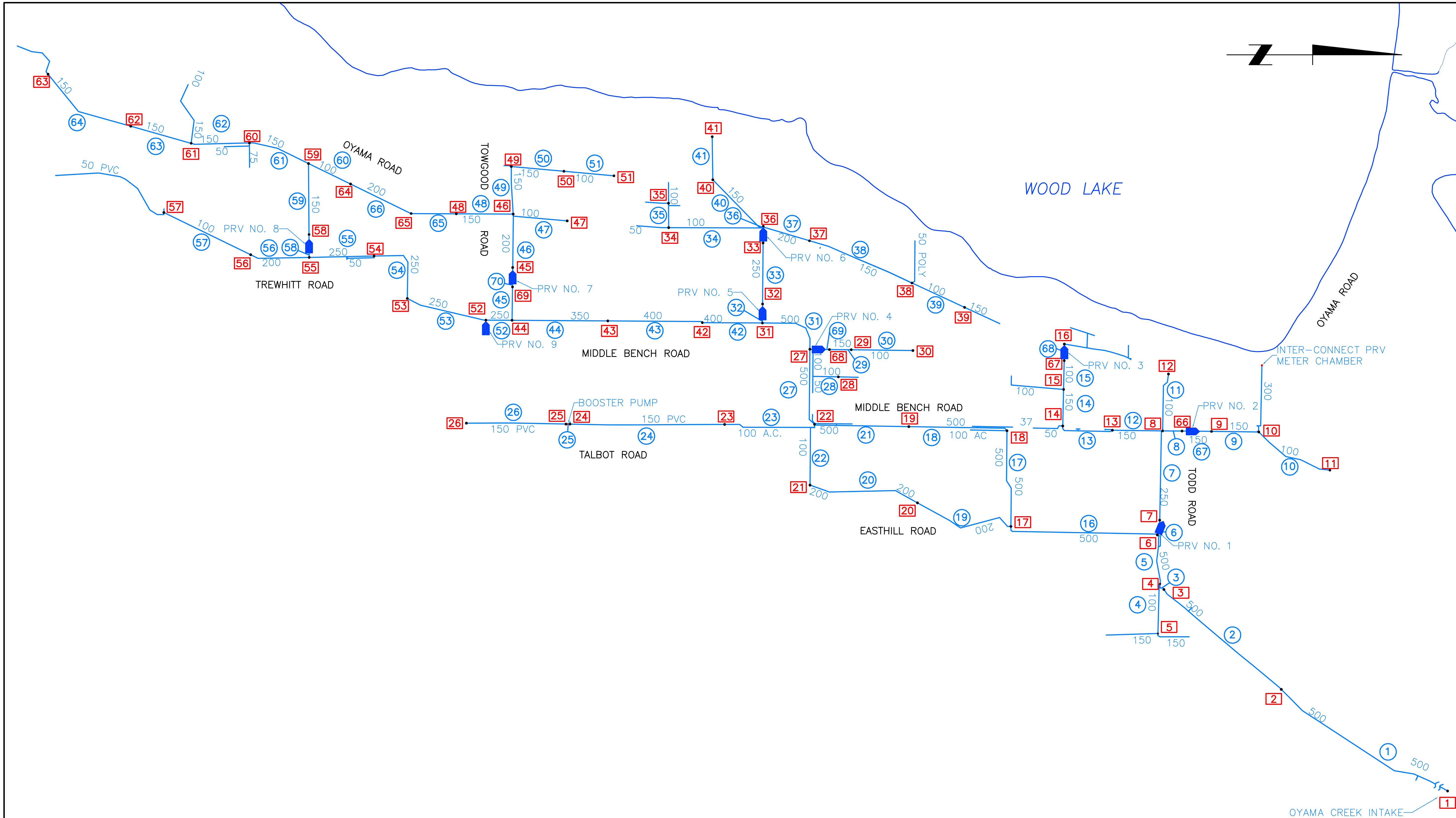
BOOST TABLE

Pipe	Pumps	OpCurve	Boost ft	Status ON
25	1	BOOSTER	244.04	

REDUCING (PRV) TABLE

Pipe	Source	Pressure psi	OpenK	CKV	PRVLoss ft	CKVState	PRV #
6	1	67		no	189.68	Open	1
67	1	50		no	150.23	Open	2
68	1	50		no	176.91	Open	3
69	1	55		no	164.46	Open	4
32	1	55		no	233.50	Open	5
36	1	50		no	101.46	Open	6
70	1	85		no	116.14	Open	7
58	1	68		no	77.54	Open	8

INTAKE Flow USgpm	INTAKE Head ft	BOOSTER Flow USgpm	BOOSTER Head ft
0	0	0	275
1000	0	18	263
2000	0	30	238
3000	0	50	175
5000	0	70	75
7000	0		



LEGEND

EXISTING WATERMAIN

PIPE

NODE

PRESSURE REDUCING VALVE

Mould Engineering

DISTRICT OF LAKE COUNTRY

WATER MASTER PLAN
OYAMA LAKE WATER SOURCE
DISTRIBUTION SYSTEM SCHEMATIC

SCALE 1:15000

MARCH 2012

appendix d

WATER QUALITY REQUIREMENTS
SECTIONS 5.4-5.7
(MOULD ENGINEERING)

5.4 WATER QUALITY CONCEPTS

The concept of dual (separate) and single distribution systems has been discussed by many communities in rural areas. During the 60's and 70's, the majority of the rural pipelines installed were mainly for irrigation and the water source fed by gravity from upland lakes. Since then, rural areas or irrigation districts have been developed and incorporated under the water quality requirements of IH. The pipelines are mostly made of Asbestos Concrete (AC) and the long term objective in Canada is to replace all AC lines as the opportunity arises.

A dual distribution system would require the installation of a complete duplicate system with smaller diameter piping (probably PVC) for domestic water, alongside the existing system. The existing system would become the irrigation and fire flow distribution system and no or minimal treatment would be required at the source. Installing a dual system increases operations, maintenance and management twofold, and is not considered financially feasible where irrigation and domestic supplies are needed within the same large geographical area. Also, this concept will create the most public discontent due to the fact that almost every road will have to dug up to install the new watermains.

A single distribution system is currently in use within the District. The downside of this type of system is that the treatment facilities required must be sized to treat irrigation as well as domestic water, although irrigation water is required for less than 50 % of time.

The following 4 concepts were discussed in Section 6 – Source Interconnections:

- Dual – Interconnected
- Dual – Not Interconnected
- Single – Interconnected
- Single – Not Interconnected

5.5 WATER QUALITY OPTIONS & CAPITAL COST ESTIMATES

In total, 10 variations of the 4 water quality concepts described were created. All the variations met GCDWQ requirements for Drinking water. The Dual – Interconnected concept provided 3 options, while four options were created for the Dual – Not Interconnected concept. The Single – Interconnected concept provided two options and only one option for the Single Not Interconnected concept. Capital cost calculations were done for all of the above options. Initial studies revealed that installing a dual distribution system for all four major water sources, providing interconnections between the systems, and constructing a small domestic water treatment plant at Eldorado would cost approximately double the amount of a single system interconnected with a large water treatment plant at Eldorado. Refer to the table below for the comparison between the 10 different Options. The list of 10 options was narrowed down to 4 suitable options. Options 1 to 4 are reviewed in detail in Section 5.6. Option 2 was selected as the preferred option.

5.5.1 SELECTION & EVALUATION CRITERIA

In order to evaluate the 10 options and determine which option meets the highest rating, the options were evaluated using 10 criteria selected by the WAC. Each criterion was then assigned a weighting factor which graded them into order of importance to the community. For instance, *Capital Cost* at 19% was almost 4 times more important than *Phaseability* at 5%. The weighting factor was expressed as a percentage of 100%. The evaluation criteria were:

- Capital Cost
- Social Cost
- Sustainability
- Risk
- System Renewal
- Reliability
- Interconnections
- Operating Cost
- Phaseability
- Manageability

Table 5.9 below shows the evaluation matrix of one option. Each criterion was evaluated on a scale of one to 10. As shown on the table, ten is not always the highest or best score on the scale. Once rated, the scale value was expressed as a percentage and totaled. In the example below, the option was rated 63% out of a possible 100%.

Table 5.9 – Evaluation Table

Criteria	Wt	Importance	Evaluation - Enter 1 to 10										Importance	% Value
			1	2	3	4	5	6	7	8	9	10		
Capital Cost	19%	High			3								Low	6%
Social Cost	5%	High								8			Low	4%
Sustainability	9%	Not								8			Very	7%
Risk	9%	High										10	Low	9%
System Renewal	9%	High	1										Low	1%
Reliability	12%	Not										10	Very	12%
Interconnections	10%	None										10	Some	10%
Operating Cost	12%	High			3								Low	4%
Phaseability	5%	Few								8			Many	4%
Manageability	10%	Complex						6					Simple	6%
Total														**63%**

The next step was to total the evaluations of all the options and create a short list of options. The option with the best rating was selected out of each water configuration concept. The SC debated the advantages and disadvantages of dual versus single water distribution systems and formulated shortlist of options for the WAC to select the preferred option to present to council.

The guiding principles, established by the SC, for selecting the preferred option were:

- Utilize all four water sources
- No filtration facilities at Okanagan & Kalamalka Lakes

It was immediately evident on the shortlist of 4 options that the majority of the options encompass the following principles:

- Single Distribution Systems
- Interconnected
- Using Beaver Lake and Oyama Lake as the Primary Water Sources
- Using Okanagan & Kalamalka Lakes as Secondary and /or Backup Sources
- Water Treatment Facility at Eldorado Reservoir

Figure 5.1 – Flow Chart Showing Selection, Development, and Implementation Stages

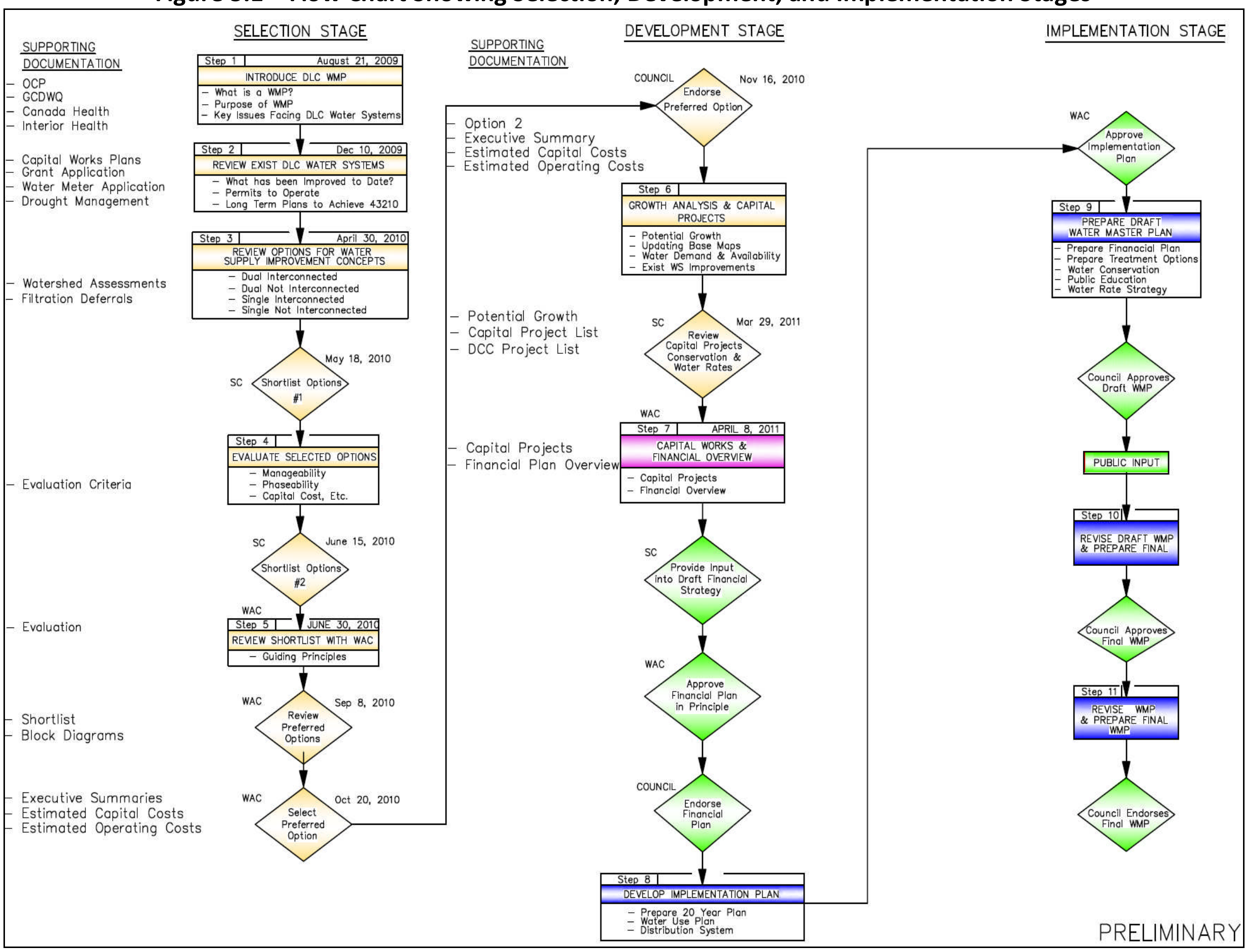


Figure 5.1 shows the decision making process broken down into 3 stages: the selection stage, the development stage, and the implementation stage. Each water configuration option was derived by using this technique. The four options on the shortlist as selected by the SC are described in the next section.

5.6 OPTIONS 1 TO 4

Table 5.10 below shows the description and source comparison for Option 1 to 4. In Section 5.6, each option is discussed in detail and corresponding figures and costs will be included. Option 2 was selected as the preferred option factoring all relevant criteria.

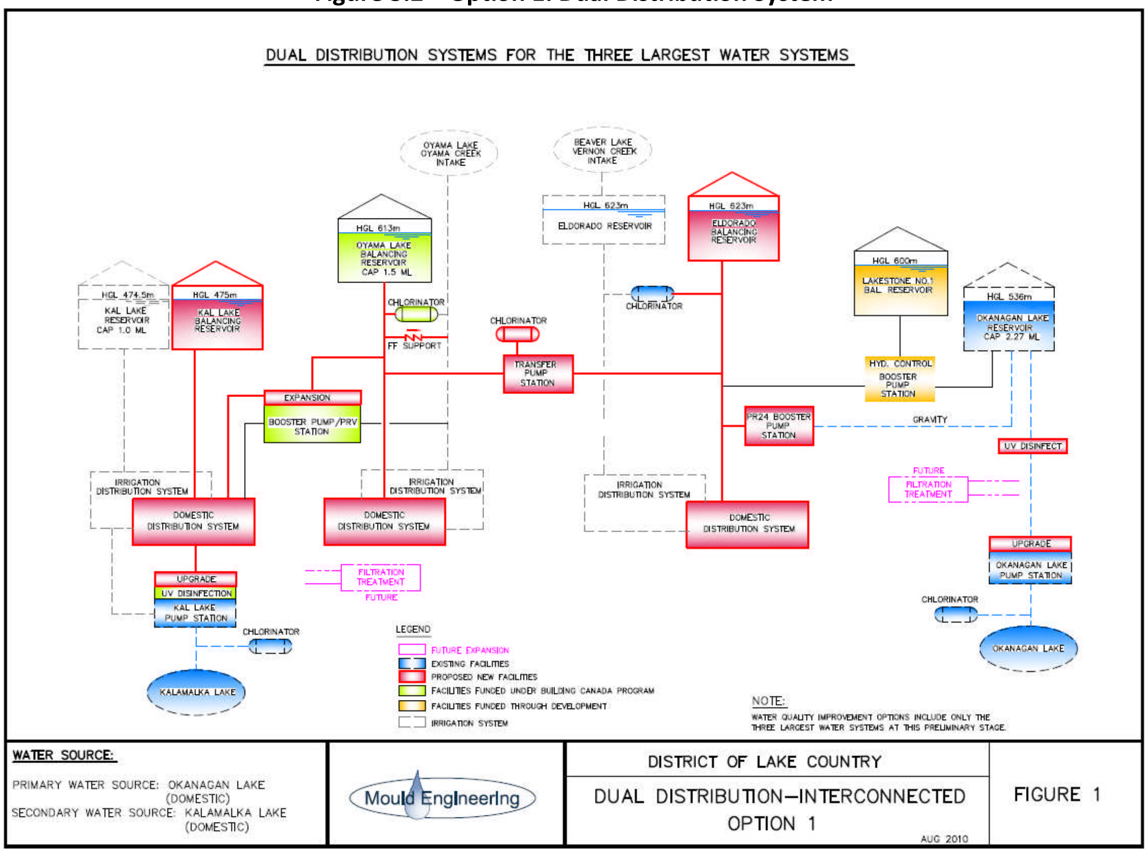
Table 5.10 – Option Source and Description Comparison

Option Comparison	Water Source		Option Description	Capital Costs & (Operating Costs)		Evaluation Matrix Reading
	Primary	Secondary		Phase 1 - 3	Phase 4 Future	
Option 1: Dual Distribution System for Beaver / Okanagan, Oyama, & Kalamalka Lake WS (Interconnected)	Okanagan Lake	Kalamalka Lake	Domestic water supplied from Okanagan and Kalamalka Lakes with systems interconnected. Dual disinfection at each source only. Irrigation water supplied from Beaver & Oyama Lakes. Filtration Deferral required at Okanagan and Kalamalka Lakes.	$53,000,000 ($530,000)	$25,000,000 ($270,000)	51%
Option 2: Single Distribution System for Beaver / Okanagan, Oyama, & Kalamalka Lake WS (Interconnected)	Beaver & Okanagan Lakes	Okanagan & Kalamalka Lakes	Domestic and irrigation water supplied from Beaver & Okanagan Lake with systems interconnected. Large treatment plant at Eldorado Reservoir. Oyama Lake discharge diverted to Eldorado Reservoir. Backup water supplied from Okanagan and Kalamalka Lakes. Kalamalka and Okanagan Lake systems operate similar to existing. Filtration deferral required at Kalamalka Lake.	$48,000,000 ($540,000)	$23,000,000 ($170,000)	47%
Option 3: Single Distribution System for Beaver / Okanagan Lake Water Systems (Not Interconnected)	Beaver & Okanagan Lakes	Okanagan Lake	Domestic and Irrigation water supplied from Beaver and Okanagan Lake. Treatment plant at Eldorado Reservoir. Backup water supplied from Okanagan Lake. No interconnection between Beaver/Okanagan Lake WS and Oyama Lake / Kalamalka Lake WS.	$47,200,000 ($540,000)	$15,800,000 ($220,000)	49%
Option 4: Single / Dual Distribution System for Beaver / Okanagan Lake WS (Interconnected)	Beaver & Okanagan Lakes	Okanagan Lake	Domestic and irrigation water supplied from Beaver and Okanagan Lake with backup water from Okanagan Lake. Treatment Plant at Eldorado Reservoir.	$55,000,000 ($530,000)	$11,000,000 ($140,000)	39%

5.6.1 OPTION #1 – DUAL DISTRIBUTION SYSTEM (INTERCONNECTED)

Option #1 is based on the concept of installing a separate distribution system for domestic use utilizing the two best water sources in the valley, Okanagan and Kalamalka Lakes. Domestic use is described as in-house and yard watering, which matches the use of the existing domestic services within the District. This option includes an interconnection between the Beaver/Okanagan Lake System and the Oyama Lake System. The connection provides each system with a backup domestic water supply, although only at a portion of their respective maximum daily demands.

Figure 5.2 – Option 1: Dual Distribution System



Irrigation as well as some fire flow requirements will continue to be supplied from Beaver Lake & Oyama Lake through the existing distribution systems. However, considerable portions of the new domestic system will also be designed for fire flows as numerous areas will have no irrigation system (e.g.: Town Centre, The Lakes, etc.). If at some point the Okanagan and Kalamalka Lake sources are deemed not suitable for filtration deferral, a filtration facility will be required at each source.

5.6.1.1 WATER SOURCES

All four water sources will continue to be utilized, Beaver and Oyama Lakes for irrigation purposes, and Okanagan and Kalamalka Lakes for domestic purposes. Additional capacity will be available within the irrigation systems once the domestic demand is transferred off. The Okanagan and Kalamalka Lake pump stations will both be utilized to near full capacity when meeting the domestic maximum day demand. Therefore, pump station upgrades will be required at each facility to provide backup pumping capacity. Further upgrades or new source facilities will be required to supply growth.

Option 1 does not have a backup water source for domestic purposes other than the interconnection between the systems.

5.6.1.2 EVALUATION PROCESS

As mentioned in the introduction of this section, each option was examined with the 10 point evaluation process. The table below shows that Option 1 scored 51 %, where the largest contributing factor was sustainability. However, this option also has a high social cost and relatively high capital cost.

Table 5.11 – Evaluation of Option 1

Criteria	Wt	Importance	Evaluation - Enter 1 to 10										Importance	% Value
			1	2	3	4	5	6	7	8	9	10		
Capital Cost	19%	High			3								Low	6%
Social Cost	5%	High	1										Low	1%
Sustainability	9%	Not										10	Very	9%
Risk	9%	High									9		Low	8%
System Renewal	9%	High								8			Low	7%
Reliability	12%	Not				4							Very	5%
Interconnections	10%	None					5						Some	5%
Operating Cost	12%	High					5						Low	6%
Phaseability	5%	Few		2									Many	1%
Manageability	10%	Complex				4							Simple	4%
Total														**51%**

5.6.1.3 COST ESTIMATE NOTES

The estimates are based on conceptual designs and should be viewed to be accurate within an order of magnitude of 25%.

Notes pertaining to the order of magnitude cost estimate that are common to all estimates are as follows:

- The Lakestone Reservoir and Booster station, shown as part of the Beaver/Okanagan Lake Water System, are assumed to be facilities that will be funded through development. Also, the Building Canada grant funded works shown within the Kalamalka and Oyama Lake Systems has been excluded from the capital cost estimates.

- No allowance has been made for incorporating any other utilities (e.g. Ponderosa, Lake Pine, Alto).
- Long term system renewal and existing infrastructure improvements have not been considered in the estimate with the exception of some 100 mm diameter pipe and domestic services as noted below.
- Cost of expanding the system to service existing properties or development has not been considered in this estimate.
- No allowance has been made for the acquisition of real estate.
- No allowance has been made for the installation of universal water meters.
- No allowance has been made within the annual operating costs for renewal of the new distribution system.

There are also specific conditions associated with the installation of a separate domestic distribution system, upon which the estimates are based.

- This estimate includes only the cost of reconnecting existing domestic services to the new watermain. No allowance has been made for the complete renewal, including curb stops, of domestic water service connections;
- No allowance has been made for the connection of domestic services that were installed along the recently installed Okanagan Centre Rd East watermain but were not transferred to the new pipe;
- No allowance has been made for the replacement of larger pipelines and hydrants in numerous areas currently serviced by 100 mm diameter pipelines and hydrants that do not meet minimum fire flows;
- New pressure reducing stations for all three water systems are only included where a new domestic watermain is installed;
- The capital cost of installing a complete duplicate water distribution system does not include replacing some of the existing distribution system or resurfacing the entire road width.

5.6.1.4 CONSTRUCTION PHASES

This option has been divided into four phases. Ultra-violet disinfection will be installed at Okanagan Lake in Phase 1, which provides the dual disinfection required. The ultraviolet disinfection system at Kalamalka Lake will be installed under the Building Canada Fund project, which is currently in the planning stages. The phasing approach assumes that approval of filtration deferral will be obtained at both lakes.

The first three phases each contain construction of a domestic distribution system. Oyama, the smallest of the three systems, will be in the 3rd phase because that system already provides high quality water to its users and will have dual disinfection at the source. The fourth phase is the future installation of filtration facilities at Okanagan Lake and Kalamalka Lake.

5.6.1.5 CAPITAL & OPERATING COST ESTIMATES

Below is a cost summary of the first 3 phases spread over a period of 15 years. The annual operating cost for phase 1 to 3 is estimated to be **$530,000**.

Table 5.12 – Option 1: Construction Phases 1 to 3

OPTION 1 – Construction Phases 1 to 3			
#	Phase Breakdown	Sub-Total	Total
PHASE 1: (1 – 5 YRS)			
1	UV Disinfection Facility at Okanagan Lake Pump Station	$1,600,000	
2	Okanagan Lake Pump Station - Pump Upgrade	$900,000	
3	Dual Distribution System - Oyama Lake WS	$11,000,000	
4	Kalamalka Lake Pump Station Upgrade	$1,300,000	
	Total Estimated Capital Cost - Phase 1		***$14,800,000***
PHASE 2: (6 - 10 YRS)			
1	PR24 Booster Pump Station	$1,300,000	
2	Dual Distribution System - Beaver/Okanagan Lake WS	$23,000,000	
3	Eldorado Balancing Reservoir	$2,700,000	
	Total Estimated Capital Cost - Phase 2		***$27,000,000***
PHASE 3: (11 - 15 YRS)			
1	Transfer Pump Station & Chlorination Facility	$1,700,000	
2	Watermain from Beaver/Okanagan Lake WS to Transfer Pump Station	$3,500,000	
3	Dual Distribution System - Kal Lake WS	$4,000,000	
4	Kalamalka Lake Balancing Reservoir	$2,000,000	
	Total Estimated Capital Cost - Phase 3		***$11,200,000***
SUB-TOTAL ESTIMATED COST - Option 1, Phases 1 to 3			**$53,000,000**

Below is a cost summary for the fourth phase if filtration deferral is not approved and maintained. The annual operating cost for phase 4 is estimated to be **$270,000.**

Table 5.13 – Option 1: Construction Phase 4

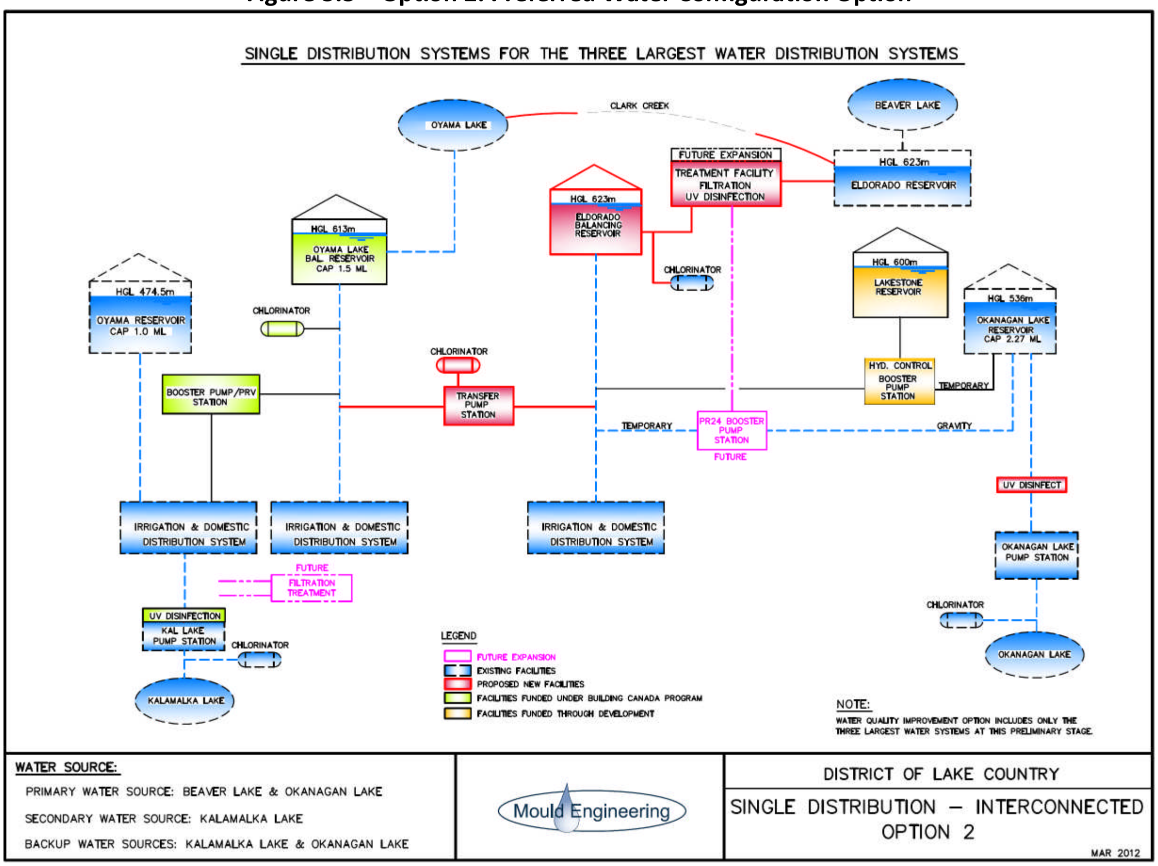
OPTION 1 – Construction Phases 4			
#	Phase Breakdown	Sub-Total	Total
PHASE 4: (FUTURE FILTRATION)			
1	Filtration, Chlorination & Dual Disinfection @ Okanagan Lake (40 ML/day)	$20,000,000	
2	Filtration, Chlorination & Dual Disinfection @ Kalamalka Lake (7 ML/day)	$5,000,000	
	Total Estimated Capital Cost - Phase 4		***$25,000,000***
TOTAL ESTIMATED COST – Option 1			**$78,000,000**

5.6.2 Option #2 – Single Distribution System (Interconnected)

Option #2 consists of maintaining the single distribution pipelines for the three largest water systems. The primary water source is Beaver and Oyama Lakes, the latter of which will be diverted to Eldorado Reservoir via Clark Creek. The option includes a large full treatment facility at Eldorado Reservoir to treat maximum daily domestic and irrigation demands. A large interconnection conveys water from the Beaver/Okanagan Lake System to the Oyama Lake System. Kalamalka Lake Pump Station will continue to supply its current area.

If at some point the Okanagan and Kalamalka Lake Sources are deemed unsuitable for filtration deferral, a filtration facility will be required for each source. For the Okanagan Lake Source, instead of installing a filtration facility at the lake, this option pumps lake water through a dedicated mainline to an expanded treatment facility at Eldorado Reservoir. For Kalamalka Lake, a filtration facility could be installed at the Kalamalka Lake Pump Station, or the balancing reservoir.

Figure 5.3 – Option 2: Preferred Water Configuration Option



5.6.2.1 Water Sources

All four water sources will continue to be utilized for both irrigation and domestic purposes. The Kalamalka and Okanagan Lake sources would continue to serve their respective areas. The treatment facilities at Eldorado reservoir will be sized to maximize the existing mainline gravity supply. Once the treatment facilities and interconnection works are operational, Oyama Lake water will be diverted via Clark Creek to Eldorado reservoir to supplement water supply for treatment.

5.6.2.2 EVALUATION PROCESS

The table below shows the evaluation process for Option 2. Although this option will have a high capital and social cost, the risk factor is low. In total, this Option ranked 47%, which is a contributing factor resulting in the preferred option decision.

Table 5.14 – Evaluation of Option 2

Criteria	Wt	Importance	Evaluation - Enter 1 to 10										Importance	% Value
			1	2	3	4	5	6	7	8	9	10		
Capital Cost	19%	High	1										Low	2%
Social Cost	5%	High	1										Low	1%
Sustainability	9%	Not										10	Very	9%
Risk	9%	High										10	Low	9%
System Renewal	9%	High								8			Low	7%
Reliability	12%	Not					5						Very	6%
Interconnections	10%	None					5						Some	5%
Operating Cost	12%	High				4							Low	5%
Phaseability	5%	Few	1										Many	1%
Manageability	10%	Complex			3								Simple	3%
Total														**47%**

5.6.2.3 COST ESTIMATE NOTES

The estimates are based on conceptual designs and should be viewed to be accurate within an order of magnitude of 25%. Notes pertaining to the order of magnitude cost estimate that are common to all estimates are as follows:

- The Lakestone Reservoir and Booster station, shown as part of the Beaver/Okanagan Lake Water System, are assumed to be facilities that will be funded through development. Also, the Building Canada grant funded works shown within the Kalamalka and Oyama Lake Systems has been excluded from the capital cost estimates.
- No allowance has been made for incorporating any other utilities (e.g. Ponderosa, Lake Pine, Alto).
- Long term system renewal and existing infrastructure improvements have not been considered in the estimate.
- Cost of expanding the system to service existing properties or

development has not been considered in this estimate.

- No allowance has been made for the acquisition of real estate.
- No allowance has been made for the installation of universal water meters.
- No allowance has been made within the annual operating costs for renewal of the existing distribution system.

5.6.2.4 CONSTRUCTION PHASES

This option has been divided into four phases. Ultra-violet disinfection will be installed at Okanagan Lake in Phase 1, which provides the dual disinfection required. The Ultra-violet disinfection system at Kalamalka Lake will be installed under the Building Canada Fund project, which is currently in the planning stages. The first phase includes the construction of the treatment facility at Eldorado Reservoir, which is sized for approximately 70% of the water demand. The phasing approach assumes that approval of filtration deferral will be obtained at both Okanagan and Kalamalka Lakes.

During the second phase the transfer pump station and connecting pipeline to the Oyama Lake System will be constructed. Until then, residents of the Oyama and Kalamalka Lake areas will continue receiving water from their respective water systems. Once Oyama Lake water can be diverted to Eldorado Reservoir and the interconnecting pipeline has been constructed, the full-sized treatment facilities at Eldorado will completed in Phase 3.

The fourth phase is the future installation of filtration facilities at Kalamalka Lake and the expansion of the filtration facilities at Eldorado to accommodate the additional pumped capacity from Okanagan Lake. The future filtration is sized to accommodate one pump operating (230 lps) at Okanagan Lake Pump Station.

5.6.2.5 CAPITAL & OPERATING COST ESTIMATES

Below is a cost summary of the first 3 phases spread over a period of 15 years. The annual operating cost for phase 1 to 3 is estimated to be **$540,000**.

Table 5.15 – Option 2: Construction Phases 1 to 3

OPTION 2 – Construction Phases 1 to 3			
#	**Phase Breakdown**	**Sub-Total**	**Total**
PHASE 1: (1 – 5 YRS)			
1	UV Disinfection Facility at Okanagan Lake Pump Station	$1,600,000	
2	Eldorado Balancing Reservoir	$2,700,000	
3	Treatment Facilities at Eldorado Reservoir (Partial Demand)	$21,000,000	
	Total Estimated Capital Cost - Phase 1		***$25,300,000***
PHASE 2: (6 - 10 YRS)			
1	Transfer Pump Station & Chlorination Facility	$1,700,000	
2	Watermain from Beaver/Okanagan Lake WS to Transfer Pump Station	$8,000,000	
3	Oyama Lake Diverted to Clark Creek & Eldorado Reservoir	$3,000,000	
	Total Estimated Capital Cost - Phase 2		***$12,700,000***
PHASE 3: (11 - 15 YRS)			
1	Treatment Facilities at Eldorado Reservoir (Remainder of Demand)	$10,000,000	
	Total Estimated Capital Cost - Phase 3		***$10,000,000***
SUB-TOTAL ESTIMATED COST - Option 2, Phases 1 to 3			**$48,000,000**

Below is a cost summary for the fourth phase if filtration deferral is not approved and maintained. The annual operating cost for phase 4 is estimated to be **$170,000.**

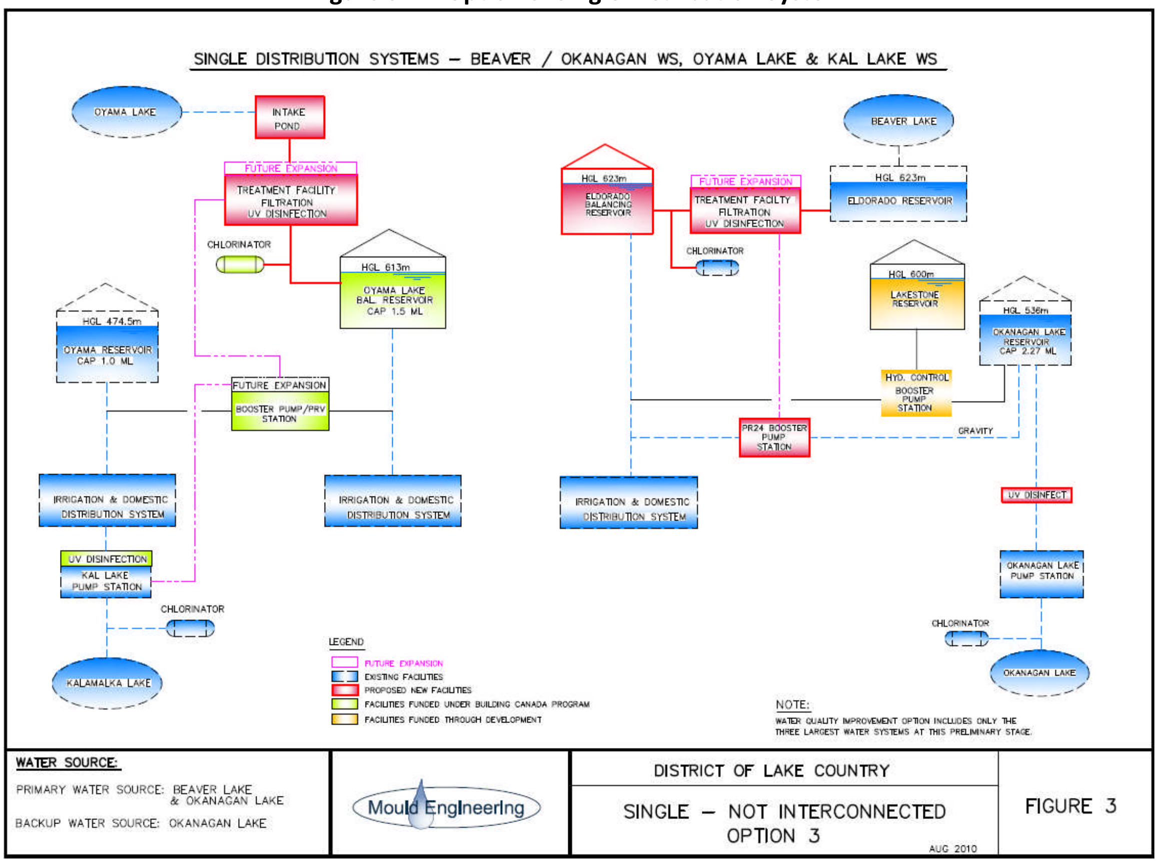
Table 5.16 – Option 2: Construction Phase 4

OPTION 2 – Construction Phases 4			
#	**Phase Breakdown**	**Sub-Total**	**Total**
PHASE 4: (FUTURE FILTRATION)			
1	PR24 Booster Pump Station	$1,300,000	
2	Watermain from PR24 to Eldorado Reservoir	$1,700,000	
3	Filtration Expansion @ Eldorado Treatment Site (20 ML/day)	$8,000,000	
4	Filtration, Chlorination & Dual Disinfection @ Kalamalka Lake (16 ML/day)	$11,000,000	
5	Misc Piping Configurations	$1,000,000	
	Total Estimated Capital Cost - Phase 4		***$23,000,000***
TOTAL ESTIMATED COST – Option 2			**$71,000,000**

5.6.3 OPTION #3 – SINGLE DISTRIBUTION SYSTEM (NOT INTERCONNECTED)

Option #3 is similar to Option #2 in that single distribution pipelines are maintained for the three largest water systems. However, there is no long pipeline interconnect, but rather a second treatment facility on the Oyama Lake source. This option includes full treatment facilities for the Beaver/Okanagan Lakes water system at Eldorado Reservoir. In the future Okanagan Lake water will be pumped directly from the Okanagan Lake Reservoir by a new booster pump station and dedicated pipeline. This concept avoids having to install future filtration facilities at Okanagan Lake.

Figure 5.4 – Option 3: Single Distribution System



As mentioned, a new treatment facility will be installed at Oyama Creek intake to supply treated water to the Oyama Lake single distribution system. If at some point the Kalamalka Lake source is deemed not suitable for filtration deferral, a filtration facility expansion will be required at the Oyama Creek Intake. This option includes pumping Kalamalka Lake water through a dedicated mainline to an expanded treatment facility at the Oyama Creek intake.

5.6.3.1 WATER SOURCES

All four water sources will continue to be utilized for both irrigation and domestic purposes. The water treatment facility at Eldorado will treat primarily Beaver Lake water for the Beaver/Okanagan Lake WS. If filtration deferral is not acceptable, Okanagan Lake water will be pumped to the Eldorado treatment facility to blend with Beaver Lake water. No future filtration will be required at Okanagan Lake.

Similarly, Oyama Lake water will be the primary source of treated water for the Oyama Lake System. If filtration deferral is not acceptable, Kalamalka Lake water will be pumped to the treatment facilities to blend with Oyama Lake water.

5.6.3.2 EVALUATION PROCESS

Based on the table below, Option 3 ranked high for capital and social cost and relatively low for system renewal and risk. In total, Option 3 scored an evaluation value of 49 %, which is relatively similar to Option 1 and 2.

Table 5.17 – Evaluation of Option 3

Criteria	Wt	Importance	Evaluation - Enter 1 to 10										Importance	% Value
			1	2	3	4	5	6	7	8	9	10		
Capital Cost	19%	High		2									Low	4%
Social Cost	5%	High	1										Low	1%
Sustainability	9%	Not								8			Very	7%
Risk	9%	High									9		Low	8%
System Renewal	9%	High								8			Low	7%
Reliability	12%	Not					5						Very	6%
Interconnections	10%	None					5						Some	5%
Operating Cost	12%	High						6					Low	7%
Phaseability	5%	Few		2									Many	1%
Manageability	10%	Complex			3								Simple	3%
Total														**49%**

5.6.3.3 COST ESTIMATE NOTES

The estimates are based on conceptual designs and should be viewed to be accurate within an order of magnitude of 25%.

Notes pertaining to the order of magnitude cost estimate that are common to all estimates are as follows:

- The Lakestone Reservoir and Booster station, shown as part of the Beaver/Okanagan Lake Water System, are assumed to be facilities that will be funded through development. Also, the Building Canada grant funded works shown within the Kalamalka and Oyama Lake Systems has been excluded from the capital cost estimates.

- No allowance has been made for incorporating any other utilities (e.g. Ponderosa, Lake Pine, Alto).
- Long term system renewal and existing infrastructure improvements have not been considered in the estimate.
- Cost of expanding the system to service existing properties or development has not been considered in this estimate.
- No allowance has been made for the acquisition of real estate.
- No allowance has been made for the installation of universal water meters.
- No allowance has been made within the annual operating costs for renewal of the existing distribution system.

5.6.3.4 CONSTRUCTION PHASES

This option has been divided into four phases. Ultra-violet disinfection will be installed at Okanagan Lake in Phase 1, which provides the dual disinfection required. The Ultra-violet disinfection system at Kalamalka Lake will be installed under the Building Canada Fund project, which is currently in the planning stages. The phasing approach assumes that approval of filtration deferral will be obtained at Okanagan Lake and Kalamalka Lake.

The first three phases each contain a treatment facility. Oyama/Kalamalka Lake will be in the 3rd phase because that system already provides high quality water, improved under the Canada Building Fund, to its users and will have dual disinfection at the source.

The fourth phase is the future expansion of the filtration facilities at both treatment plants to accommodate the additional capacities from Okanagan Lake and Kalamalka Lake complete with booster pumps and dedicated pipelines.

5.6.3.5 CAPITAL & OPERATING COST ESTIMATES

Below is a cost summary of the first 3 phases spread over a period of 15 years. The annual operating cost for phase 1 to 3 is estimated to be **$540,000**.

Table 5.18 – Option 3: Construction Phases 1 to 3

OPTION 3 – Construction Phases 1 to 3			
#	**Phase Breakdown**	**Sub-Total**	**Total**
PHASE 1: (1 – 5 YRS)			
1	UV Disinfection Facility at Okanagan Lake Pump Station	$1,600,000	
2	Eldorado Balancing Reservoir	$2,600,000	
3	Treatment Facilities at Eldorado Reservoir (Partial Demand, 50 ML/day)	$18,000,000	
	Total Estimated Capital Cost - Phase 1		***$22,200,000***
PHASE 2: (6 - 10 YRS)			
1	Treatment Facilities at Eldorado Reservoir (Remainder of Demand, 23 ML/day)	$9,000,000	
2	PR24 Booster Pump Station	$1,300,000	
	Total Estimated Capital Cost - Phase 2		***$10,300,000***
PHASE 3: (11 - 15 YRS)			
1	Treatment Facilities at Eldorado Reservoir (Remainder of Demand, 26ML/day)	$11,000,000	
2	New Oyama Creek Intake Pond	$1,400,000	
3	Booster / PRV Station Expansion	$1,000,000	
4	New Watermains	$1,300,000	
	Total Estimated Capital Cost - Phase 3		***$14,700,000***
SUB-TOTAL ESTIMATED COST - Option 3, Phases 1 to 3			**$47,200,000**

Below is a cost summary for the fourth phase if filtration deferral is not approved and maintained. The annual operating cost for phase 4 is estimated to be **$220,000**.

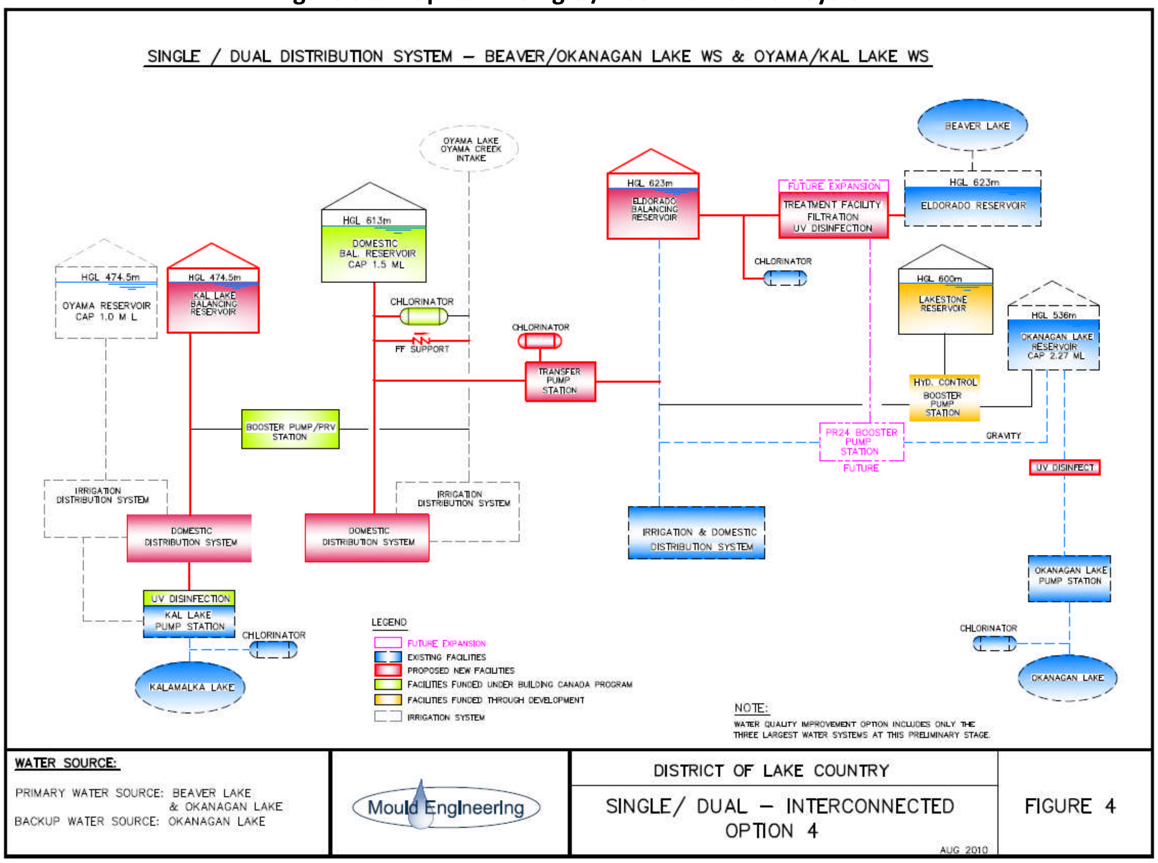
Table 5.19 – Option 3: Construction Phase 4

OPTION 3 – Construction Phases 4			
#	**Phase Breakdown**	**Sub-Total**	**Total**
PHASE 4: (FUTURE FILTRATION & MISC WATERMAINS)			
1	Filtration Expansion @ Eldorado Treatment Site (20 ML/day)	$8,000,000	
2	Filtration Expansion @ Oyama Creek Treatment Plant (16 ML/day)	$6,100,000	
3	Watermain from PR24 to Eldorado Reservoir	$1,700,000	
	Total Estimated Capital Cost - Phase 4		***$15,800,000***
TOTAL ESTIMATED COST – Option 3			**$63,000,000**

5.6.4 OPTION #4 – SINGLE / DUAL DISTRIBUTED SYSTEM (INTERCONNECTED)

Option #4 is based on the concept of a combination of single and dual distribution systems for domestic use. The Beaver/Okanagan Lake system will remain as a single distribution system and will be supplied from a treatment facility at Eldorado Reservoir. The Oyama and Kalamalka Lake systems will be duplicated for domestic use and receive their supply from the Eldorado treatment facility through a long interconnection pipeline. Domestic use is described as in-house and yard watering, which matches the use of the existing domestic services within the District.

Figure 5.5 – Option 4: Single / Dual Distribution System



Irrigation as well as some fire flow requirements will continue to be supplied from Oyama Lake through the existing distribution systems. However, considerable portions of the new domestic system will also be designed for fire flows as numerous areas will have no irrigation system such as the two urban residential areas in Oyama.

5.6.4.1 WATER SOURCES

All four water sources will continue to be utilized; however, only Beaver and Okanagan Lake sources will be utilized for domestic purposes. The lone treatment plant will be located at Eldorado Reservoir and supply treated water to Oyama and Kalamalka systems via a long connecting pipeline and transfer pump station. Oyama Lake and Kalamalka Lake will continue to provide irrigation water to their respective areas. Kalamalka Lake will be a backup source for domestic water as long as filtration deferral is maintained.

5.6.4.2 EVALUATION PROCESS

The table below shows the evaluation process for Option 4 using the 10 criteria. The implementation of Option 4 will result in a high social cost, with a low reliability. Overall, Option 4 has a total evaluation of 39 %, which is the lowest rank compared to the first 3 options. This low ranking is a contributing factor to not selecting Option 4 as the preferred option.

Table 5.20 – Evaluation of Option 4

Criteria	Wt	Importance	Evaluation - Enter 1 to 10										Importance	% Value
			1	2	3	4	5	6	7	8	9	10		
Capital Cost	19%	High				4							Low	8%
Social Cost	5%	High	1										Low	1%
Sustainability	9%	Not									9		Very	8%
Risk	9%	High			3								Low	3%
System Renewal	9%	High								8			Low	7%
Reliability	12%	Not		2									Very	2%
Interconnections	10%	None	1										Some	1%
Operating Cost	12%	High				4							Low	5%
Phaseability	5%	Few	1										Many	1%
Manageability	10%	Complex				4							Simple	4%
Total														**39%**

5.6.4.3 COST ESTIMATE NOTES

The estimates are based on conceptual designs and should be viewed to be accurate within an order of magnitude of 25%.

Notes pertaining to the order of magnitude cost estimate that are common to all estimates are as follows:

- The Lakestone Reservoir and Booster station, shown as part of the Beaver/Okanagan Lake Water System, are assumed to be facilities that will be funded through development. Also, the Building Canada grant funded works shown within the Kalamalka and Oyama Lake Systems has been excluded from the capital cost estimates.

- No allowance has been made for incorporating any other utilities (e.g. Ponderosa, Lake Pine, Alto).

- Long term system renewal and existing infrastructure improvements have not been considered in the estimate.

- Cost of expanding the system to service new developments has not been considered in this estimate.
- No allowance has been made for the acquisition of real estate.
- No allowance has been made for the installation of universal water meters.
- No allowance has been made within the annual operating costs for renewal of the existing distribution system.

There are also specific conditions associated with the installation of a separate domestic distribution system for the Oyama and Kalamalka Lake system, upon which the estimates are based:

- This estimate includes only the cost of reconnecting existing domestic services to the new watermains. No allowance has been made for the complete renewal, including curb stops, of domestic water service connections.
- No allowance has been made for the replacement of pipelines and hydrants in numerous areas currently serviced by 100 mm diameter pipelines and hydrants that do not meet minimum fire flows.
- The capital cost of installing a complete duplicate water distribution system does not include replacing some of the existing distribution system or resurfacing the entire road width.

5.6.4.4 CONSTRUCTION PHASES

This option has been divided into four phases. Ultra-violet disinfection will be installed at Okanagan Lake in Phase 1, which provides the dual disinfection required. The Ultra-violet disinfection system at Kalamalka Lake will be installed under the Building Canada Fund project, which is currently in the planning stages. The phasing approach assumes that approval of filtration deferral will be obtained at both lakes.

The first phase includes the construction of the treatment facility at Eldorado Reservoir, which is sized for approximately 70% of the water demand. The 2nd and 3rd phases contain the domestic distribution systems of Oyama and Kalamalka Lake systems. Kalamalka Lake, the smallest of the three, will be in the 3rd phase because that system already provides high quality water to its users and will have dual disinfection at the source. The completion of the treatment facility at Eldorado is also scheduled for the 3rd phase when treated water will be required in the Oyama and Kalamalka service areas.

The fourth phase is the future expansion of filtration facilities at Eldorado Reservoir to handle the increased capacity from Okanagan Lake.

5.6.4.5 CAPITAL & OPERATING COST ESTIMATES

Below is a cost summary of the first 3 phases spread over a period of 15 years. The annual operating cost for phase 1 to 3 is estimated to be **$530,000**.

Table 5.21 – Option 4: Construction Phases 1 to 3

OPTION 4 – Construction Phases 1 to 3			
#	**Phase Breakdown**	**Sub-Total**	**Total**
PHASE 1: (1 – 5 YRS)			
1	UV Disinfection Facility at Okanagan Lake Pump Station	$1,600,000	
2	Eldorado Balancing Reservoir	$2,600,000	
3	Treatment Facilities at Eldorado Reservoir (Partial Demand, 53 ML/day)	$18,800,000	
	Total Estimated Capital Cost - Phase 1		***$23,000,000***
PHASE 2: (6 - 10 YRS)			
1	Dual Distribution System – Oyama Lake Water System	$13,000,000	
2	Transfer Pump Station & Chlorination Facility	$1,700,000	
2	Watermain from Beaver / Okanagan Lake Water System to Transfer Pump Stn	$3,800,000	
	Total Estimated Capital Cost - Phase 2		***$18,500,000***
PHASE 3: (11 - 15 YRS)			
1	Dual Distribution System – Kalamalka Lake Water System	$500,000	
2	Kalamalka Lake Balancing Reservoir	$2,000,000	
3	Treatment Facilities at Eldorado Reservoir (Remainder of Demand, 27 ML/day)	$11,000,000	
	Total Estimated Capital Cost - Phase 3		***$13,500,000***
SUB-TOTAL ESTIMATED COST - Option 3, Phases 1 to 3			**$55,000,000**

Below is a cost summary for the fourth phase if filtration deferral is not approved and maintained. The annual operating cost for phase 4 is estimated to be **$140,000.**

Table 5.22 – Option 4: Construction Phase 4

OPTION 4 – Construction Phases 4			
#	**Phase Breakdown**	**Sub-Total**	**Total**
PHASE 4: (FUTURE FILTRATION & MISC WATERMAINS)			
1	Filtration Expansion @ Eldorado Treatment Site (20 ML/day)	$8,000,000	
2	PR24 Booster Pump Station	$1,300,000	
3	Watermain from PR24 to Eldorado Reservoir	$1,700,000	
	Total Estimated Capital Cost - Phase 4		***$11,000,000***
TOTAL ESTIMATED COST – Option 4			**$66,000,000**

5.7 PREFERRED OPTION

Option 2 emerged as the preferred option. The option was submitted to Council and endorsed as the preferred water configuration option. A schematic of the preferred water configuration option is shown in Figure 5.3. Some of the advantages in the selection of this option have been mentioned before and are summarized below:

- Single Distribution System: Use the same distribution system that is currently in place.
- Low Social Cost: Although not the cheapest solution, this option can easily be constructed with the least upheaval in the community. Most of the construction will be on land outside the residential neighbourhoods.
- The primary water source is Beaver and Okanagan Lake. Oyama Lake water will be diverted in the future via Clark Creek to the Eldorado Reservoir to supplement the water supply during irrigation season or drought years.
- A single large treatment site at Eldorado on land already owned by the District. A central treatment facility will be more manageable, reliable, sustainable, and cost less to operate.

The option does require a filtration facility to be constructed at Kalamalka Lake some time in the future when filtration deferral is withdrawn which is contrary to the Guiding Principles as set out by the SC.

This option requires the construction of a pump station to assist in the transfer of water during high season demands. During normal demand periods flow will be by gravity. The configuration also includes a reverse flow alternative, where flow can be pumped using the transfer pump station, from the Kalamalka/Oyama Lake Water Sources to the Beaver/Okanagan Lake Water Sources.

Figure 5.6 – East Side of Valley

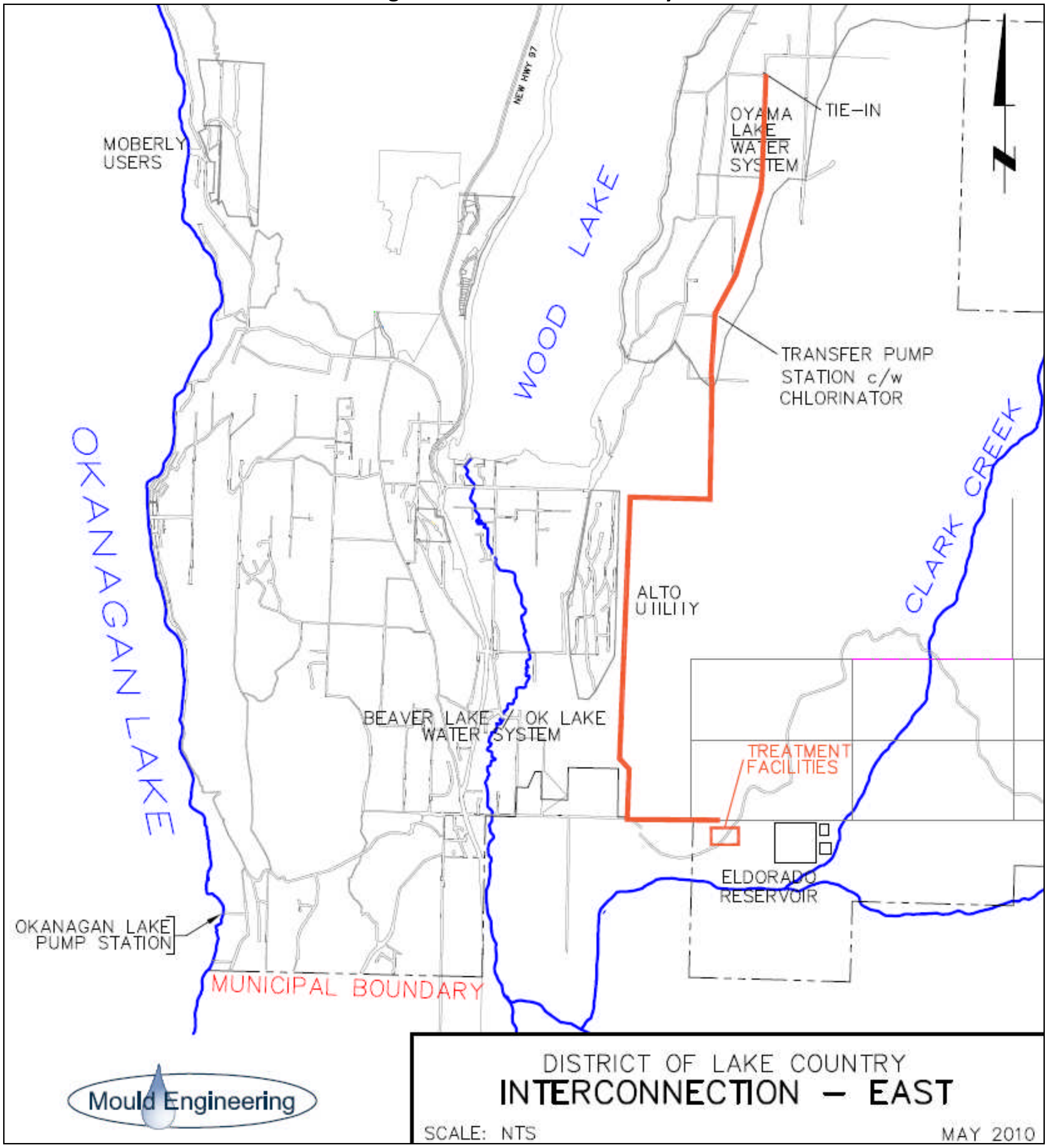


Figure 5.6 shows the route proposed for the East side of valley. The east side route travels on the upper slopes east of Copperhill and Alto Utility, through the ranch areas of Woodsdale Ranch, and into the Oyama Lake distribution area of Woodlake to tie-in to the existing Oyama Lake Water Source.

5.8 ANNEX

Table 5.23 – Water Quality Comparison to GCDWQ

Water Quality Comparison to GCDWQ						
Conventional Parameters in Water		GCDWQ* Maximum Acceptable Concentrations	Beaver Lake / Vernon Cr	Okanagan Lake	Kalamalka Lake	Oyama Lake / Crk[6]
pH Laboratory		6.5 - 8.5	7.6	8	8.1	7.4
Conductivity	µS/cm		81	278	407	56
Hardness[1], Total	$Ca\ CO_3$	<500 mg/l	45	138	186	37
Temperature		≤15°C	9.1	8.6	8.6	8.4
UV Transmittance @ 25nm				87.1		
True Colour	TCU	≤15 TCU	33.5	5	5	48
Turbidity[2]	NTU	<1.0 NTU	1.2	0.35	0.9	1.35
Total Dissolved Solids	TDS	≤500		163	238	58.2
MO Alkalinity	$Ca\ CO_3$		49.8	122		
Total Alkalinity	$Ca\ CO_3$			116	152	25.27
Ammonia	NH_3		0.005			0.008
Dissolved Fluoride	F	≤1.5		0.18	0.24	
Chloride Residual	Cl		0.63	0.67	0.45	0.87
Total Carbon			14.4			
Total Inorganic Carbon			7.9			
Total Organic Carbon		≤4.0 mg/l	15.5**			16
Nitrate	NO_3^-	<10		0.04	0.69	<0.023
Nitrite	NO_2^-	≤1.0		<0.01	0.01	
Dissolved $NO_3 + NO_2$		45	0.048			0.074
Dissolved Sulfate	SO_4	≤500		34	51	
Dissolved Oxygen (On Site)			10	11		11.49
Total Phosphorous[4]	mg/l		0.02-0.035	0-0.01	0-0.01	0.01-0.02
Total Cyanide		0.2		<0.01	0.01	
Metals Analysis in Water		mg/l	mg/l	mg/l	mg/l	mg/l[5]
Aluminum[3]	Al	0.1/0.2	0.06	<0.05	0.05	0.13
Antimony	Sb	0.006		<0.001	0.003	<0.06
Arsenic	As	0.01	<0.06	<0.005	0.005	<0.06
Barium	Ba	1	0.006	0.0277	0.027	0.008
Beryllium	Be			<0.001		<0.001
Boron	B	5		<0.04	0.021	<0.01
Cadmium	Cd	0.005		<0.0001	0.0001	<0.006
Calcium	Ca		8.3	36.2	40.6	4.3
Chromium	Cr	0.05	0.006	<0.005	0.015	<0.006
Cobalt	Co			<0.0005		0.013
Copper	Cu	≤1.0	0.006	<0.0024	0.003	<0.006
Iron	Fe	≤0.3		<0.10	0.2	0.196
Lead	Pb	0.01		<0.001	0.001	0.06
Magnesium	Mg			10.9	19.8	1.7
Manganese	Mn	≤0.05		<0.002	0.005	0.014
Mercury	Hg	0.001		<0.0005	0.0003	
Molybdenum	Mo			0.0035	0.005	0.01
Nickel	Ni			<0.002		<0.02
Potassium	K			2.03	5.07	1
Selenium	Se	0.01		0.0035	0.005	<0.06
Silicon	Si			38.4		2.88
Silver	Ag			<0.0005		<0.01
Sodium	Na	≤200		12.4	18.4	2
Uranium	U	0.02		0.00246	0.003	
Vanadium	V			<0.01		<0.01
Zinc	Zn	≤5.0		<0.01	0.011	<0.002

NOTES FOR TABLE 5.23

Subscript Notes:

[1] Hardness Levels in excess of 500 mg/l are normally considered as unacceptable.

[2] pH, Conductivity, Temperature, Colour, and Turbidity values are based on averages between RAW and DS. Hardness values are only based on the RAW results and Chlorine Residual is only based on the DS results for each water system. Data obtained from the Systems' Monthly Water Quality Summaries. The monthly results were averaged over the entire year of 2009. Refer to the DLC website in the "Water Quality Reports -2009" section. The results for 2010 were inaccessible from the DLC website at the time of research.

[3] Drinking water treatment plants with aluminum-based coagulants (0.1 mg/l applies to conventional treatment plants, and 0.2 mg/l applies to other types of treatment systems).

[4] Total Phosphorous amount is based on the trophic status of the lake.

a) Oligotrophic – Total Phosphorous: 0 – 0.01 mg/l

b) Mesotrophic – Total Phosphorous: 0.01 – 0.02 mg/l

c) Meso-Eutrophic – Total Phosphorous: 0.02 – 0.035 mg/l

c) Eutrophic – Total Phosphorus: >0.035 mg/l

[5] The results for the metals for Oyama Lake were obtained from the Water Quality Assessment for Oyama Creek, Completed By Ministry of Environment – March 2008 (Sample from Site E224123 and Date 21/09/2000)

[6] The results for Alkalinity, Dissolved Ammonia, Dissolved Oxygen, Nitrate, and Total Dissolved Solids for Oyama Lake were obtained from the Water Quality Assessment for Oyama Creek, Completed By Ministry of Environment – March 2008 (Sample from Site E224123, "Average Value" used).

** 2008 GCDWQ values.*

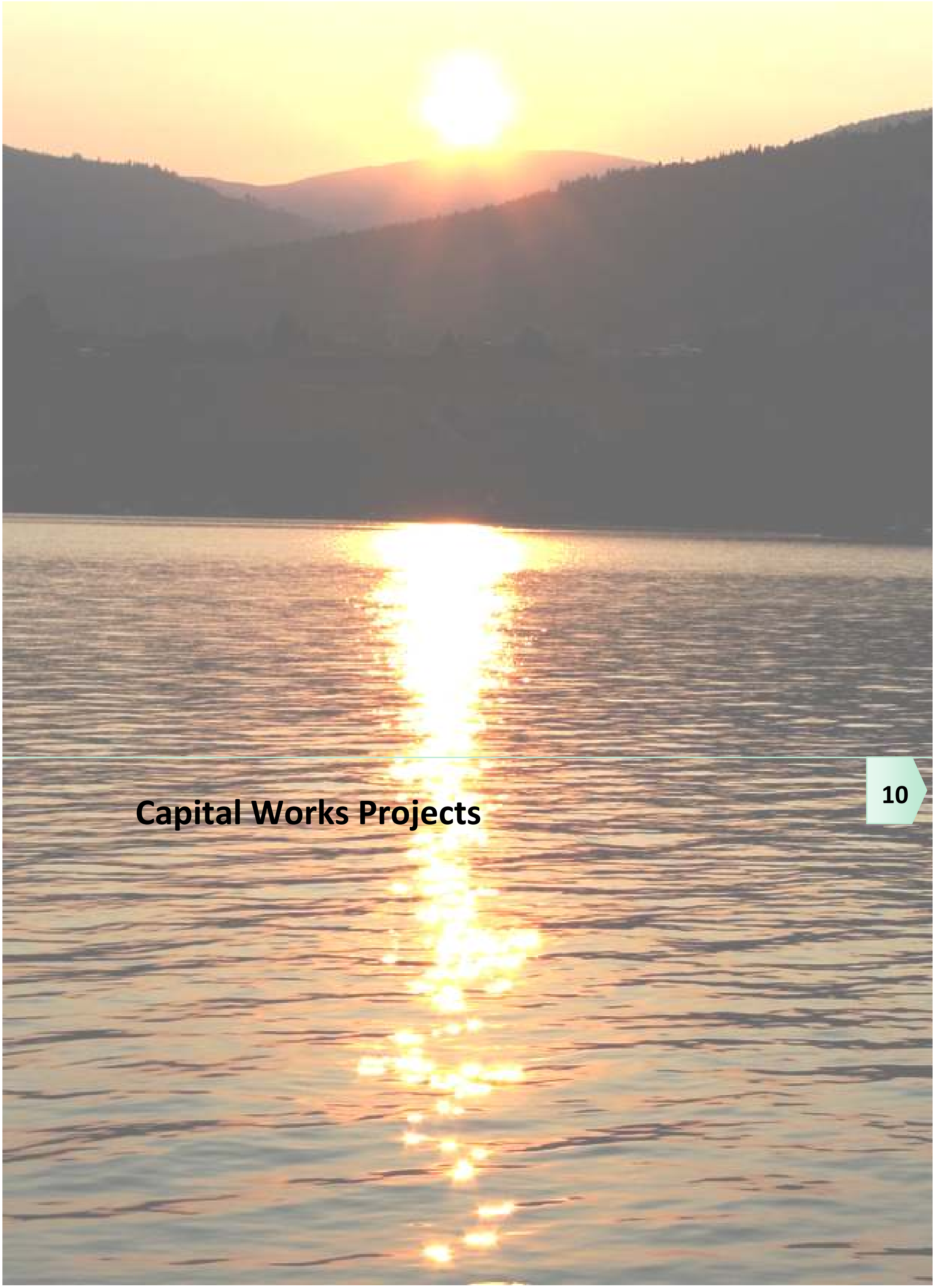
*** Vernon Creek: Swalwell Reservoir - Total Organic Carbon (2008 & 2009 Average).*

General Notes:

1. Unless otherwise noted, all values are milligrams per litre (mg/l)
2. μg/l = micrograms per litre
3. Analyzing data from DLC and GVW Water Quality Data.
4. Analyzing data sample for Okanagan Lake taken April 21, 2010 Caro Analytical Services
5. Oyama Creek results obtained from Oyama Source Water Assessment (2008 & 2009 Avg)

appendix e

CAPITAL WORKS PROJECT (MOULD ENGINEERING)



10

Capital Works Projects

DISTRICT OF LAKE COUNTRY
WATER MASTER PLAN

SECTION 10.0 – CAPITAL WORKS PROJECTS

TABLE OF CONTENTS

TABLES

FIGURES

10.0 CAPITAL WORKS PROJECTS

The projects identified and described in this section will provide water quality improvements and service the predicted growth for the next 20 years. District staff has also identified various capital projects required within the existing water sources to maintain existing services and improve the system in terms of maintenance and operations. This paper covers all projects that have an estimated capital cost greater than $200,000. There are also numerous smaller projects that are self explanatory and they are listed in the detailed cost estimates by name only. These projects establish the water rates as well as the Development Cost Charges and Capital Expenditure Charges

The capital works outlined in this section are divided into 6 groups to assist in the implementation of the projects and in applying for the various funding assistances available from Federal and Provincial infrastructure programs.

- Water Conservation
- Water Treatment Facilities
- Water Storage
- Pipelines and Miscellaneous Infrastructure
- Hydraulic Control Facilities
- Minor Projects & Administration

Future projects are also discussed as the 20 year planning period is short for some infrastructure projects. Refer to Table 11.1 in Section 11 for the Project Sequencing Summary.

10.1 WATER CONSERVATION

There are approximately 4,010 multi and single family units, 185 industrial, commercial, and institutional connections, as well as 580 agricultural irrigation connections.

A public education program along with water meters and an appropriate rate structure are all important components of a successful water conservation program.

Metering promotes equity between users and water conservation as it accurately tracks the water usage for each user in the District. The water metering program is also a prerequisite to obtaining government grants for other projects. The metering project will be divided into 2 phases, as described below.

10.1.1 UNIVERSAL WATER METERING – PHASE 1

The universal metering program will be implemented in two phases starting in 2013 and be completed over a 3 year period. Phase 1 will consist of implementing a public education water conservation program and installing water meters at all commercial, industrial, and agricultural connections.

Estimated Cost: $1,000,000

10.1.2 UNIVERSAL WATER METERING – PHASE 2

Phase 2 will consist of installing water meters at all multi and single family connections.

Estimated Cost: $3,000,000

10.2 WATER TREATMENT FACILITIES

This section describes the projects required for water quality improvements. Some of these projects are carried over from the Assessment Response Plan prepared in 2004 for the Winfield Okanagan Centre Water Systems. The location and title of each project has been plotted on *Figure 10.1 – Capital Works Projects*.

10.2.1 KALAMALKA LAKE UV DISINFECTION

The UV disinfection installation at Kalamalka Lake pump station is part of the *Building Canada Infrastructure* grant awarded in 2010 for the Kalamalka & Oyama Lake Sources, Water Quality & Supply Improvements. The other components of this grant are the Oyama Lake balancing reservoir and booster pump station at Sawmill Road discussed later in this section.

The Kalamalka Lake Source water does not currently meet the Guidelines for Canadian Drinking Water Quality (GCDWQ) criteria of 4-Log removal or inactivation of viruses and 3-log inactivation of protozoa achieved using minimum of 2 disinfection processes. Inactivation of viruses (4-log) is achieved with the chlorine disinfection process; however, 3-log inactivation of protozoa *(Cryptosporidium & Giardia)* is not achieved due to their resistance to chlorine. The District is planning to add an ultra-violet disinfection facility on this source in 2012 which will enable the above criteria to be met.

This project is required for the District to qualify for filtration deferral. The transmittance is high and turbidity in Kalamalka Lake remains less than 1 NTU most of the time, enabling this technology to be very effective on this source and provide a dual barrier.

Kalamalka Lake Pump Room

It is anticipated from preliminary designs that UV units will be installed on the discharge header of the turbine pumps. The photo shows a view of the pump room at Kalamalka Lake Pump Station. In addition to the UV units, minor improvements will be done to the pump station such as installing a washroom facility and replacing pump starters.

Estimated Cost: $1,070,000

10.2.2 Okanagan Lake UV Disinfection

The installation of UV units at the Okanagan Lake Pump Station has been listed as a water quality improvement requirement since 2004. UV will be very effective on this source as the water quality is excellent. It is again listed as a priority and is part of the permit to operate issued by IH as early as 2009, which requires dual disinfection of surface water sources. The exact location and design of the installation has not been determined. There are three possible locations for the UV units; the Okanagan Lake Pump Station, Okanagan Lake Reservoir Expansion project, or Eldorado Reservoir, as discussed in Section 10.7.1.

The intake screens located inside the station currently do not meet the Ministry of Environment standards due to the following concerns:

- The screens are too coarse;
- They do not provide sufficient surface area;
- They should be located at the intake entrance instead of the wet well.

Estimated Cost: $2,060,000

10.2.3 Filtration Facilities at Eldorado Reservoir – Phase 1

The proposed facilities will meet GCDWQ objectives of filtration and dual disinfection of the Beaver Lake Source. The first phase of the facilities will be sized to meet the maximum day demand on this source.

Water from Eldorado Reservoir will receive full treatment and filtration to address the colour and turbidity issues and then be disinfected by UV and chlorination. The actual treatment technology that will be used has not been established. A pilot plant located at the Eldorado Reservoir, as part of the overall project, will determine which technology will be the most effective. The water quality piloting will should be implemented for a one to two year period prior to proceeding with the design. This project is scheduled to start within the next 10 years. The first phase of the Filtration Facilities at Eldorado Reservoir is associated with the Eldorado Treated Water Reservoir (refer to 10.3.3).

Estimated Cost Phase 1: $24,000,000

10.2.4 FILTRATION FACILITIES AT ELDORADO RESERVOIR – PHASE 2

Phase 2 of this treatment facility will be an expansion to meet the maximum day water demand of the Oyama Lake Water Source. Phase 2 will be constructed after the interconnecting pipeline and booster pump station are installed between the Eldorado Reservoir and the Oyama Lake Water Source. The following projects are all associated to supply maximum day demand:

- Filtration Facilities at Eldorado Reservoir – Phase 2 (Section 10.2.4)
- Interconnecting Pipeline from Eldorado to Oyama Water Source (Section 10.4.2)
- Transfer Pump Station to Oyama Lake Water Source (Section 10.5.5)
- Oyama Lake flow diversion to Eldorado Reservoir (Section 10.7.3)

The sequencing of the projects is discussed more in Section 11.0.

Estimated Cost Phase 2: $10,000,000

10.3 Water Storage

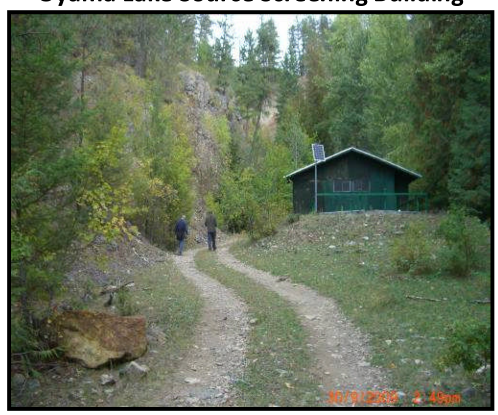
Construction of three more concrete reservoirs is planned for the District over the next 20 years. The reservoirs are:

- Oyama Lake Balancing Reservoir;
- Expansion of the Okanagan Lake Reservoir; and
- Treated Water Reservoir at Eldorado Filtration Facility.

The purpose for each reservoir is described in the following sections. Each reservoir has its own distinct origin which dates as far back as 1998. In each case, the reservoirs will be constructed on land already owned by the District.

10.3.1 Oyama Lake Reservoir & Chlorinator

Oyama Lake Source Screening Building



The need for a balancing reservoir for the Oyama Water Source was noted in the WLWS Capital Works Plan (1998). Currently there is no water storage on the system which makes management of the system complex.

Funding for this reservoir and chlorination facility is a 2/3 grant from the *Building Canada Infrastructure* Program which was approved in 2010. A balancing reservoir with a capacity of 1.5 ML will be constructed at the Oyama Creek Intake.

The reservoir will provide: balancing storage on the distribution system as well as the Oyama Creek supply; Sawmill Road Booster Pump balancing storage; disinfection contact time; and fire flow storage. The project is scheduled for a spring 2013 completion date. Included in the project is a new chlorine gas disinfection facility at the reservoir site. The old chlorination facility on Todd Road, also chlorine gas, will be decommissioned and removed.

Estimated Cost: $2,550,000

10.3.2 Okanagan Lake Reservoir Expansion

The Okanagan Lake Reservoir expansion will provide additional balancing capacity to supply the peak hour demand within its service area. This project was first identified in the *Assessment and Response Plan, 2004*. A considerable portion of the growth will likely occur in the gravity and pressure-reduced areas from the Okanagan Lake

Reservoir; therefore, the additional storage capacity is required so that the Okanagan Lake Pump Station does not need to supply the peak hour demand.

A proposed reservoir, sized for 2.5 million litres, will be situated at the same elevation as the existing structure. A second pipeline will also be installed from the 850 mm steel mainline on Okanagan Centre Rd W to the reservoir in order to work toward a dedicated supply main to the reservoir. Funding for the reservoir will be through future development. Preliminary schedule for construction, depending on growth, is 2015 – 2020.

If there is no filtration deferral of Okanagan Lake water, then this project may no longer be needed at this location. The existing reservoir will become part of a dedicated supply system that pumps all the water demand needed from the Okanagan Lake Water Source to the Eldorado treatment facility. The additional reservoir storage would then be required at the Eldorado site. This is discussed further in Section 10.7.1.

Estimated Cost: ***$1,600,000***

10.3.3 ELDORADO TREATED WATER RESERVOIR

The Eldorado Treated Water Reservoir is part of the water treatment facilities planned to be constructed in Section 10.2.3. The reservoir will be sized to provide treated water storage for peak hour demand, disinfection contact time, and fire flow storage for the Beaver Lake Source. The cost estimate of the reservoir is based on a preliminary size of between 6 and 7 ML.

Estimated Cost: ***$3,700,000***

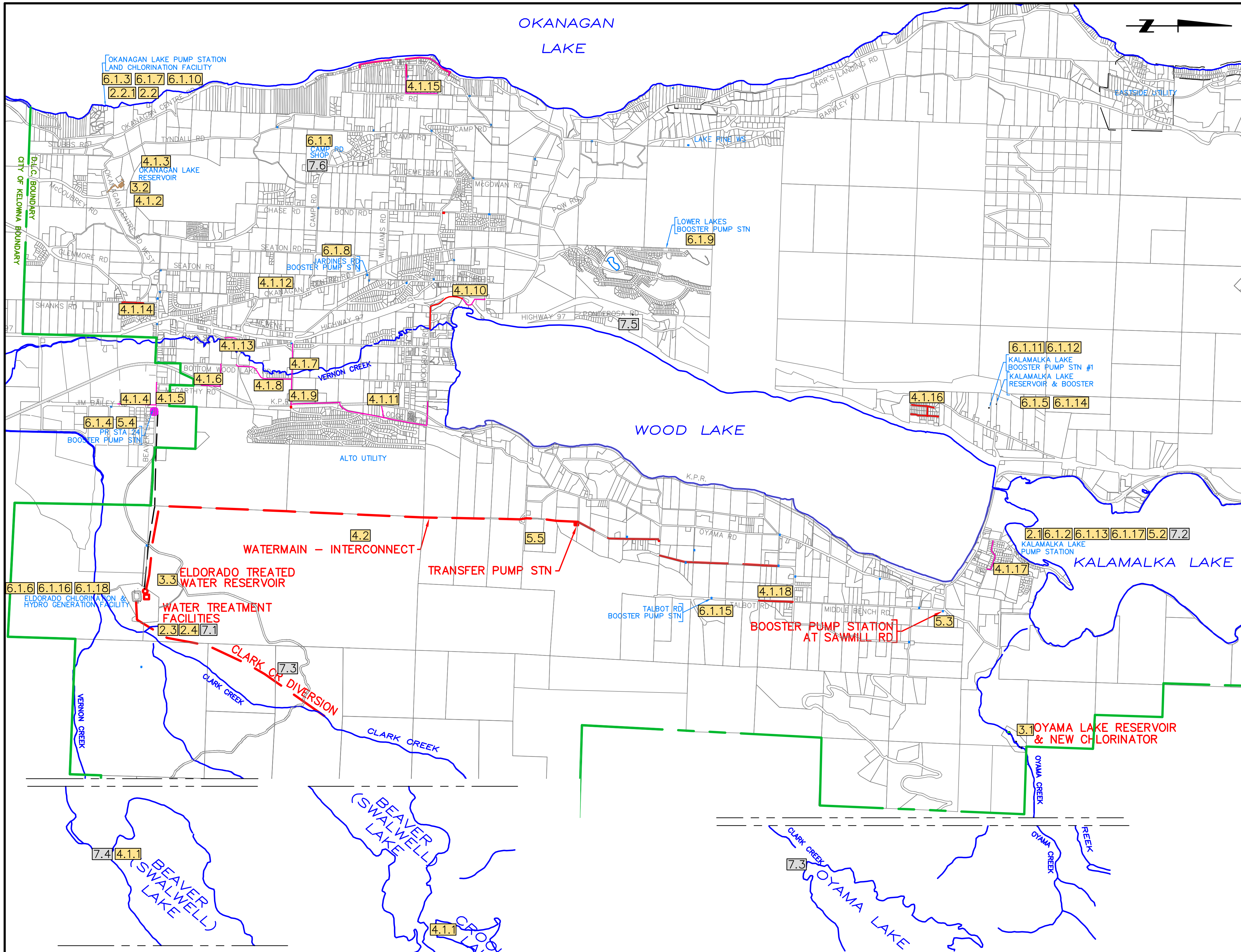


FIGURE 10.1

DISTRICT OF LAKE COUNTRY

WATER MASTER PLAN
CAPITAL WORKS PROJECTS

SCALE: 1:50,000

NOV. 2011

LAKE COUNTRY
LIFE. THE OKANAGAN WAY.

Mould Engineering

FUTURE PROJECTS 2031 & BEYOND

PROJECT NO	LOCATION	DESCRIPTION OF WORK
7.0	FUTURE WATER INFRASTRUCTURE PROJECTS	
7.1	ELDORADO RESERVOIR	FILTRATION FACILITY EXPANSION
7.2	KALAMALKA LAKE	FILTRATION FACILITIES
7.3	OYAMA LAKE & CLARK CREEK	OYAMA LAKE WATER DIVERTED TO ELDORADO RESERVOIR
7.4	BEAVER LAKE	RAISE WATER LEVEL
7.5	PONDEROSA	PONDEROSA WATER SYSTEM IMPROVEMENTS
7.6	CAMP RD.	PHASE 2 – UPGRADE PUBLIC WORKS OFFICE

CAPITAL WORKS PROJECTS 2011 TO 2030

PROJECT NO.	LOCATION	DESCRIPTION OF WORK
1.0	WATER CONSERVATION	
1.1	NOT SHOWN	UNIVERSAL WATER METERING–PHASE 1 & 2
2.0	WATER TREATMENT FACILITIES	
2.1	KALAMALKA LAKE PUMP STATION	KALAMALKA LAKE UV DISINFECTION
2.2	OKANAGAN LAKE PUMP STATION	OKANAGAN LAKE UV DISINFECTION
2.2.1	OKANAGAN LAKE PUMP STATION	NEW INTAKE SCREENS
2.3	ELDORADO RESERVOIR	PHASE 1 – FILTRATION FACILITIES
2.4	ELDORADO RESERVOIR	PHASE 2 – FILTRATION FACILITIES
3.0	WATER STORAGE	
3.1	OYAMA CREEK	OYAMA LAKE RESERVOIR & CHLORINATOR
3.2	OKANAGAN CENTRE RD. W	OKANAGAN LAKE RESERVOIR EXPANSION
3.3	ELDORADO RESERVOIR	ELDORADO TREATED WATER RESERVOIR
4.0	PIPELINES & MISC. INFRASTRUCTURE	
4.1.1	BEAVER (SWALWELL) LAKE DAM	REFURBISH & UPGRADE
4.1.2	LAKESTONE	BOOSTER PUMP STATION RESERVOIR @ HGL 600, WATERMAIN & VALVE CHAMBER
4.1.3	LAKESTONE	WATERMAIN FROM EXISTING STEEL MAIN TO HGL 536m
4.1.4	JIM BAILEY RD.	WATERMAIN–OKANAGAN LAKE MAINLINE TO BEAVER LAKE RD
4.1.5	BEAVER LAKE RD.	WATERMAIN–JIM BAILEY RD TO McCARTHY RD
4.1.6	McCARTHY RD.	WATERMAIN – McCARTHY RD TO BOTTOM WOOD LAKE RD
4.1.7	BOTTOM WOOD LAKE RD.	WATERMAIN – BOTTOM WOOD LAKE RD TO LODGE RD
4.1.8	BOTTOM WOOD LAKE RD.	WATERMAIN – BOTTOM WOOD LAKE RD/KONSHUH/MEADOW RD TO LODGE RD
4.1.9	LODGE RD.	WATERMAIN – LODGE RD TO SHERMAN RD INCLUDING PR STATION
4.1.10	OCEOLA RD.	WATERMAIN–OCEOLA RD TO WOODSDALE RD
4.1.11	WOODSDALE RD.	WATERMAIN – WOODSDALE RD TO SHERMAN RD
4.1.12	OKANAGAN CENTRE RD. E	COVERT AREA TO OKANAGAN LAKE WATER
4.1.13	MAIN ST.	WATERMAIN – MAIN ST SOUTH OF GRANT RD
4.1.14	GLENMORE RD.	WATERMAIN – GLENMORE RD EXTENSION
4.1.15	HARE RD.	WATERMAIN–UPGRADE & IMPROVEMENTS
4.1.16	HIGHLAND RD.	WATERMAIN – HIGHLAND RD UPGRADE
4.1.17	YOUNG RD.	WATERMAIN – YOUNG RD UPGRADE
4.1.18	TALBOT RD.	WATERMAIN – TALBOT RD UPGRADE
4.2	EAST SIDE OF VALLEY	INTERCONNECTING PIPELINE FROM ELDORADO TO OYAMA LAKE WATER SOURCE
5.0	HYDRAULIC CONTROL FACILITIES	
5.1	NOT SHOWN	PRESSURE REGULATING STATIONS–UPGRADE & REPLACE. SEE TABLE 10.2
5.2	KALAMALKA LAKE	KALAMALKA LAKE INTAKE EXTENSION
5.3	SAWMILL RD. & MIDDLE BENCH RD.	SAWMILL RD BOOSTER PUMP STATION
5.4	JIM BAILEY RD.	JIM BAILEY RD BOOSTER PUMP STATION UPGRADE
5.5	TREWHITT RD.	NEW TRANSFER PUMP STATION
6.0	MINOR PROJECTS & ADMINISTRATION	
6.1.1	CAMP RD.	PHASE 1 –UPGRADE PUBLIC WORKS OFFICE
6.1.2	KALAMALKA LAKE PUMP STATION	RAW WATER LINE, SCADA, TURBIDITY & CHLORINE SYSTEM MODIFICATION
6.1.3	OKANAGAN LAKE PUMP STATION	SCADA, PUMP STARTERS & CHLORINE SYSTEM MODIFICATION
6.1.4	JIM BAILEY RD.	INSTALL SCADA
6.1.5	KALAMALKA LAKE RESERVOIR	RESERVOIR DRAIN PIPE & FENCING
6.1.6	ELDORADO RESERVOIR	SCADA, ELECTRICAL, LANDSCAPING
6.1.7	OKANAGAN LAKE PUMP STATION	SCADA HMI, REPLACE OLD UNIT
6.1.8	JARDINES RD.	PUMP STATION IMPROVEMENTS
6.1.9	LOWER LAKES PUMP STATION	PUMP STATION IMPROVEMENTS
6.1.10	OKANAGAN LAKE PUMP STATION	NEW LIGHTNING, PAINT & INSTALL DEHUMIDIFIER
6.1.11	KALAMALKA LAKE RESERVOIR	BOOSTER PUMP STATION #1 – REBUILD
6.1.12	KALAMALKA LAKE RESERVOIR	BOOSTER PUMP STATION #2 – REBUILD
6.1.13	KALAMALKA LAKE PUMP STATION	REHAB & REPLACE PUMPS & STARTERS
6.1.14	KALAMALKA LAKE BOOSTER PUMP STATION #2	INSTALL SCADA
6.1.15	TALBOT RD.	BOOSTER PUMP STATION REBUILD
6.1.16	ELDORADO RESERVOIR	RECONDITION VALVES & INSTALL HOIST
6.1.17	KALAMALKA LAKE PUMP STATION	INSTALL EMERGENCY POWER SUPPLY – GENSET
6.1.18	ELDORADO RESERVOIR	INSTALL VALVE ON TURBINE FEED LINE

10.4 Pipelines & Miscellaneous Infrastructure

10.4.1 Beaver Lake Dam – Refurbish & Upgrade

The Beaver Lake Dam Safety Review, which includes an inspection of the outlet works, has recently been completed. The outlet structure was in need of immediate repair, so a short-term clean and patch solution was completed. Annual inspections are required to ensure the remedial work has hindered the deterioration. Other dam deficiencies include the following:

- Under-sized spillway;
- Lack of freeboard;
- Low strength concrete in the intake tower;
- Inadequate outlet channel;
- Eroded measuring weir; and
- Leaking control gate.

Estimated Cost: ***$1,800,000***

10.4.2 Watermains – Installations, Replacements, and Upgrades

This watermain section is divided into two parts, where the first part is designated toward the existing 100 mm diameter watermains, and the second part is designated toward growth-related pipelines.

Below is an excerpt from the 2004 ARP report;

> *"The District has approximately 12 km of 100 mm diameter AC pipe. Approximately 7 km of length results in inadequate hydrant capacities and funds should be set aside to replace sections annually. In most cases, 150 mm diameter pipe is adequate. However, each project should be reviewed, as future growth or other considerations may dictate larger diameter pipe."*

Although the watermain lengths have changed, as the ARP analyzed only the Beaver and Okanagan Lake Water Sources, this statement is still true; work to replace the 100 mm diameter AC pipe should be scheduled on an annual basis. The following five watermain upgrade projects have been scheduled and are shown in Figure 10.1:

- Watermain on Glenmore Road
    - Loop on Glenmore Road in same trench
- Hare Road, Okanagan Centre – watermain improvements
- Watermain – Highland Road, Oyama
- Watermain – Young Road upgrade
- Watermain – Talbot Road, Wood Lake

In all cases, the 100 mm watermains create a restriction in the distribution system which affects pipeline velocities, pressures, and the ability to supply growth or fire flows in the area. All other 100 AC watermains that need to be replaced can be identified from the distribution system computer models for all the major water sources and work can be prioritized and scheduled accordingly.

Growth will also have a significant impact on the water distribution system improvements needed. It is anticipated that most of the cost of these watermain improvements will be paid for through Development Cost Charges.

Each project must be analyzed on an individual basis but the following provides a general outline of the watermains needed to supply the growth areas. Some of these watermain projects were first discussed in the 2004 ARP, and a complete list is as follows:

- Okanagan Centre Road W / Tyndall / Chase, HGL 600 m;
- Watermain from existing steel main to new reservoir, HGL 536 m;
- Watermain Jim Bailey Road – Okanagan Lake Mainline to Beaver Lake Road;
- Watermain Beaver Lake Road – Jim Bailey Road to McCarthy Road;
- Watermain McCarthy Road to Bottom Wood Lake Road;
- Watermain Bottom Wood Lake Road to Lodge Road;
- Watermain Bottom Wood Lake / Konshuh / Meadow Roads to Lodge Road;
- Watermain Lodge Road to Sherman Road, including PR Station;
- Watermain – Oceola Road to Woodsdale Road;
- Watermain – Woodsdale Road to Sherman Road;
- Convert area to Okanagan Lake water (see description below);
- Watermain – Main Street South of Grant Road; and
- AC Watermain Replacement – Ongoing Projects

There are approximately 131 domestic and 49 irrigation services that need to be converted to the Okanagan Lake Source. In 2007-2008 a 450mm diameter PVC watermain was installed from Glenmore Road to Jardines Road Booster Pump Station. North of the booster station, a 300mm PVC watermain was installed along Okanagan Centre Road E up to the Lower Lakes Reservoir as part of The Lakes Development water supply system. Except for a few users in the Win-View and Kel-Vern subdivisions as well as a few users on Glenmore and Seaton Roads, no other users were connected to the new 450 mm main.

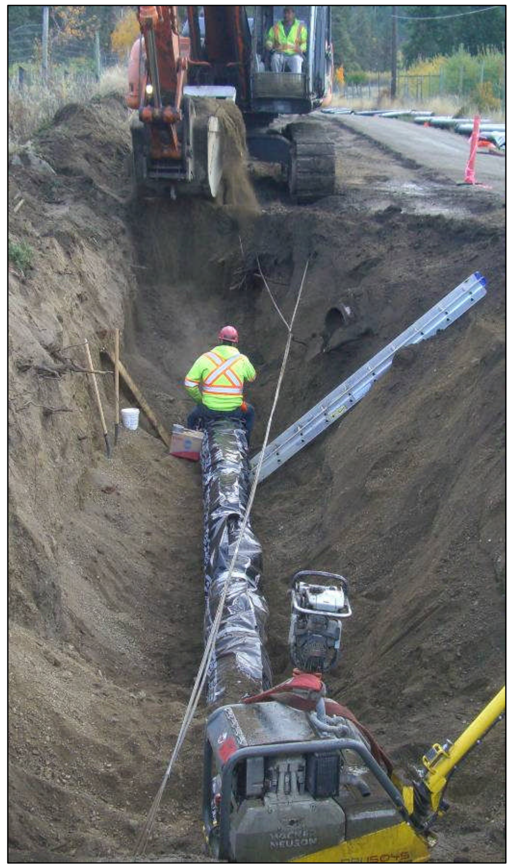
As development occurs, the District may have to upgrade various pipelines to meet the water demands. It should be noted that predicting where and when new development happens is not an exact science, and there will likely be several supply options depending on the extent, location and timing of development. A contingency value is included to account for minor pipe upgrades not identified in this plan. Ongoing projects also would include water services, which may need to be replaced.

Estimated Cost: $11,800,000

10.4.3 INTERCONNECTING PIPELINE FROM ELDORADO TO OYAMA WATER SOURCE

In order to supply treated water to the Oyama Lake Source area, a pipeline will be installed to convey water from the Eldorado Treated Water Reservoir to Middle Bench Road. A 600 mm watermain is required along Beaver Lake Rd and then along a north-south utility easement on the eastern slopes of the valley above Copperhill Subdivision. The treated water can flow by gravity to nearly meet maximum day demands, but needs to be pumped during periods of higher demand, as described Section 10.5.5.

Installation of Underground Watermains



The exact location of the easement has not been determined, and costs associated with acquiring land have not been included in the estimates. The tie-in location on the Oyama Water Source distribution system is to the 500 mm diameter mainline on Middle Bench Road. It is noted that the Beaver Lake Source cannot supply the additional annual water requirements of the Oyama Lake Source until the Oyama Lake Diversion to Eldorado Reservoir (10.7.3) is implemented.

Estimated Cost: $8,000,000

10.5 HYDRAULIC CONTROL FACILITIES

Most of the Pressure Reducing (PR) stations were installed with the original system under the ARDA program in the 60's and 70's. Some of the PR stations are below ground and create a confined space entry situation. It is anticipated that replacing or improving these stations will be an annual budget item to 2030 and beyond. Each project will be evaluated on its own merit and scheduled accordingly.

10.5.1 PRESSURE REDUCING STATIONS – UPGRADING & REBUILDING

The distribution system PR stations are vital to the performance and longevity of the distribution system. Table 10.1 is a list of all the PR stations currently in the system and the new ones planned. The distribution system is complicated and several of the recommended adjustments and works must be completed simultaneously. The consensus is that systematically all PR stations should be upgraded or possibly even reconstructed above ground where practical.

The '*Comments'* column in Table 10.1 specifies what needs to be done at each station. Some stations have been abandoned or will be in future because of changes in the system. Abandonment of a station should include the complete removal of all the works and the site restored to eliminate any future maintenance problems.

Some of the PR stations may be reconstructed as part of development funded projects and will be scheduled accordingly. The Seaton Rd PR station, which replaced the old PR #5 & #6, included some developer funded components, and also serves as an inter-connection between the Okanagan Lake Water Source and the Beaver Lake Water Source.

Seaton Rd PR Station under Construction

Estimated Cost: $1,690,000

Table 10.1 – Pressure Regulating Stations

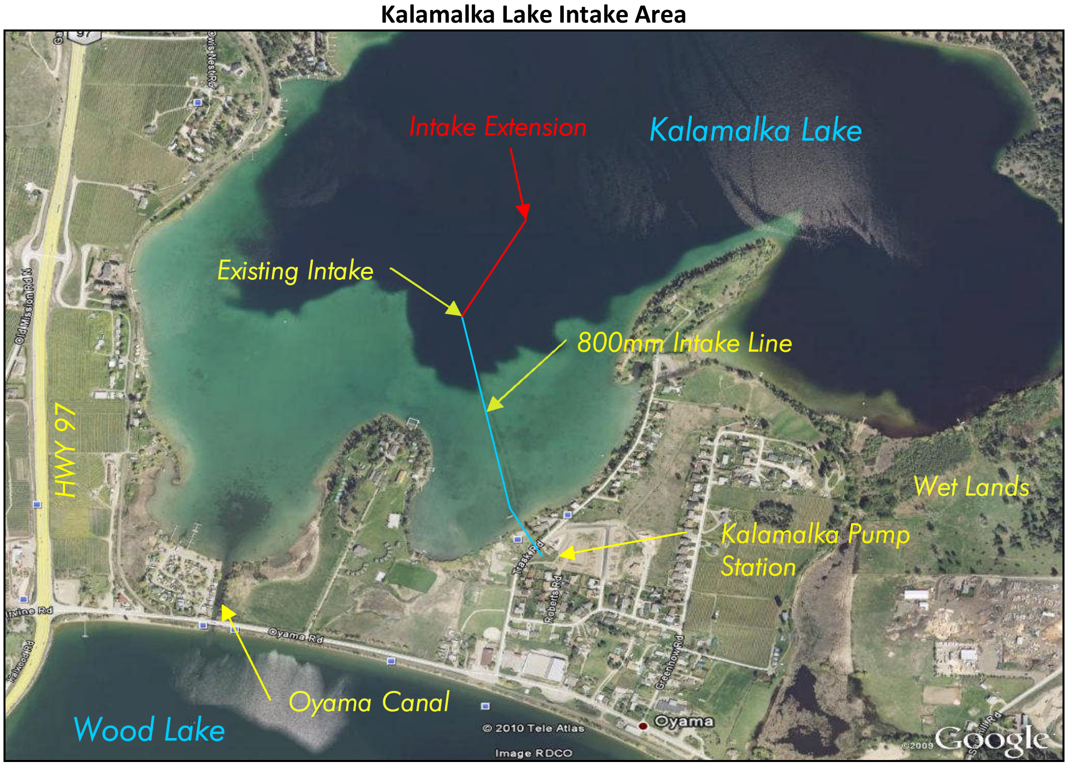
PR #	PR Station Name / Location	Valve Sizes (in)	Ex. D/S Pressure (psi)	Ex. D/S HGL (m)	New D/S Pressure (psi)	New D/S HGL (m)	Comments
PR Stations - Beaver Lake Water Sources							
1	Upper Range	12, 10, 8, 4					Abandoned
2	Lower Range -Beaver Lake Rd	12, 10, 8, 4, 4					Abandoned
3	Bottom Wood Lake Rds (East)	6, 2	90	486			To be Removed
4	Bottom Wood Lake Rds (West)	6, 2	70	472			To be Removed
5	Kobayashi						Abandoned
	INTERCONNECTION	8	94	533			Proposed Telemetry to Okanagan Lake Reservoir
6	Seaton Rd	8, 2.5	124	554			Supplies Glenmore Road South
7	Shanks Rd	6, 2	92	532			
8	Read Rd	3, 2	60	514			To be Removed
9	Seaton / Dick Rd	4, 2	0	527			
10	Camp & Bond Rd	8, 3	64	577			
11	Bond Rd	8, 6, 3	60	577			Reconstruct
12	McGowan Rd	4, 2	44	559	75	585	To be relocated, larger valve required
13	Brew Rd	4, 2	30	506	25	502	Change after reconfiguration of PR19
14	Hare Rd	4, 2	61	434			
15	6th St	4, 2	58	421			Construct New PR Stn
16	Tyndall Rd	4, 2	40	553			
17	Camp Rd	6, 2	79	484			
18	Davidson Rd	6, 2, 1.5	41	527			
19	Robinson Rd	3, 2	77	506	95		Rebuild & Reconfigure
20	Pretty Rd	4, 2	57	463			
22	Goldie Rd	6, 2	59	492			
23	Carrs Landing Rd	4, 1.5	83	450	60	445	Relocate, larger valve Required
24	INTERCONNECTION Jim Bailey Rd PRV / Booster (100 Hp)	10	90	512			Backup to Okanagan Lake Supply Rebuild – New Above Ground Booster Pump Station
		8, 2	82	491			Fire Flow Backup
PR Stations - Okanagan Lake Water Source							
21	Jardines Rd Booster Pump Station	4	35	527			PR in Pump Station is back-up to Okanagan Lake Reservoir supply. Remove Old PR21 Chamber.
24	INTERCONNECTION Jim Bailey Rd PRV / Booster (100 Hp)	10	120	512			Backup to Okanagan Lake Supply Rebuild - New Above Ground Booster Pump Stn
		8, 2	90	491			TOWN CENTRE SUPPLY
26	Taiji Ct	8, 2	78	462	Open		To be Removed
29	Pretty / Roberts Rd	6, 2	62	487			
	INTERCONNECTION						
5	Seaton PR Stn	10, 3	40	496			Supplies Town Centre
	Lower Ponderosa PRV					470	Setting to be Verified
	Upper Ponderosa PRV					514	Setting to be Verified
PR Stations - Kalamalka Lake Water Source							
	Oyama Road Interconnect PRV & Meter Chamber	150	100	470	62	471	To be relocated to Sawmill Road Booster Pump Station
PR Stations - Oyama Lake Water Source							
1	Todd Rd	4	67	544			Most require larger valves to supply fire flows
2	Middle Bench / Todd Rd	4	50	496			
3	Oyama Rd	1	50	474			
4	Middle Bench Rd	2	55	541			
5	Allison Rd	4	55	526			
6	Oyama / Broadwater Rd	4	50	492			
7	Towgood Rd	4	85	559			
8	Trewhitt Rd	3	68	561			
9	Middle Bench / Towgood Rd						

10.5.2 KALAMALKA LAKE INTAKE EXTENSION

One of the recommendations that resulted from the watershed assessment report of the Kalamalka Lake Water Source, refer to the photo below, is lowering the intake depth from 22 m to 30 m. A wide range of human activities, as well as weather related influences, impact the quality of water at the south end of the lake. For instance, turbulences are more intense on the south end of the lake than they are at the north end of the lake because of the shape of the lake basin. The advantages according to the *Assessment Report* in increasing the depth of the intake are:

- *Reduced seiches impact, transport of surface contaminants*
- *Maximum temperature deviation during seiches would be lowered to < 4 - 6°C*
- *Lower overall water temperature*
- *Lower turbidity, (Range in 2008 = 0.1 – 0.7 NTU vs. 0.6 – 0.8 NTU at 22 m)*
- *Lower total coliforms and possibly pathogens*
- *Lower pH, (Range in 2008 = 7.6 – 7.9 versus 7.8 – 8.0 at 20 m)*
- *Lower algae production,* (*Range of chlor-a in 2008 = 1.2 – 2.4 µg/L vs. 1.1 – 4.1µg/L at 22 m)*

Kalamalka Lake Intake Area



To lower the intake from 22 m to 30 m would require an estimated 220 m of 800 mm diameter pipe plus a new intake screen assembly.

Estimated Cost: $1,000,000

10.5.3 BOOSTER PUMP STATION AT SAWMILL ROAD

The pump station will house 2 booster pumps and an interconnecting PR valve between Oyama Lake Source and Kalamalka Lake Source. The pumps will boost Kalamalka Lake water up to the new Oyama Lake balancing reservoir described in Section 10.3.1. This new booster pump station is part of the grant funding received from the *Building Canada Infrastructure* program. The property for the pump station facility has been purchased by the District and is located on the eastern side of Sawmill Rd at the intersection with Middle Bench Rd. Construction is scheduled to be completed by the spring of 2013.

Estimated Cost: $880,000

10.5.4 JIM BAILEY ROAD BOOSTER PUMP STATION UPGRADE

The original design of this facility was to house a pressure reducing valve, called PR 24 to provide fire flows to the city of Kelowna Industrial area. In 2002, a booster pump was installed in the underground chamber. The booster pump was needed to pump Okanagan Lake water into the Beaver Lake Source distribution area. The installation is operational and has been very useful since 2002, but should be upgraded as discussed in Section 6.2.3. Design of the upgraded facility should be completed in conjunction with a review of the proposed works within the Lakestone Development as well as the possible future filtration project described in Section 10.7.1.

Estimated Cost: $900,000

10.5.5 TRANSFER PUMP STATION TO OYAMA LAKE WATER SOURCE

This transfer pump station is part of the pipeline project described in Section 10.4.3. The pipeline interconnects the Eldorado Reservoir and Oyama Lake Water Source. During most flow conditions, treated water will be supplied into the Oyama Lake Source through a pressure reducing or altitude valve. However, a booster station is required to pump the treated water during peak demand periods. A second set of pumps would be located in this same station to enable Kalamalka Lake water, via the Sawmill Road booster station, to be delivered to the Eldorado Reservoir. A preliminary location for the pump station is at the south end of Middle Bench Rd.

Estimated Cost: $1,700,000

10.6 MINOR PROJECTS & ADMINISTRATION

There are numerous small projects identified to be completed over the next 20 years. Some of those projects are technology improvements such as SCADA, and others are improving the facilities to ensure a safe working environment for the District staff.

10.6.1 MINOR PROJECTS

Engineering Staff at the District have identified various items, projects and improvements they would like to see completed over the next 20 years to provide improved water management, supply and operations. All minor projects are estimated to cost less than $200,000 and the majority can be done by in-house staff or with local contractors.

There are some minor projects that occur on an annual basis and they are:

- General Electrical Maintenance;
- SCADA Support;
- Water Service Replacement; and
- Pump rebuilds.

All other minor projects are infrastructure specific and will be scheduled by District Staff as required.

Estimated Cost: $1,650,000

10.6.2 DEVELOPMENT & ADMINISTRATION

The Water Master Plan is a working document which will require updating on a five year basis to:

- Update the water supply and demand status;
- Review the implementation of the water quality improvement projects;
- Analyze and update the growth and water conservation projections;
- Update the capital works projects required; and
- Ensure the Development Cost Charges, Capital Expenditure Charges, and water rates adequately cover the respective costs.

Estimated Cost: $600,000

10.7 FUTURE WATER INFRASTRUCTURE PROJECTS

A 20 year planning period can be short for some water infrastructure projects that have a long life expectancy. Therefore, a few projects have been identified that will be required beyond the year 2030. The first two of the four projects relate to filtration deferral of Okanagan and Kalamalka Lakes. This Water Master Plan has been prepared with the assumption that the District will obtain filtration deferral status on the Okanagan and Kalamalka Lake Sources. Filtration deferral of these two sources is very important for the District's infrastructure planning and water rates.

10.7.1 FILTRATION FACILITY EXPANSION AT ELDORADO RESERVOIR

The preferred water quality scheme is that the Okanagan Lake Water Source will continue to supply its users without any filtration. However, the filtration deferral status is based on the water quality of the Lake and can be withdrawn by Interior Health if the water quality deteriorates.

Future expansion of the filtration facility at Eldorado Reservoir is one option if the filtration status at Okanagan Lakes changes. An alternative is to build filtration at the Okanagan Lake Reservoir location. The optimum location needs to be studied in detail. One of the guiding principles on which the Water Advisory Committee based their selection of the preferred water quality option, was to centralize the treatment and filtration facilities as much as possible.

If filtration deferral on Okanagan Lake water is not granted, or is withdrawn at a later date, the following major projects would be required to convey the water up to the Eldorado treatment facilities:

- Disconnect all waterlines from the Okanagan Lake Mainline, including the Okanagan Centre Road East pipeline and the two pressure reduced connections servicing the Town Centre / Woodsdale Road areas, in order to obtain a dedicated mainline to the Jim Bailey Road Booster Station;
- Construct new booster pump station on Jim Bailey Rd;
- Install a dedicated pipeline to convey Okanagan Lake water from Jim Bailey Road Pump Station to Eldorado Reservoir; and
- Expand the Eldorado treatment, reservoir storage, and UV disinfection facilities.

10.7.2 FILTRATION FACILITY AT KALAMALKA LAKE

Similarly, if filtration deferral is not granted or maintained on the Kalamalka Lake Water Source, a new filtration facility will need to be constructed at the lake or at the balancing reservoir. A dedicated mainline will be required if the balancing reservoir is selected as the preferred location. This filtration facility will be sized to meet the maximum day demand of the users on the Kalamalka Lake Source.

10.7.3 OYAMA LAKE DIVERSION TO ELDORADO RESERVOIR

This project will become reality once the projects in Section 10.4.3 and 10.5.5 are installed and the annual demand of the Oyama Lake Water Source needs to be supplied with treated water. This project involves diverting the releases from the Oyama Lake Reservoir down Clark Creek instead of Oyama Creek. Clark Creek is currently one of the natural overflows from Oyama Lake and it flows past the Eldorado Reservoir site. An intake on the creek and a pipeline will be required to divert the water into the hydro generation facility at Eldorado Reservoir. The water will be treated at an expanded facility at this location rather than build a satellite treatment facility at the Oyama Creek Intake.

10.7.4 BEAVER LAKE RAISING

A report was completed in 2010 analyzing the environmental impact and cost of raising upland reservoirs, one of them being Beaver Lake. Raising the Beaver Lake reservoir may be beneficial as it prepares the District for drought conditions and future climate changes that impact hydrology.

10.8 CAPITAL COST ESTIMATES

Capital cost estimates have been prepared for all Capital Works Projects including the Minor Projects. The estimates do not include land acquisitions and are based on limited design and fieldwork. The estimates should therefore be considered preliminary (± 25%). Subsurface materials such as bedrock or groundwater that may be encountered during construction have not been included in the estimates. Estimates are based on price inquiries and on 2011 dollars. Refer to the following Annex for details of the estimate.

Table 10.2 - Summary of Capital Cost Estimates

Capital Cost Estimates			
Section	**Description**	**Sub-Total**	**Total Cost**
1	**WATER CONSERVATION**		
1.1	Universal Water Metering – Phases 1 & 2	$4,000,000	
			$4,000,000
2	**WATER TREATMENT FACILITIES**		
2.1	Kalamalka Lake UV Installation	$1,070,000	
2.2	Okanagan Lake UV Installation	$2,060,000	
2.3	Filtration Facilities @ Eldorado Reservoir Phase 1	$24,000,000	
2.4	Filtration Facilities @ Eldorado Reservoir Phase 2	$10,000,000	
			$37,130,000
3	**WATER STORAGE**		
3.1	Oyama Lake Water Source Reservoir & Chlorinator	$2,550,000	
3.2	Okanagan Lake Reservoir Expansion	$1,600,000	
3.3	Eldorado Treated Water Reservoir	$3,700,000	
			$7,850,000
4	**PIPELINES & MISCELLANEOUS INFRASTRUCTURE**		
4.1	Swalwell (Beaver) Lake Dam – Refurbish & Upgrade	$1,800,000	
4.2	Watermains - New, Replacement & Upgrading	$11,800,000	
4.3	Interconnecting Pipeline from Eldorado to Oyama WS	$8,000,000	
			$21,600,000
5	**HYDRAULIC CONTROL FACILITIES**		
5.1	Pressure Regulating Stations – Upgrade & Rebuild	$1,690,000	
5.2	Kalamalka Lake Intake Extension	$1,000,000	
5.3	Booster Pump Station at Sawmill Road	$880,000	
5.4	Jim Bailey Road Booster Pump Station Upgrade	$900,000	
5.5	Transfer Pump Station to Oyama Lake Water System	$1,700,000	
			$6,170,000
6	**MINOR PROJECTS & ADMINISTRATION**		
6.1	Minor Projects < $200,000	$1,650,000	
6.2	Development & Administration	$600,000	
			$2,250,000
Total Capital Cost Budget to 2030			***$79,000,000***

10.9 ANNEX

Table 10.3 – Detailed Estimates for Water Conservation

1	WATER CONSERVATION	Qty	Unit	$/Unit	Sub Total	Total
1.1	*Universal Water Metering*					
	Supply & Install New Domestic Water Meters (16mm x 19mm) – Includes integrated transmitter, leak detection, backflow detection, no flow detection, rate of flow indication	1875	ea	$450	$843,750	
	Supply & Install New Mobile Homes or Crawl Space – Same as 1.1 with additional access cost	375	ea	$500	$187,500	
	Retrofit existing water meters with electronic transmitters and electronic coders in newer residential developments	850	ea	$330	$280,500	
	Supply & Install Single Check Valves in all Domestic Services	3100	ea	$150	$465,000	
	Contingencies @ 10% (Includes minor & major carpentry)				$165,250	
	Sub Total				***$1,942,000***	
	Installation Records, Photographs, Customer Service and Meter Verification @ 10%				$190,000	
	Tendering, Inspection, Project Management and Admin @ 5%				$95,000	
					Project Cost	**$2,227,000**
1.1.1	*Institutional, Commercial and Industrial Water Meters*					
	Supply & Install ICI water meters, sizes ranging from 25mm to 100mm, and install strainer and electronic coder	95	ea	$2,000	$190,000	
	Retrofit existing water meters with electronic transmitters and electronic coders	35	ea	$1,200	$42,000	
	Supply & Install Flow Control Valves in all ICI Services	130	ea	$200	$26,000	
	Supply & Install Dual Check Valves in all ICI Services	260	ea	$250	$65,000	
	Contingencies @ 10% (Includes minor & major carpentry)				$25,000	
	Sub Total				***$348,000***	
	Installation Records, Photographs, Customer Service and Meter Verification @ 10%				$35,000	
	Tendering, Inspection, Project Management and Admin @ 5%				$17,000	
					Total Project Cost	**$400,000**
1.1.2	*Irrigation Water Meters*					
	Supply & Install Irrigation Water Meters (25mm) – Includes integrated transmitter, leak detection, isolation valve, upstream and downstream test tees for drainage and pre-fabricated meter box.	355	ea	$1,000	$355,000	
	Supply & Install Irrigation Water Meters (38mm) – Includes integrated transmitter, leak detection, isolation valve, upstream and downstream test tees for drainage and pre-fabricated meter box.	190	ea	$2,000	$380,000	
	Supply & Install Irrigation Water Meters (50mm) – Includes integrated transmitter, leak detection, isolation valve, upstream and downstream test tees for drainage and pre-fabricated meter box.	35	ea	$2,500	$87,500	
	Supply & Install Flow Control Valves	580	ea	$200	$116,000	
	Supply & Install double back flow preventer assemblies (25mm)	355	ea	$150	$53,250	
	Supply & Install double back flow preventer assemblies (38mm)	190	ea	$250	$47,500	
	Supply & Install double back flow preventer assemblies (50mm)	35	ea	$300	$10,500	
	Contingencies @ 10%				$92,250	
	Sub Total				***$1,142,000***	
	Installation Records, Photographs, Customer Service and Meter Verification @ 10%				$110,500	
	Tendering, Inspection, Project Management and Admin @ 5%				$55,000	
					Total Project Cost	**$1,307,500**
1.1.3	*Drive-By Meter Reading System*					
	Supply & Install Mobile Drive-By Reading System Includes on-site training and implementation	1	ea	$25,500	$25,500	
	Radio Frequency Annual License Fee	N/A				
					Total Project Cost	**$25,500**
1.1.4	*Public Education Program*					
	Public Education / Communication Program includes: Consulting fees, web design, publication, advertising and administration costs.	3810	ea	$10.50	$40,000	
					Total Project Cost	**$40,000**
	Total Project Cost for Universal Metering (Phase 1 & 2)					**$4,000,000**
TOTAL COST FOR WATER CONSERVATION						**$4,000,000**

Table 10.4 – Detailed Estimates for Water Treatment Facilities

2	WATER TREATMENT FACILITIES	Qty	Unit	$/Unit	Sub-Total	Total
2.1	***Kalamalka Lake UV Disinfection***					
	Building Addition Including Sub-Structure	25	m2	$2,500	$62,500	
	Existing Building Renovations	1	LS	$35,000	$35,000	
	Heating & Ventilation	1	LS	$10,000	$10,000	
	Sitework, Excavation & Backfill	1	LS	$25,000	$25,000	
	Landscaping & Restoration	1	LS	$10,000	$10,000	
	Redundant UV Disinfection, 600 mm UV Swift 4L	2	LS	$220,000	$440,000	
	Mechanical, Chlorine Inject Relocation, Misc Metal Work	1	LS	$65,000	$65,000	
	Electrical & Telemetry Upgrade	1	LS	$55,000	$55,000	
	On-Line Transmittance Sampling Unit	1	LS	$20,000	$20,000	
	Contingencies @ 10%				$64,000	
	Sub Total				***$786,500***	
	Design Engineering, Surveying, Consulting @ 10%				$75,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$112,500	
					Total Project Cost	**$974,000**
2.1.1	***Removal of Existing Todd Road Chlorinator***					
	Sitework & Demolition	1	LS	$20,000	$20,000	
	Mechanical, Flowmeter Removal	1	LS	$28,000	$28,000	
	Electrical & Telemetry Salvage/Removal	1	LS	$15,000	$15,000	
	Landscaping & Restoration	1	LS	$5,000	$5,000	
	Contingencies @ 10%				$6,000	
	Sub Total				***$74,000***	
	Design Engineering, Surveying, Consulting @ 15%				$11,000	
	Tendering, Project Management, & Admin @ 15%				$11,000	
					Total Project Cost	**$96,000**
					Total Project Cost for Kalamalka Lake UV Installation	**$1,070,000**
2.2	***Okanagan Lake UV Disinfection***					
	Building Addition Including Sub-Structure	50	m2	$2,500	$125,000	
	Heating & Ventilation	1	LS	$15,000	$15,000	
	Sitework, Excavation & Backfill	1	LS	$30,000	$30,000	
	Landscaping & Restoration	1	LS	$10,000	$10,000	
	Redundant UV Disinfection, 600 mm UV Swift 4L	3	LS	$220,000	$660,000	
	Mechanical, Chlorine Inject Relocation, Misc Metal Work	1	LS	$100,000	$100,000	
	Electrical & Telemetry Upgrade	1	LS	$80,000	$80,000	
	On-Line Transmittance Sampling Unit	1	LS	$20,000	$20,000	
	Mobilization & Demobilization	1	LS	$25,000	$25,000	
	Miscellaneous & Contingencies @ 20%				$187,000	
	Sub Total				***$1,252,000***	
	Design Engineering, Surveying, Consulting @ 15%				$174,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$174,000	
					Total Project Cost	**$1,600,000**
2.2.1	***Intake Screens***					
	Replace Intake Screens				$400,000	
	Install New VFD				$60,000	
					Total Project Cost	**$460,000**
					Total Project Cost for Okanagan Lake UV Installation	**$2,060,000**

Table 10.5 – Detailed Estimates for Water Treatment Facilities (Continued)

2	WATER TREATMENT FACILITIES (CONTINUED)	Qty	Units	$/Unit	Sub-Total	Total
2.3	Filtration Facilities @ Eldorado Reservoir – Phase 1					
2.3.1	*Sitework at Treatment Building*					
	Mobilization & Demobilization	1	LS	$50,000	$50,000	
	Tie-ins	2	ea	$5,000	$10,000	
	Excavation & Site Preparation	1	LS	$150,000	$150,000	
	Underground Utilities & Watermains	1	LS	$270,000	$270,000	
	Parking Area-Gravel Base	400	m³	$75	$30,000	
	Road Improvements / Site Drainage - Allowance	1	LS	$100,000	$100,000	
	Fencing & Landscaping	1	LS	$40,000	$40,000	
	Miscellaneous & Contingencies @ 20%				$100,000	
	Sub Total				*$750,000*	
	Design Engineering, Surveying, Consulting @ 15%				$100,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$100,000	
					Total Project Cost	**$950,000**
2.3.2	*Water Treatment Building*					
	Concrete Block Walls, Steel Frame & Corrugated Steel Roof					
	Including Foundations	500	m²	$2,000	$1,000,000	
	Plumbing & Misc. Metals	1	LS	$200,000	$200,000	
	Heating & Ventilating	1	LS	$150,000	$150,000	
	Building Electrical	1	LS	$250,000	$250,000	
	Mono Rails/Manual Hoist	1	LS	$50,000	$50,000	
	Painting & Cleanup	1	LS	$20,000	$20,000	
	Miscellaneous & Contingencies @ 20%				$300,000	
	Sub Total				*$1,970,000*	
	Design Engineering, Surveying, Consulting @ 15%				$295,500	
	Tendering, Project Management, Commissioning & Admin @ 15%				$295,500	
					Total Project Cost	**$2,561,000**
2.3.3	*Mechanical & Electrical*					
	Neutralization Backwash Tank Package System	1	LS	$750,000	$750,000	
	Membrane Filtration Plant Package System	1	LS	$4,500,000	$4,500,000	
	UV Reactors - Packaged System	4	ea	$250,000	$1,000,000	
	Chemical Feed System	1	LS	$500,000	$500,000	
	Flocculation Clarification	1	LS	$5,000,000	$5,000,000	
	Mechanical	1	LS	$750,000	$750,000	
	Valves & Instrumentation	1	LS	$500,000	$500,000	
	Electrical, Telemetry & Programming	1	LS	$750,000	$750,000	
	3-Phase Power Supply & Telephone	1	LS	$150,000	$150,000	
	Sludge Disposal System	1	LS	$600,000	$600,000	
	Miscellaneous & Contingencies @ 20%				$2,589,000	
	Sub Total				*$17,089,000*	
	Design Engineering & Consulting @ 10%				$1,700,000	
	Tendering, Project Management, Commissioning & Admin @ 10%				$1,700,000	
					Total Project Cost	**$20,489,000**
	Total Project Cost for Filtration Facilities @ Eldorado (Phase 1)					**$24,000,000**
2.4	Filtration Facilities @ Eldorado Reservoir – Phase 2					
2.4.1	*Sitework at Treatment Building-Expansion*					**$500,000**
2.4.2	*Water Treatment Building - Building Addition*					**$1,040,000**
2.4.3	*Mechanical & Electrical Additional Equipment*					**$8,460,000**
	Total Project Cost for Filtration Facilities @ Eldorado (Phase 2)					**$10,000,000**
TOTAL COST FOR WATER TREATMENT FACILITIES						**$37,130,000**

Table 10.6 – Detailed Estimates for Water Storage

3	WATER STORAGE	Qty	Unit	$/Unit	Sub-Total	Total
3.1	***Oyama Lake Reservoir***					
	Access Road to Site	1	LS	$40,000	$40,000	
	Clearing & Grubbing	1	LS	$20,000	$20,000	
	Oyama Creek Bridge Replacement	1	LS	$70,000	$70,000	
	Supply, Discharge & Overflow Pipelines	1	LS	$250,000	$250,000	
	Concrete Structure	240	m^3	$2,000	$480,000	
	Sitework, Reservoir Foundation, Excavation & Backfill	1	LS	$160,000	$160,000	
	Mechanical, Circulation Header	1	LS	$140,000	$140,000	
	Miscellaneous Steel, Hatches, Ladders, Vents.	1	LS	$50,000	$50,000	
	Telemetry	1	LS	$10,000	$10,000	
	Pressure Test & Disinfection	1	LS	$5,000	$5,000	
	Fencing & Landscaping	1	LS	$20,000	$20,000	
	Contingencies @ 10%				$115,000	
	Sub Total				***$1,360,000***	
	Design Engineering, Surveying, Consulting @ 10%				$130,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$200,000	
					Total Project Cost	**$1,690,000**
3.1.1	***New Chlorination Facility***					
	Chlorination Building Including Foundation	30	m^2	$2,500	$75,000	
	Heating & Ventilating	1	LS	$25,000	$25,000	
	Sitework, Excavation & Backfill	1	LS	$25,000	$25,000	
	On-Site Hypochlorite Generation Equipment	1	LS	$300,000	$300,000	
	Mechanical, Flowmeter & Misc Metal Work	1	LS	$60,000	$60,000	
	3-Phase Power Supply	1	LS	$80,000	$80,000	
	Electrical & Telemetry	1	LS	$50,000	$50,000	
	Fencing & Landscape	1	LS	$30,000	$30,000	
	Contingencies @ 10%				$55,000	
	Sub Total				***$700,000***	
	Design Engineering, Surveying, Consulting @ 10%				$60,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$100,000	
					Total Project Cost	**$860,000**
	Total Project Cost for Oyama Lake Water Source Reservoir & Chlorinator					**$2,550,000**
3.2	***Okanagan Lake Reservoir Expansion***					
	Clearing & Grubbing	1	LS	$25,000	$25,000	
	Supply, Discharge & Overflow Pipelines	1	LS	$15,000	$15,000	
	Concrete Structure incl. Steel Reinforcing	325	m^3	$2,000	$650,000	
	Sitework, Reservoir Foundation, Excavation & Backfill	1	LS	$150,000	$150,000	
	Mechanical & Circular Header	1	LS	$150,000	$150,000	
	Miscellaneous Steel, Hatches, Ladders, Vents.	1	LS	$50,000	$50,000	
	Telemetry	1	LS	$10,000	$10,000	
	Pressure Test & Disinfection	1	LS	$5,000	$5,000	
	Mobilization & Demobilization	1	LS	$50,000	$50,000	
	Miscellaneous & Contingencies @ 10%				$120,000	
	Sub Total				***$1,225,000***	
	Surveying, Design Engineering & Consulting @ 15%				$187,500	
	Tendering, Project Management, Commissioning & Admin @ 15%				$187,500	
	Total Project Cost for Okanagan Lake Reservoir Expansion					**$1,600,000**
3.3	***Eldorado Treated Water Reservoir***					
	Access Road Allow	1	LS	$75,000	$75,000	
	Clearing & Grubbing	1	LS	$50,000	$50,000	
	Supply, Discharge & Overflow Pipelines	1	LS	$300,000	$300,000	
	Concrete Structure	620	m^3	$2,000	$1,240,000	
	Sitework, Reservoir Foundation, Excavation & Backfill	1	LS	$150,000	$150,000	
	Reservoir Piping & Mechanical	1	LS	$250,000	$250,000	
	Miscellaneous Steel, Hatches, Ladders, Vents.	1	LS	$100,000	$100,000	
	Telemetry	1	LS	$40,000	$40,000	
	Pressure Test & Disinfection	1	LS	$10,000	$10,000	
	Fencing & Landscaping	1	LS	$50,000	$50,000	
	Mobilization & Demobilization	1	LS	$100,000	$100,000	
	Miscellaneous & Contingencies @ 20%				$480,000	
	Sub Total				***$2,845,000***	
	Surveying, Design Engineering & Consulting @ 15%				$427,500	
	Tendering, Project Management, Commissioning & Admin @ 15%				$427,500	
	Total Project Cost for Eldorado Treated Water Reservoir					**$3,700,000**
TOTAL COST FOR WATER STORAGE						**$7,850,000**

Table 10.7 – Detailed Estimates for Pipelines & Miscellaneous Infrastructure

4	PIPELINES & MISCELLANEOUS INFRASTRUCTURE	Qty	Unit	$/Unit	Sub-Total	Total
4.1	***Beaver (Swalwell) Lake Dam - Refurbish & Upgrade***					
	Crooked Lake – Access Roads, Gates, Improvements; *Beaver (Swalwell) Lake – Construction of new outlet works;* *Replacing Headwall & Railing, etc*				$1,800,000	
	Total Project Cost for Swalwell (Beaver) Lake Dam - Refurbish & Upgrade					**$1,800,000**
4.2	**Watermains - New, Replacement & Upgrade**					
4.2.1	***Okanagan Centre Rd W / Tyndall / Chase @ HGL 600***					
	Booster Pump Station PZ 536 to PZ 600				$1,125,000	
	Cost from Agua Consulting Inc. 2007					
	Pump Station PZ 536 to PZ 600					
	500mm Watermain from Pump Stn to Reservoir HGL 600mm				$550,000	
	New Reservoir at HGL 600 - 2.5 ML				$1,300,000	
	Valve Chamber at Reservoir HGL 600				$350,000	
					Total Project Cost	**$3,325,000**
4.2.2	***Watermain from existing steel main to new reservoir HGL 536m***					
	600 mm Dia D.I. Pipe	210	m	$550	$115,500	
	Valves and Fittings	1	LS	$15,000	$15,000	
	Live tap Connection to 850mm Steel Main	1	LS	$40,000	$40,000	
	Connections to Inlet / Outlet piping	2	ea	$20,000	$40,000	
	Landscaping Restoration Allowable	1	LS	$10,000	$10,000	
	Mobilization & Demobilization	1	LS	$10,000	$10,000	
	Contingency @ 10%				$20,000	
	Sub Total				***$250,500***	
	Surveying, Design Engineering & Consulting @ 15%				$35,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$35,000	
					Total Project Cost	**$320,500**
4.2.3	***Watermain Jim Bailey Road –Okanagan Lake Mainline to Beaver Lake Road***					
	500 mm Dia D.I. Pipe	460	m	$450	$207,000	
	Valves and Fittings	1	LS	$30,000	$30,000	
	Beaver Lake Road Crossing	1	LS	$10,000	$10,000	
	Asphalt Replacement incl. Road base (2m wide strip)	700	m2	$45	$31,500	
	Tie-ins	2	ea	$5,000	$10,000	
	Landscaping Restoration Allowable	1	LS	$20,000	$20,000	
	Mobilization & Demobilization	1	LS	$25,000	$25,000	
	Contingency @ 10%				$30,000	
	Sub Total				***$363,500***	
	Surveying, Design Engineering & Consulting @ 15%				$50,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$50,000	
					Total Project Cost	**$463,500**
4.2.4	***Watermain Beaver Lake Road - Jim Bailey Road to McCarthy Road***					
	400 mm Dia D.I. Pipe	280	m	$400	$112,000	
	Valves and Fittings	1	LS	$30,000	$30,000	
	Domestic Service Connection	1	ea	$2,500	$2,500	
	Asphalt Replacement incl. Road base (2m wide strip)	560	m2	$45	$25,200	
	Tie-ins	2	ea	$5,000	$10,000	
	Landscaping Restoration Allow.	1	LS	$20,000	$20,000	
	Mobilization & Demobilization	1	LS	$15,000	$15,000	
	Contingency @ 10%				$20,000	
	Sub Total				***$234,700***	
	Surveying, Design Engineering & Consulting @ 15%				$30,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$30,000	
					Total Project Cost	**$294,700**
4.2.5	***Watermain McCarthy Road to Bottom Wood Lake Road***					
	250 mm Dia PVC Pipe	500	m	$250	$125,000	
	Valves and Fittings	1	LS	$20,000	$20,000	
	Domestic Service Connection	1	ea	$2,500	$2,500	
	Irrigation Service Connection	1	ea	$3,000	$3,000	
	Railway Crossing	1	LS	$15,000	$15,000	
	Asphalt Replacement incl. Road base (2m wide strip)	1000	m2	$45	$45,000	
	Tie-ins	2	ea	$5,000	$10,000	
	Landscaping Restoration Allow.	1	LS	$20,000	$20,000	
	Mobilization & Demobilization	1	LS	$20,000	$20,000	
	Contingency @ 10%				$20,000	
	Sub Total				***$280,500***	
	Surveying, Design Engineering & Consulting @ 15%				$40,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$40,000	
					Total Project Cost	**$360,500**

Table 10.8 – Detailed Estimates for Pipelines & Miscellaneous Infrastructure (Continued)

4	PIPELINES & MISCELLANEOUS INFRASTRUCTURE (CONTINUED)	Qty	Unit	$/Unit	Sub-Total	Total
4.2.6	***Watermain Bottom Wood Lake Road to Lodge Road***					
	300 mm Dia PVC Pipe	1,200	m	$275	$330,000	
	200 mm Dia PVC Pipe	430	m	$200	$86,000	
	Valves and Fittings	1	LS	$50,000	$50,000	
	Domestic Service Connection	2	ea	$2,500	$5,000	
	Irrigation Service Connection	6	ea	$3,000	$18,000	
	Asphalt Replacement incl. Road base-Full Road Width	5900	m2	$45	$265,500	
	Tie-ins	1	ea	$5,000	$5,000	
	Branch Connections for future Extensions	2	ea	$5,000	$10,000	
	Blow-off	1	ea	$3,000	$3,000	
	Landscaping Restoration Allow.	1	LS	$40,000	$40,000	
	Mobilization & Demobilization	1	LS	$30,000	$30,000	
	Contingency @ 10%				$74,500	
	Sub Total				***$917,000***	
	Surveying, Design Engineering & Consulting @ 15%				$130,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$130,000	
					Total Project Cost	**$1,177,000**
4.2.7	***Watermain Bottom Wood Lake / Konshuh / Meadow Roads to Lodge Road***					
	350 mm Dia D.I. Pipe	750	m	$375	$281,250	
	Valves and Fittings	1	LS	$50,000	$50,000	
	Domestic Service Connection	1	ea	$1,100	$1,100	
	Asphalt Replacement incl. Road base (2m wide strip)	1000	m2	$45	$45,000	
	ROW Clearing & Grubbing	250	m	$20	$5,000	
	Tie-ins	1	ea	$5,000	$5,000	
	Landscaping Restoration Allow.	1	LS	$25,000	$25,000	
	Mobilization & Demobilization	1	LS	$20,000	$20,000	
	Contingency @ 10%				$35,150	
	Sub Total				***$467,500***	
	Surveying, Design Engineering & Consulting @ 15%				$65,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$65,000	
					Total Project Cost	**$597,500**
4.2.8	***Watermain Lodge Road to Sherman Rd Incl. PR Stn***					
	200 mm Dia PVC Pipe	160	m	$200	$32,000	
	Valves and Fittings	1	LS	$10,000	$10,000	
	ROW Clearing & Grubbing	160	m	$20	$3,200	
	Tie-ins	2	ea	$5,000	$10,000	
	Landscaping Restoration Allow.	1	LS	$10,000	$10,000	
	PR Station	1	LS	$60,000	$60,000	
	Mobilization & Demobilization	1	LS	$5,000	$5,000	
	Contingency @ 10%				$10,000	
	Sub Total				***$140,200***	
	Surveying, Design Engineering & Consulting @ 10%				$10,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$15,100	
					Total Project Cost	**$165,300**
4.2.9	***Watermain - Oceola Rd to Woodsdale Rd***					
	250 mm Dia PVC Pipe	350	m	$250	$87,500	
	Valves and Fittings	1	LS	$10,000	$10,000	
	Domestic Service Connection	4	ea	$2,500	$10,000	
	Fire Hydrants	2	ea	$5,500	$11,000	
	Blow-off	1	ea	$5,000	$5,000	
	Highway 97 Crossing (steel sleeve)	1	LS	$20,000	$20,000	
	Asphalt Replacement incl. Road base (2m wide strip)	700	m2	$45	$31,500	
	Tie-ins	2	ea	$5,000	$10,000	
	Landscaping Restoration Allow.	1	LS	$15,000	$15,000	
	Mobilization & Demobilization	1	LS	$10,000	$10,000	
	Contingency @ 10%				$20,000	
	Sub Total				***$230,000***	
	Surveying, Design Engineering & Consulting @ 15%				$30,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$30,000	
					Total Project Cost	**$290,000**

Table 10.9 – Detailed Estimates for Pipelines & Miscellaneous Infrastructure (Continued)

4	PIPELINES & MISCELLANEOUS INFRASTRUCTURE (CONTINUED)	Qty	Unit	$/Unit	Sub-Total	Total
4.2.10	***Watermain - Woodsdale Rd to Sherman Rd***					
	300 mm Dia PVC Pipe	1100	m	$275	$302,500	
	Valves and Fittings	1	LS	$15,000	$15,000	
	Asphalt Replacement incl. Road base (2m wide strip)	2200	m2	$45	$99,000	
	Tie-ins	2	ea	$5,000	$10,000	
	Landscaping Restoration Allow.	1	LS	$20,000	$20,000	
	Mobilization & Demobilization	1	LS	$15,000	$15,000	
	Contingency @ 10%				$40,000	
	Sub Total				***$501,500***	
	Surveying, Design Engineering & Consulting @ 15%				$70,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$70,000	
					Total Project Cost	**$641,500**
4.2.11	***Convert Area to Okanagan Lake Water***					
	Read Rd					
	Domestic Service Connection	24	ea	$715	$17,160	
	Irrigation Service Connection	10	ea	$715	$7,150	
	Abandon old watermain -drain & plug, remove in-line valves	1	LS	$1,500	$1,500	
	OK Centre Rd from Read to Jardines					
	Domestic Service Connection	54	ea	$715	$38,610	
	Irrigation Service Connection	26	ea	$715	$18,590	
	Abandon old watermain -drain & plug, remove in-line valves	1	LS	$750	$750	
	OK Centre Rd from Jardines to Oceola					
	Domestic Service Connection	45	ea	$715	$32,175	
	Irrigation Service Connection	12	ea	$715	$8,580	
	Abandon old watermain -drain & plug, remove in-line valves	1	LS	$750	$750	
	Davidson Rd					
	Domestic Service Connection	8	ea	$715	$5,720	
	Irrigation Service Connection	1	ea	$715	$715	
	Abandon old watermain -drain & plug, remove in-line valves	1	LS	$750	$750	
	Contingency @ 10%				$10,550	
	Sub Total				***$143,000***	
	Tendering, Project Management, Commissioning & Admin @ 15%				$17,000	
	Add additional domestic from Brew Rd and PR Reconfigure				$30,000	
					Total Project Cost	**$190,000**
4.2.12	***Watermain - Main Street South of Grant Rd***					
	300 mm Dia PVC Pipe	150	m	$275	$41,250	
	Valves and Fittings	1	LS	$5,000	$5,000	
	Domestic Service Connection	5	ea	$2,500	$12,500	
	Asphalt Replacement incl. Road base (2m wide strip)	300	m2	$45	$13,500	
	Tie-ins	2	ea	$5,000	$10,000	
	Landscaping Restoration Allow.	1	LS	$5,000	$5,000	
	Mobilization & Demobilization	1	LS	$5,000	$5,000	
	Contingency @ 10%				$9,225	
	Sub Total				***$101,475***	
	Surveying, Design Engineering & Consulting @ 15%				$13,013	
	Tendering, Project Management, Commissioning & Admin @ 15%				$13,013	
					Total Project Cost	**$127,500**
4.2.13.1	***Watermain on Glenmore Rd***					
	300mm Watermain Extension	210	m	$275	$57,750	
	In-Line Valve Stations & Misc Fittings	1	LS	$10,000	$10,000	
	Tie-ins	2	ea	$5,000	$10,000	
	Landscaping Restoration Allow.	1	LS	$25,000	$25,000	
	Asphalt Replacement incl. Road base (2m wide strip)	250	m²	$45	$11,250	
	Mobilization & Demobilization	1	LS	$10,000	$10,000	
	Miscellaneous & Contingencies @ 10%				$10,000	
	Sub Total				***$134,000***	
	Surveying, Design Engineering & Consulting @ 15%				$15,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$15,000	
					Total Project Cost	**$164,000**
4.2.13.2	***Loop on Glenmore Rd in same trench***					
	150mm Watermain Extension	200	m	$150	$30,000	
	In-Line Valve Stations & Misc Fittings	1	LS	$10,000	$10,000	
	Tie-ins	2	ea	$5,000	$10,000	
	Miscellaneous & Contingencies @ 10%				$5,000	
	Sub Total				***$55,000***	
	Surveying, Design Engineering & Consulting @ 15%				$6,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$6,000	
					Total Project Cost	**$67,000**

Table 10.10 – Detailed Estimates for Pipelines & Miscellaneous Infrastructure (Continued)

4	PIPELINES & MISCELLANEOUS INFRASTRUCTURE	Qty	Unit	$/Unit	Sub-Total	Total
4.2.14	***Hare Rd, Okanagan Centre - Watermain Improvements***					
	Watermain Improvements	1	LS	$892,000	$892,000	
					Total Project Cost	**$892,000**
4.2.15	***Watermain - Highland Rd, Oyama***					
	200mm Watermain Extension	350	m	$200	$70,000	
	In-Line Valve Stations & Misc Fittings	1	LS	$10,000	$10,000	
	Air Valve Stations	1	LS	$10,000	$10,000	
	Tie-ins	2	ea	$5,000	$10,000	
	Landscaping Restoration Allow.	1	LS	$20,000	$20,000	
	Asphalt Replacement incl. Road base (2m wide strip)	700	m²	$45	$31,500	
	Mobilization & Demobilization	1	LS	$10,000	$10,000	
	Miscellaneous & Contingencies @ 10%				$12,500	
	Sub Total				***$174,000***	
	Surveying, Design Engineering & Consulting @ 15%				$20,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$20,000	
					Total Project Cost	**$214,000**
4.2.16	***Watermain - Young Road Upgrade***					
	300 mm Dia PVC Pipe	370	m	$200	$74,000	
	Valves and Fittings	1	LS	$10,000	$10,000	
	Domestic Service Connection	21	ea	$2,500	$52,500	
	Fire Hydrants	1	ea	$5,500	$5,500	
	Asphalt Replacement incl. Road base (2m wide strip)	740	m2	$45	$33,300	
	Tie-ins	5	ea	$5,000	$25,000	
	Landscaping Restoration Allow.	1	LS	$20,000	$20,000	
	Mobilization & Demobilization	1	LS	$10,000	$10,000	
	Contingency @ 10%				$19,700	
	Sub Total				***$250,000***	
	Surveying, Design Engineering & Consulting @ 15%				$30,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$30,000	
					Total Project Cost	**$310,000**
4.2.17	***Watermain - Talbot Rd, Wood Lake***					
	200mm Watermain Extension	350	m	$200	$70,000	
	In-Line Valve Stations & Misc Fittings	1	LS	$10,000	$10,000	
	Air Valve Stations	1	LS	$10,000	$10,000	
	Tie-ins	2	ea	$5,000	$10,000	
	Landscaping Restoration Allow.	1	LS	$20,000	$20,000	
	Asphalt Replacement incl. Road base (2m wide strip)	350	m²	$45	$15,750	
	Mobilization & Demobilization	1	LS	$10,000	$10,000	
	Miscellaneous & Contingencies @ 10%				$14,250	
	Sub Total				***$160,000***	
	Surveying, Design Engineering & Consulting @ 15%				$20,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$20,000	
					Total Project Cost	**$200,000**
4.2.18	***AC Watermain Replacement - Ongoing Projects***					
	Annual Budget	20	yrs	$50,000	$1,000,000	
	Over sizing Watermains & Facilities	10	yrs	$100,000	$1,000,000	
					Total Project Cost	**$2,000,000**
	Total Project Cost for Watermains - New, Replacement & Upgrading					**$11,800,000**
4.3	***Interconnecting Pipeline from Eldorado to Oyama Lake Water Source***					
	600mm Watermain	9000	m	$450	$4,050,000	
	In-Line Valve Stations & Misc Fittings	1	LS	$100,000	$100,000	
	Air Valve Stations	1	LS	$60,000	$60,000	
	Tie-ins	2	ea	$10,000	$20,000	
	Landscaping Restoration Allow.	1	LS	$100,000	$100,000	
	Asphalt Replacement including Road base	10000	m²	$45	$450,000	
	Mobilization & Demobilization	1	LS	$50,000	$50,000	
	Miscellaneous & Contingencies @ 20%				$1,200,000	
	Sub Total				***$6,030,000***	
	Surveying, Design Engineering & Consulting @ 15%				$985,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$985,000	
	Total Project Cost for Interconnecting Pipeline from Eldorado to Oyama WS					**$8,000,000**
TOTAL COST FOR PIPELINES						**$21,600,000**

Table 10.11 – Detailed Estimates for Hydraulic Control Facilities

5	HYDRAULIC CONTROL FACILITIES	Qty	Unit	Unit Cost	Sub-Total	Total
5.1	***Pressure Regulating Stations - Upgrade & Rebuild***					
	PR Station Abandonment & Removal	6	ea	$15,000	$90,000	
	PR Station Rebuilds	14	ea	$75,000	$1,050,000	
	PR Station Upgrades	8	ea	$65,000	$520,000	
	Misc Improvements				$30,000	
	Total Project Cost for Pressure Regulation Stations - Upgrade & Rebuild					**$1,690,000**
5.2	***Kalamalka Lake Intake Extension***					
	Based on 220m extension to lower line from 22m to 30m				$1,000,000	
	Total Project Cost for Kalamalka Lake Intake Extension					**$1,000,000**
5.3	***Booster Pump Station at Sawmill Road***					
	Pump Station Building	50	m²	$1,600	$80,000	
	Sub-Structure	1	LS	$30,000	$30,000	
	Sitework, Excavation & Backfill	1	LS	$30,000	$30,000	
	Booster Pumps, Horizontal Split Case	2	ea	$25,000	$50,000	
	Mechanical & Misc Metal Work	1	LS	$150,000	$150,000	
	Water System Tie-ins	1	LS	$20,000	$20,000	
	Pressure Test & Disinfection	1	LS	$3,000	$3,000	
	Electrical & Telemetry	1	LS	$150,000	$150,000	
	3-Phase Power Supply	1	LS	$15,000	$15,000	
	Heating & Ventilating	1	LS	$25,000	$25,000	
	Fencing, Parking & Landscaping	1	LS	$35,000	$35,000	
	OWS PRV Reconfiguration & Abandonment	1	LS	$30,000	$30,000	
	Contingencies @ 10%				$53,000	
	Sub Total				***$671,000***	
	Design Engineering, Surveying, Consulting @ 10%				$64,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$100,000	
	Total Project Cost					**$835,000**
5.3.1	***Relocation of PRV No. 2***					
	Sitework	1	LS	$15,000	$15,000	
	Mechanical	1	LS	$12,000	$12,000	
	Traffic Control	1	LS	$2,000	$2,000	
	Landscaping & Restoration	1	LS	$3,000	$3,000	
	Contingencies @ 10%				$3,000	
	Sub Total				***$35,000***	
	Design Engineering, Surveying, Consulting @ 15%				$5,000	
	Tendering, Project Management, & Admin @ 15%				$5,000	
	Total Project Cost					**$45,000**
	Total Project Cost for Booster Pump Station at Sawmill Road					**$880,000**
5.4	***Jim Bailey Rd Booster Pump Station Upgrade***					
	Pump Station Building	75	m²	$2,000	$150,000	
	Sub-Structure	1	LS	$40,000	$40,000	
	Sitework, Excavation & Backfill	1	LS	$50,000	$50,000	
	Booster Pumps, Horizontal Split Case	2	ea	$75,000	$150,000	
	Mechanical & Misc Metal Work	1	LS	$125,000	$125,000	
	Water System Tie-ins	1	LS	$10,000	$10,000	
	Pressure Test & Disinfection	1	LS	$3,000	$3,000	
	Electrical & Telemetry	1	LS	$100,000	$100,000	
	Heating & Ventilating	1	LS	$35,000	$35,000	
	Fencing, Parking & Landscaping	1	LS	$35,000	$35,000	
	Mobilization & Demobilization	1	LS	$20,000	$20,000	
	Miscellaneous & Contingencies @ 10%				$52,000	
	Sub Total				***$770,000***	
	Surveying, Design Engineering & Consulting @ 10%				$65,000	
	Tendering, Project Management, Commissioning & Admin @ 10%				$65,000	
	Total Project Cost for Jim Bailey Road Booster Pump Station Upgrade					**$900,000**

Table 10.12 – Detailed Estimates for Hydraulic Control Facilities (Continued)

5	HYDRAULIC CONTROL FACILITIES (Continued)	Qty	Unit	$/Unit	Sub-Total	Total
5.5	***Transfer Pump Station to Oyama Lake Water System***					
	Pump Station Building	75	m²	$1,600	$120,000	
	Sub-Structure	1	LS	$40,000	$40,000	
	Sitework, Excavation & Backfill	1	LS	$50,000	$50,000	
	Booster Pumps, Horizontal Split Case 300Hp	2	ea	$75,000	$150,000	
	Mechanical & Misc Metal Work	1	LS	$200,000	$200,000	
	Water System Tie-ins	1	LS	$20,000	$20,000	
	Pressure Test & Disinfection	1	LS	$3,000	$3,000	
	Electrical & Telemetry	1	LS	$150,000	$150,000	
	3-Phase Power Supply	1	LS	$20,000	$20,000	
	Heating & Ventilating	1	LS	$35,000	$35,000	
	Fencing, Parking & Landscaping	1	LS	$35,000	$35,000	
	Mobilization & Demobilization	1	LS	$20,000	$20,000	
	Miscellaneous & Contingencies @ 20%				$172,000	
	Sub Total				***$1,015,000***	
	Design Engineering, Surveying, Consulting @ 15%				$160,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$160,000	
					Total Project Cost	**$1,335,000**
5.5.1	***Chlorination Facility***					
	Chlorination Building Including Foundation	30	m²	$2,000	$60,000	
	Heating & Ventilating	1	LS	$25,000	$25,000	
	Sitework, Excavation & Backfill	1	LS	$25,000	$25,000	
	12% Sodium Hypochlorite Equipment	1	LS	$50,000	$50,000	
	Mechanical, Flowmeter & Misc Metal Work	1	LS	$20,000	$20,000	
	Electrical & Telemetry	1	LS	$15,000	$15,000	
	Fencing & Landscape	1	LS	$25,000	$25,000	
	Mobilization & Demobilization	1	LS	$15,000	$15,000	
	Miscellaneous & Contingencies @ 20%				$46,000	
	Sub Total				***$281,000***	
	Design Engineering, Surveying, Consulting @ 15%				$42,000	
	Tendering, Project Management, Commissioning & Admin @ 15%				$42,000	
					Total Project Cost	**$365,000**
Total Project Cost for Transfer Pump Station to Oyama Lake WS						**$1,700,000**
TOTAL COST FOR HYDRAULIC CONTROL FACILITIES						**$6,170,000**

Table 10.13 – Detailed Estimates for Minor Projects and Administration

6	MINOR PROJECTS & ADMINISTRATION	Qty	Unit	$/Unit	Sub-Total	Total
6.1	***Minor Projects < $200,000***					
	(Estimates for all Minor Projects obtained from District Staff)					
	General Maintenance - Electrical	20	yrs	$20,000	$400,000	
	SCADA Support	20	yrs	$5,000	$100,000	
	Phase 1 - Upgrade to Public Works Office, Camp Rd				$83,000	
	Kalamalka Lake Pump Station Raw water line, SCADA, Turbidity				$65,000	
	OK Lake Pump Station SCADA, Pump Starters, etc				$53,000	
	PR#24 Booster Pump Station SCADA Install				$7,000	
	Watershed Protection				$15,000	
	Dam Safety Manuals				$25,000	
	Service Truck				$100,000	
	Kalamalka Lake Reservoir Drain Pipe & Fencing				$10,000	
	Eldorado Chlorination & Hydro Generation Facility SCADA, Electrical, Landscaping				$20,000	
	OK Lake Pump Station SCADA HMI				$4,000	
	Jardines Rd Pump Station Improvements				$21,000	
	Lower Lakes Booster Pump Stn Improvements				$3,500	
	Kalamalka Lake Booster Pump Stn #1 - Rebuild				$100,000	
	Kalamalka Lake Booster Pump Stn #2- Rebuild				$155,000	
	Kalamalka Lake Pump Station - Rehab/Replace				$150,000	
	Kalamalka Lake Booster Pump Stn #2 Install SCADA				$10,000	
	Talbot Rd Pump Station New above ground				$40,000	
	Eldorado Chlorination & Hydro Generation Facility Recondition Valves				$19,000	
	Kalamalka Lake Pump Station Genset				$75,000	
	Eldorado Chlorination & Hydro Generation Facility Valve on Turbine feed line				$50,000	
	Misc Small Projects				$144,500	
					Total Project Cost for Minor Projects < $200,000	**$1,650,000**
6.2	***Development & Administration***					
	Includes updating schedule, implementation plan and budgeting	20	yrs	$30,000	$600,000	
					Total Project Cost for Development & Administration	**$600,000**
TOTAL COST FOR MINOR PROJECTS & ADMINISTRATION						**$2,250,000**
TOTAL CAPITAL COST BUDGET TO 2030						**$79,000,000**

appendix f

FINANCIAL PLAN

District of Lake Country

LAKE COUNTRY
Life. The Okanagan Way.

Water Master Plan Financial Strategy






Updated

1577.0048.01

October, 2012

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

The District of Lake Country is responsible for operating and maintaining a wide variety of infrastructure that is vital to the well-being of residents and businesses in the community. The District's water infrastructure includes two systems:

- Lake Country Water System – which includes the former Oyama, Wood Lake, Ponderosa and Winfield-Okanagan Centre Water Systems, and
- Coral Beach Water System.

This report describes the District's Financial Strategy for the Lake Country Water System in support of the Water Master Plan. The Coral Beach Water System, which services a portion of Carr's Landing, has not been included in this Strategy. An Asset Management Funding Plan (AMFP) model was created to help understand the annual cash flow and long term implications of upcoming capital and operational works on the long term financial sustainability of the water system.

This Financial Strategy for the water system is the first stage of an AMFP which will ultimately include all of the District's infrastructure assets. The Financial Strategy builds on work previously completed by the District including the Integrated Asset Management Capital Plan (IAMCP) in 2010 and Water System Master Plan in 2011; it is also aligned with the infrastructure goals in Lake Country's Official Community Plan (2010).

The results were presented to the Water Services Advisory Committee on May 27, 2011 and to Council on June 14, 2011. There was strong support to move forward with implementation. The District has begun its communications program, and is currently implementing the water master plan.

The Financial Strategy for the Lake Country Water System was completed in June, 2011 based on the chosen capital program from the Water Master Plan. It included an initial scenario using baseline inputs and assumptions, and two alternate scenarios based on a sensitivity analysis of growth, grants, and rate revenue. Further scenarios were considered following completion of the Financial Strategy and a preferred financing option has been selected. The Financial Strategy has been updated below to include the District's preferred financing option, recognizing that some additional updates to water projects have also been necessary as implementation occurs.

Lake Country is moving towards sustainable financing of its water infrastructure. A short term ramp-up of average user rates will allow for revenue stabilization over the 20 year planning horizon.

The following average user rate changes are recommended according to the results of the model:

- Non-Agricultural – from $486 per connection (single family equivalent) in 2011 to $730 in 2016 (5 year phase in)
- Agricultural – from $77/acre in 2011 to $120 in 2021 (10 year phase in)

The model analysis was completed using a constant dollar analysis. As such, these average user rate changes do not include inflation which should be applied on an annual basis according to current market conditions.

1.0 BACKGROUND

1.1 Water System Context

The District of Lake Country is responsible for operating and maintaining a wide variety of infrastructure, including two water systems:

- Lake Country Water System – which includes the former Oyama, Wood Lake, Ponderosa and Winfield-Okanagan Centre Water Systems, and
- Coral Beach Water System.

The focus of this Financial Strategy is on the Lake Country Water System. The Coral Beach Water System, which services a portion of Carr's Landing, has not been included in this Strategy.

Lake Country's water infrastructure is vital to the well-being of residents and businesses in the community. These systems currently serve over 3,845 connections (residential homes, industry and businesses), and over 3,875 acres of agriculture. Major infrastructure includes six storage dams, six chlorinators, seven reservoirs, eight pumphouses, 34 pressure-reducing stations, and over 125 km of mainlines.

1.2 IAMCP

The District completed a long term Integrated Asset Management Capital Plan (IAMCP) in 2010. It gave community decision-makers the information needed to better understand the level of expenditure required to maintain Lake Country's infrastructure at a sustainable level. The IAMCP is a high-level 20 year forecast of the expenditures required for the District's linear asset infrastructure in order to maintain adequate and sustainable levels of service, condition and risk. This document helped guide decisions around renewal.

1.3 Process

This project builds on the outcomes of the IAMCP and the Water System Master Plan. The purpose is to develop an Asset Management Funding Plan (AMFP) for the District of Lake Country's infrastructure assets. The initial focus is water system infrastructure, with a key component being developing a long-term business plan and communication with stakeholders and the public.

The District of Lake Country is working towards being one of British Columbia's leaders in sustainable practices and a role model for communities throughout the Okanagan. The AMFP is aligned with the infrastructure goals in Lake Country's Official Community Plan (2010):

- **Expand and improve public infrastructure.**
- **Provide reliable water and sewer services in an efficient and economically feasible manner.**

- Provide solid waste management services in an efficient and sustainable fashion.

An AMFP model was created to help understand the annual cash flow and long term implications of upcoming capital and operational works on the long term financial sustainability of the water system. The model was developed by Urban Systems Ltd. in consultation with District Staff.

The results were presented to the Water Services Advisory Committee on May 27, 2011 and to Council on June 14, 2011. There was strong support to move forward with implementation. The Financial Strategy for the Lake Country Water System was completed in June, 2011.

The District has begun its communications program (which is described in more detail in Section 4), and is currently implementing the water master plan. Further scenarios were considered following completion of the Financial Strategy and a preferred option has been selected. This Financial Strategy has been adjusted to include the most up-to-date list of water capital projects, which is aligned with the District's Water Master Plan, and include the District's preferred option for financing.

2.0 CAPITAL PROJECTS

2.1 20 Year Summary

The District completed a Water System Master Plan in 2011 which has been adjusted as the early stages of implementation occur. The 20 Year Capital Projects Summary on the next page illustrates the projects that the District of Lake Country will be undertaking to implement this updated Master Plan. It provides the major project items and where they are located, when they are scheduled to happen in sequence and estimated capital costs.

The Master Plan encompasses a wide range of water system facets, including conservation, treatment, storage, distribution, hydraulic controls, and ongoing minor capital works. It is based on achieving improvements to water quality in accordance with provincial drinking water regulations, as fast as budgetary constraints allow.

The Plan does include approximately $17 million of capital projects that will also result in renewal of existing infrastructure based on balancing the risks associated with infrastructure failure over the next 20 years with the ability of the District to raise rates to fund this renewal.

District of Lake Country - Water System Master Plan
20 Year Capital Projects Summary

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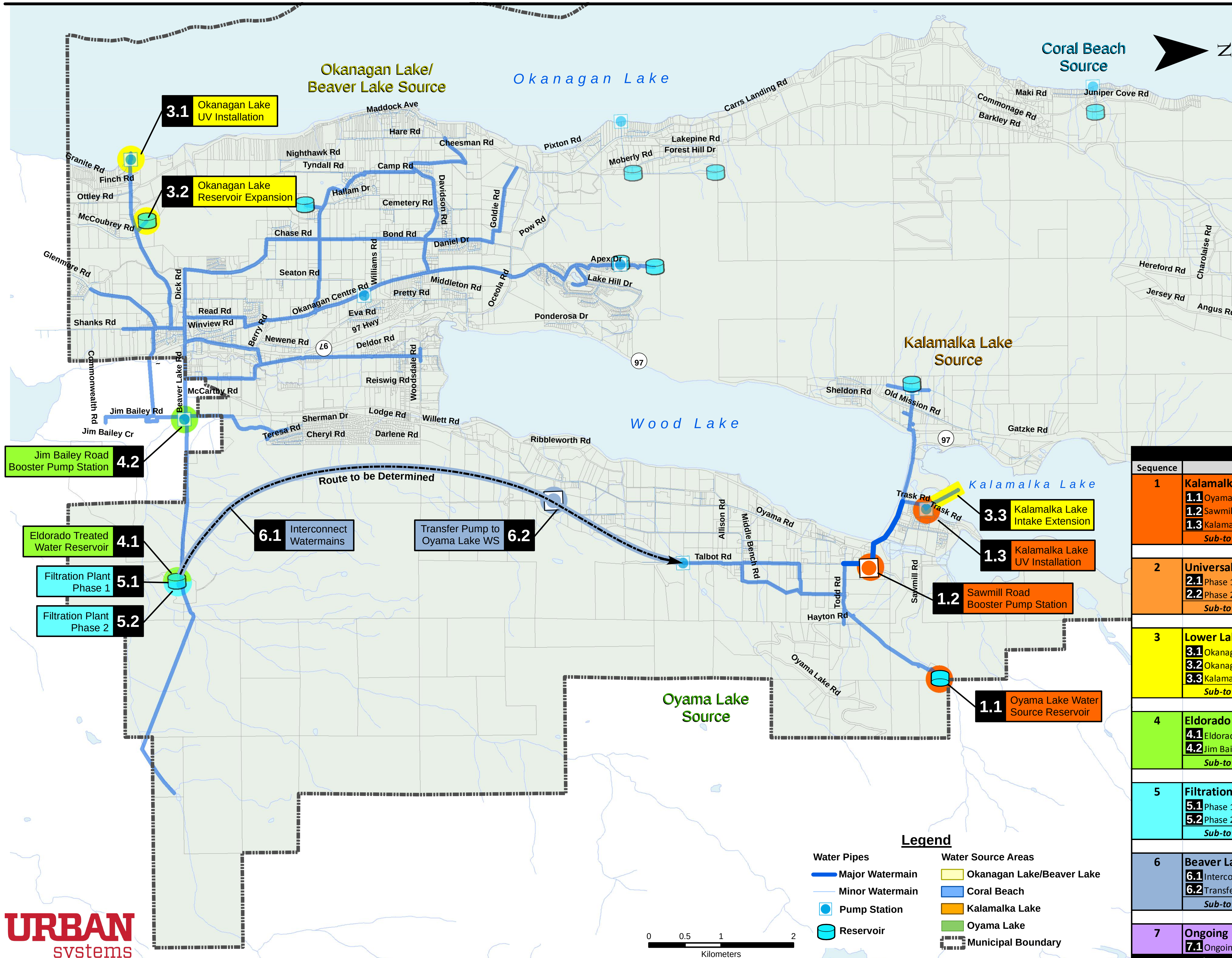

Project Type Summary	
Type	**Cost**
Water Conservation Program	
2.1 niversal Metering - Phase 1	$1,000,000
2.2 niversal Metering - Phase 2	$3,000,000
Sub-total	**$4,000,000**
Water Treatment Facilities	
1.3 alamalka Lake UV Installation	$1,070,000
3.1 kanagan Lake UV Installation	$2,060,000
5.1 iltration Plant @ Eldorado Reservoir Site - Phase 1	$24,000,000
5.2 iltration Plant @ Eldorado Reservoir Site - Phase 2	$10,000,000
Sub-total	**$37,130,000**
Water Storage	
1.1 yama Lake Reservoir	$3,010,000
3.2 kanagan Lake Reservoir Expansion	$1,600,000
4.1 ldorado Treated Water Reservoir	$3,700,000
Sub-total	**$8,310,000**
Pipelines	
7.1 Vatermains - Upgrade & Replacement	$13,600,000
6.1 eaver Lake/Oyama Lake Water System Interconnect	$8,000,000
Sub-total	**$21,600,000**
Hydraulic Control Facilities	
7.1 Miscellaneous PR Station Rebuilds & Upgrades	$1,690,000
3.3 alamalka Lake Intake Extension	$1,000,000
1.2 awmill Road Booster Pump Station	$880,000
4.2 im Bailey Road Booster Pump Station	$900,000
6.2 ransfer Pump Station to Oyama Lake WS	$1,700,000
Sub-total	**$6,170,000**
Minor Projects & Engineering	
7.1 Minor Project Listing < $200,000	$1,650,000
7.1 ngineering, Development & Adminstration	$600,000
Sub-total	**$2,250,000**
Total Water System Projects (2011 to 2030)	**$79,460,000**

Project Sequencing Summary				
Sequence	**Title**	**Project Type**	**Year**	**Cost**
1	**Kalamalka Lake Interconnect**			
	1.1 Oyama Lake Reservoir	Water Storage	2012	$3,010,000
	1.2 Sawmill Road Booster Pump Station	Hydraulic Control Facilities	2012	$880,000
	1.3 Kalamalka Lake UV Installation	Water Treatment Facilities	2012	$1,070,000
	Sub-total			**$4,960,000**
2	**Universal Metering**			
	2.1 Phase 1	Water Conservation Program	2014	$1,000,000
	2.2 Phase 2	Water Conservation Program	2015	$3,000,000
	Sub-total			**$4,000,000**
3	**Lower Lakes Water Quality Improvements**			
	3.1 Okanagan Lake UV Installation	Water Treatment Facilities	2015	$2,060,000
	3.2 Okanagan Lake Reservoir Expansion	Water Storage	2015	$1,600,000
	3.3 Kalamalka Lake Intake Extension	Hydraulic Control Facilities	2015	$1,000,000
	Sub-total			**$4,660,000**
4	**Eldorado Treated Water Reservoir**			
	4.1 Eldorado Treated Water Reservoir	Water Storage	2017	$3,700,000
	4.2 Jim Bailey Road Booster Pump Station	Hydraulic Control Facilities	2017	$900,000
	Sub-total			**$4,600,000**
5	**Filtration Plant @ Eldorado Reservoir Site**			
	5.1 Phase 1	Water Treatment Facilities	2021	$24,000,000
	5.2 Phase 2	Water Treatment Facilities	2030	$10,000,000
	Sub-total			**$34,000,000**
6	**Beaver Lake/Oyama Lake Water System**			
	6.1 Interconnect Watermains	Pipelines	2027	$8,000,000
	6.2 Transfer Pump Station to Oyama Lake WS	Hydraulic Control Facilities	2027	$1,700,000
	Sub-total			**$9,700,000**
7	**Ongoing**			
	7.1 Ongoing Annual Work ($0.88M per year)			$17,540,000
	Total Water System Projects (2011 to 2030)			**$79,460,000**

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3.0 FINANCIAL PLAN

3.1 Analysis

A detailed, interactive financial model was created to help understand the annual cash flow and long term implications of the Water Master Plan on the long term financial sustainability of the water system. The analysis of the water system is based on the project costs and timing presented in the Water Master Plan. The financial model uses a constant dollar analysis (in 2011 dollars).

An initial scenario was created using baseline inputs and assumptions. The Consultants worked closely with staff in determining the model inputs and assumptions. Additional scenarios were considered based on a sensitivity analysis of the following:

- Growth – percentage of growth within the water service area over the next 20 years
- Grants – assumed senior government grant funding for each project
- Rate Revenue – amount and timing of rate changes to achieve rate stability over time

It is important to note that this model is intended to help staff, Council, and the public develop a better understanding of the financial implications associated with their water system. The model is not intended for detailed budgeting purposes.

3.2 Model Inputs

The following inputs were used to create the financial model, in addition to the Capital Projects (Section 2):

- Connections: 3,845 units - residential + ICI (industrial, commercial, institutional)
- Agricultural Area: 3,875 acres
- Operations Budget: $1,660,000 (increasing to $2.2 million annually upon commissioning of the water treatment plant)
- Reserves (Dec. 2010):
  - Water Capital Works: $413,428
  - Water Accumulated Surplus: $484,607
  - Water DCCs: $204,090
- Confirmed Grant (2012): Kalamalka Lake Interconnect at 2/3rds of $4,500,000 (i.e. $3 million)
- Current Average Rate Revenue (2011)
  - Non-Agricultural: $486 per connection

- Agricultural: $77 per acre

- Current DCCs (Development Cost Charges)/CECs (Capital Expenditure Charges) (2011)
  - Non-Agricultural: $3,857 per connection
  - Agricultural: $4,000 per acre

3.3 Assumptions

The following baseline assumptions were used in the financial model:

- Growth
  - Non-Agricultural: 3% (3100 units in 20 years) within water service area (2.7% over entire District)
  - Agricultural:100 hectares, or 247 acres in 20 years (12.35 acres/year)
- Grants
  - Water Treatment Facilities: 50% (sequence 4)
  - Other Improvements: 33% (sequence 3, 5, 6)
- Rate Revenue
  - Non-Agricultural: 2 year ramp up to $700 per connection ($600 in 2012, $700 in 2013 …)
  - Agricultural: $4 increase annually over 10 years to $120 per acre
- DCCs/CECs
  - Non-Agricultural: increase to $4,835 in 2013 (USL calculation)
  - Agricultural: increase to $6,100 in 2013 (Mould Engineering calculation)
- Maximum Borrowing Limit: $7,500,000
- Borrowing Term: 20 years
- Reserves
  - DCCs can borrow from non-DCC reserves
- Interest
  - On invested funds: 1.5%
  - On debt: 4.73%

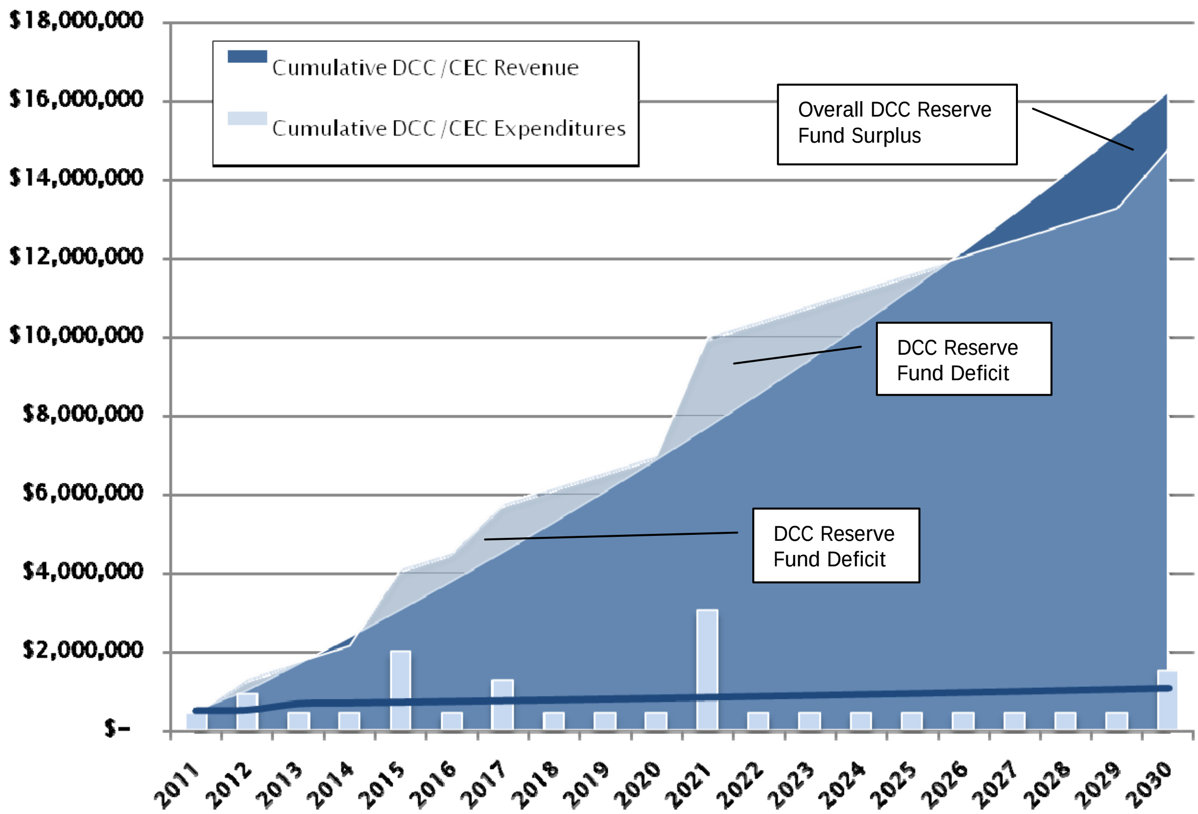
3.4 Model Outputs

The base model identified a positive balance between revenues and expenditures over 20 years (in 2011 dollars). There were cash flow challenges with DCC funds which was addressed by borrowing internally, and where necessary borrowing externally. Borrowing was needed in 2012, 2015, and 2021. Reserves were used to level out expenditure peaks. The minimum average non-agricultural rate needed is $700 per connection by 2013.

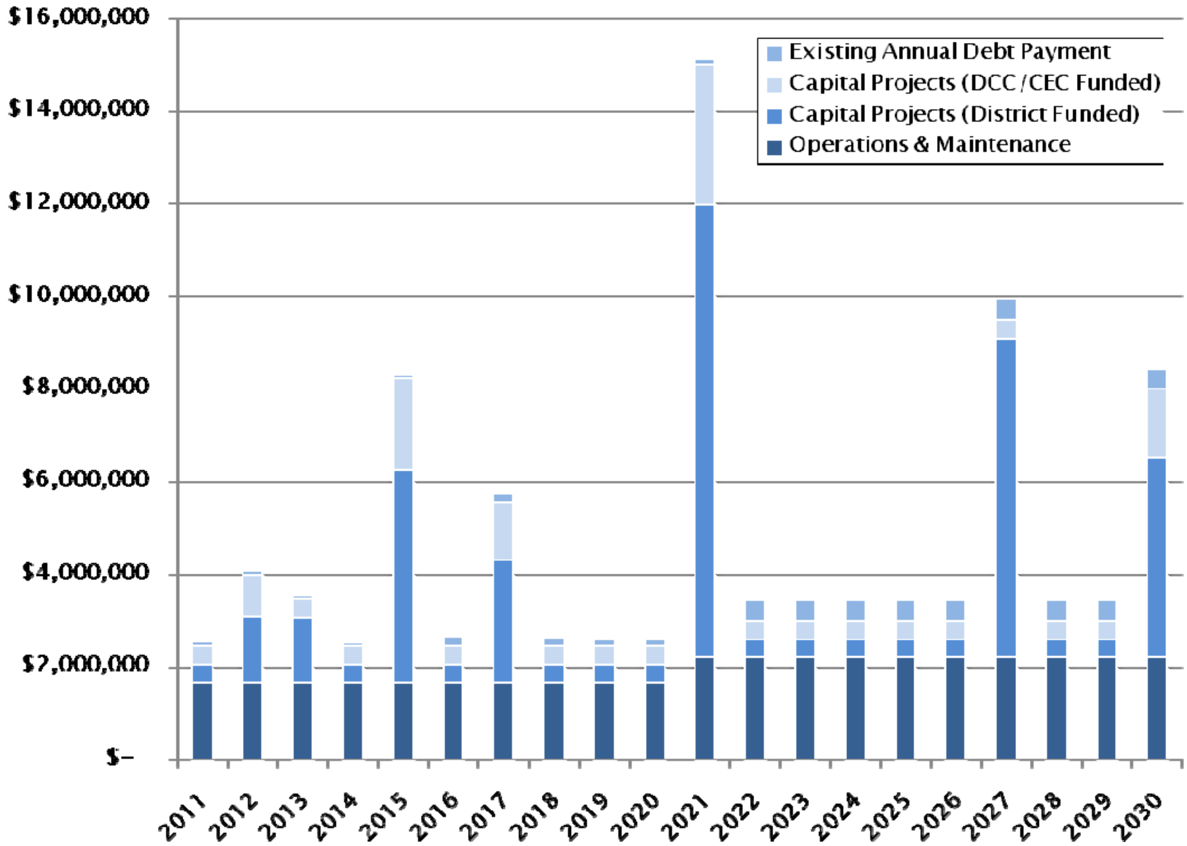
20 Year Revenue	$125 Million
20 Year Expenditures	$124 Million
Safety Factor	0.7%

End of 20 Year Reserves	$9 Million
Outstanding Debt	$3.5 Million

The DCC portion of the cumulative revenues and expenditures is illustrated in the figure below to illustrate cash flow challenges and the resulting positive revenue as the end of the 20 year period is reached.



The graph on the next page illustrates the annual expenditures as they relate to existing debt, capital projects (district and DCC/CEC funded), and operations & maintenance (according to the base model, prior to 2012 updates). There are a variety of peaks, most prominently in 2021 when the first phase of the Water Treatment Filtration Plant is constructed.



3.5 Sensitivity Scenarios

The Financial Model allows for a number of sensitivity scenarios to be run, to determine the potential impact on the Water Master Plan.

In the **high growth sensitivity scenario** 3,900 new units were assumed over the next 20 years, which represents a 3.6% growth rate in the water service area. The DCC assumptions remain unchanged ($3,857), however the agricultural CEC assumption is an increase from $4,000 to $6,100 (aligned with the base scenario). The result of the high growth scenario is a positive balance over 20 years (in 2011 dollars). There is the possibility of moving the first phase of the Filtration Plant ahead by one year (i.e. to 2020) if this level of growth occurs and is sustained over the planning horizon.

20 Year Revenue	$130 Million
20 Year Expenditures	$123 Million
Safety Factor	5.6%

End of 20 Year Reserves	$14 Million
Outstanding Debt	$2.5 Million

In the **no grants sensitivity scenario** the same inputs were used as in the baseline scenario. The only grant included was for approved projects (i.e. Kalamalka Lake Interconnect in 2012). The DCC assumption is an increase from $3,857 to $6,630, with the agricultural CEC increasing from $4,000 to $6,100 (aligned with the base scenario). The result of the no grants sensitivity scenario is that the model does not balance over 20 years (in 2011 dollars). The borrowing capacity is exceeded from 2021 and onward, meaning that most of the capital projects would have to be delayed.

20 Year Revenue	$106 Million
20 Year Expenditures	$137 Million
Safety Factor	-30%

Two additional sensitivity scenarios were considered beyond the initial study to determine alternate potential impacts:

1) Ramp up non-agricultural rate revenue over 5 years (compared to 2 years in the base model), while maintaining the same capital program, and adjust non-agricultural rate revenue as necessary
2) Ramp up non-agricultural rate revenue over 5 years to a maximum of $700 (compared to 2 years in the base model), and adjust the capital program as necessary.

In the **first additional sensitivity scenario,** a non-agricultural rate increase of approximately $50 per year is needed over the 5 year period (2012-2016), resulting in non-agricultural rate of $725. The safety factor is very minimal. More borrowing is necessary to manage cash flows.

20 Year Revenue	$125.5 Million
20 Year Expenditures	$125.4 Million
Safety Factor	0.08%

End of 20 Year Reserves	$9.6 Million
Outstanding Debt	$3.9 Million

In the **second additional sensitivity scenario,** the capital program needs to be adjusted such that Phase 1 of the Filtration Plant at Eldorado Reservoir Site is constructed in 2023 (compared to 2021 in the base scenario). The non-agricultural rate would increase over a 5 year period (2012-2016), resulting in non-agricultural rate of $700. More borrowing is necessary to manage cash flows.

20 Year Revenue	$123.3 Million
20 Year Expenditures	$122.5 Million
Safety Factor	0.65%

End of 20 Year Reserves	$6.6 Million
Outstanding Debt	$1.0 Million

3.6 Preferred Option

After considering the implications of various sensitivity analyses on the approach set out in the water master plan, a preferred option was selected. This preferred option includes adjustments to water project timing and costing based on updated information since the original Financial Strategy was completed.

In the **preferred scenario,** a non-agricultural rate increase of approximately $50 per year is needed over the 5 year period (2012-2016), resulting in non-agricultural rate of $730. Borrowing is necessary to manage cash flows, in particular in 2015 and 2021 where major capital expenditures are planned and accumulated reserves are insufficient.

20 Year Revenue	$126.5 Million
20 Year Expenditures	$125.7 Million
Safety Factor	0.63%
End of 20 Year Reserves	$10.1 Million
Outstanding Debt	$3.7 Million

3.7 Risk

The risks inherent in this financial plan for the water system fall into five main categories. The first is related to **climate change** and whether sufficient water supplies will be available in the future. The second is maintaining **filtration deferral**. The third is achieving the **assumed growth rate** and the fourth is whether **grant funding** will be made available as assumed. The final risk is whether the **investment level in infrastructure renewal is sufficient** to sustain the level of service objectives of the District over the long term. The District has assessed these risks and will monitor them with the intention of adjusting the plan further when or if it becomes necessary.

The model shows that the District has applied a realistic, yet conservative assumption for grants to fund overall water service delivery responsibilities. A 50% assistance is assumed for future water treatment and 33% for the majority of other water improvements, with the exception of the universal metering ($4,000,000) and ongoing replacement works ($17,540,000) for which no grants are anticipated.

3.8 Water Rate Analysis to Advance Water Treatment

The District completed a water rate sensitivity analysis to determine the average rate revenue needed to achieve compliance (i.e. 4-3-2-1-0) with Interior Health Authority requirements by 2015, instead of 2021.

	Average Non-Agricultural Rate	Percentage Increase in Rate
Current (2011)	$486	--
Proposed (2021)	$730	50%
IHA Mandate (2015)	$1,900	291%

Water rates would have to increase to $1,900 on average per connection to construct phase 1 of the Filtration Plant by 2015. Staff committed to a rate of $700, which is almost a 50% increase from current rates, and has since recognized that a rate increase to $730 (plus applicable inflationary factors) is needed to achieve desired outcomes. Raising rates higher than that is unlikely to be supported by the community.

4.0 SUMMARY

Lake Country is moving towards sustainable financing of its water infrastructure. A short term ramp-up of average user rates will allow for revenue stabilization (in 2011 dollars) over the 20 year planning horizon.

The following average user rate changes are recommended according to the results of the model:

- Non-Agricultural – from $486 per connection (single family equivalent) to $535 in 2012 and $730 in 2016
- Agricultural – from $77/acre to $120 per acre, with a 10 year phase in period (2021)

The model analysis was completed using a constant dollar analysis. As such, these average user rate changes do not include inflation which should be applied on an annual basis according to current market conditions.

The Financial Strategy and planned rate adjustments represent a balance approach, taking into consideration growth, grants, and affordable user rates. Even with significant senior government grant funding to help achieve water filtration objectives by 2015, as suggested by Interior Health, it is very unlikely that rates would be affordable to residents or businesses in Lake Country.

Attachment F – 2022 Okanagan Lake Sole Source Analysis

January 27, 2022 File: 1577.0104.01

District of Lake Country
10150 Bottom Lake Road
Lake Country, BC V4V 2M1

Attention: **Kiel Wilkie, AScT**

RE: Okanagan Lake Supply Expansion R2

As communicated, the District has asked for the analysis of an alternative servicing concept based on removing dependence on the Swalwell Lake source and instead feeding those demands from an expanded license from Okanagan Lake (assuming such a license can be secured). It is envisioned that this supply concept will include:

- A new intake, chlorination facility, and pump station to convey Okanagan Lake Water to the Eldorado Reservoir site (assumed in close proximity to the existing facility)
- A new UV disinfection at the Eldorado Reservoir site prior to discharge into the treated water storage
- A new ~6.0 km dedicated main to the Eldorado Reservoir

Below is a summary of the annual water demands and Water Licenses:

Swalwell Lake Licenses -Agriculture -Waterworks **-Total**	 7,459 ML/year 1,204 ML/year **8,663 ML/year**
Okanagan Lake Licenses -Agriculture -Waterworks **-Total**	 0 ML/year 10,997 ML/year **10,997 ML/year**
Okanagan Demands -Existing Demands (Ag) - Existing Demands (Waterworks) - Non Revenue Water -Demand Growth (Ag) - Demand Growth (Waterworks) - Demand Growth (Kelowna Supply – Waterworks) -**Total Demands**	 98 ML/year 1,429 ML/year 768 ML/year 0 ML/year 634 ML/year 1420 ML/year **4,348 ML/year**
Swalwell Lake Demands -Existing Demands (Ag) - Existing Demands (Waterworks) - Non Revenue Water -Demand Growth (Ag) - Demand Growth (Waterworks) -**Total Demands**	 1,854 ML/year 733 ML/year 256 ML/year 596 ML/year 963 ML/year **4,402 ML/year**

As illustrated if all demands were to be shifted to Okanagan Lake there will be a surplus Waterworks license and a deficiency of Agriculture Water license.

In order to convey all of current demands met by Swalwell Lake, the Okanagan Lake system will need to be expanded by 50 ML/day. Note that 50 ML/day represents the (existing and growth allowance) maximum day demand scenario for the customers supplied from Swalwell Lake and is not based on the annual average demands presented in the table above. This capacity assumes that the Glenmore Interconnect pump station that conveys water from the existing Okanagan Lake fed system to the Swalwell Lake System remains for emergency use only.

The estimated capital cost for the improvements needed to convey this flow from Okanagan Lake is $44,230,000 including a 25% allowance for contingency and 10-15% for engineering but excluding, borrowing or land acquisition costs. This is broken down in the table below and the pumping and pipeline costs are based on the unit rates in the Water Master Plan.

Cost Estimate	**Quantity**	**Unit**	**Unit Rate**	**Extension**
Intake	1	LS	$ 3,000,000	$ 3,000,000
Pump Station	3970	HP	$ 5,180	$ 20,550,000
Pipeline (600mm)	6000	m	$ 1,780	$ 10,680,000
UV (50 ML/day)	1	LS	$ 10,000,000	$ 10,000,000
			Total	**$ 44,230,000**

As a comparison the capital cost for the Swalwell Lake source WTP is $47,600,000. On an operating cost basis the pumping and UV electricity cost from Okanagan Lake is estimated at $0.4 Million per year in the first year and increasing to $0.55 Million per year by year 20 (based on $0.10/kWh) while the operating cost for the WTP is estimated at $0.55 Million in the initial year and rising to $0.86 Million by year 20 based on an assumed average cost of $0.20/m^3$ (based on Peachland's operating costs). The 20 year capital plus operating costs assuming a 0% discount rate (inflation=interest) is $62 Million for the Swalwell WTP and $54 Million (plus land acquisition) for the expanded Okanagan Lake Supply.

The cost for the Okanagan Lake supply assumes filtration exemption is maintained. In the event that filtration is needed on Okanagan Lake then a filtration plant cost will need to be added.

A multiple account evaluation of the two source options is outlined below:

	Swalwell WTP	**Okanagan Lake Source Expansion**
Regulatory Risks	Filtration exemption not available No license conversion required	Expanded reliance on filtration exemption License conversion required for agriculture use

	Swalwell WTP	**Okanagan Lake Source Expansion**
	Risk of impacts to DFO/MoE orders for Lower Vernon Creek base flows	Eliminates supply risks with upper watershed
Source Redundancy	Two separate sources maintained	One source is lost
Water Quality Risks	Risks impacted by upland watershed but filtration barrier provided	Risks impacted by Okanagan Lake watershed and no filtration barrier provided. Filtration may be required at a later date.
Operational Level of Complexity	Higher	Lower
Capital Cost	$47.6 Million	$44.3 Million + Land Acquisition
20 Year Total Capital + Operating	$62 Million	$54 Million + Land Acquisition

As illustrated the costs of both options are within the same order of magnitude and provide a different risk profile for each. The largest risk with increased reliance on Okanagan Lake is the ability to maintain a filtration exemption otherwise the treatment costs will also be required for this supply option. The largest risk for the Swalwell Lake Supply is the Lower Vernon Creek environmental flow needs and the potential risks associated with land slides, wild fires and climate change in the watershed.

Sincerely,

URBAN SYSTEMS LTD.

Steve Brubacher, P.Eng.
Principal
U:\Projects_KEL\1577\0104\01\A-Administration\Work Plan\2021-11-26 OK Lake Expansion Scope R1.docx

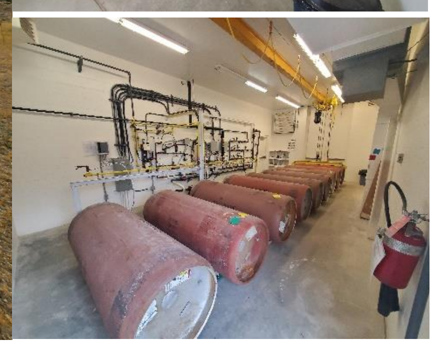
Attachment G – Beaver Lake Water Treatment Plant Feasibility Study

DISTRICT OF LAKE COUNTRY
REPORT NUMBER: 211-07826-00

BEAVER LAKE WATER TREATMENT PLANT FEASIBILITY STUDY

JUNE 27, 2022





BEAVER LAKE WATER TREATMENT PLANT FEASIBILITY STUDY

DISTRICT OF LAKE COUNTRY

DRAFT
CONFIDENTIAL

PROJECT NO.: 211-07826-00
DATE: JUNE 27, 2022

WSP
LANDMARK 6, SUITE 700
1631 DICKSON AVENUE
KELOWNA, BC V1Y 0B5

T: +1 250-980-5500
WSP.COM

June 27, 2022

District of Lake Country
10150 Bottom Wood Lake Rd,
Lake Country, BC V4V 2M1

Attention: Kiel Wilkie, Project Manager

Dear Sir:

Subject: Beaver Lake Water Treatment Plant Feasibility Study (DRAFT)

WSP is pleased to submit the draft report outlining the results our feasibility analysis to provide treatment on the Beaver Lake system. This document includes the review of the existing water system infrastructure, analysis of historical water quality and demand data, evaluation of treatment technologies and development of the feasibility level process train along with capital and operational costing data.

If you have any questions on the recommendations in the report, please contact the undersigned. Thank you for the opportunity to assist the District with its water treatment upgrade needs. Yours sincerely,

Kris Koenig, P.Eng., PMP
Manager, Land Development
and Municipal Engineering

WSP ref.:

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Kelowna, BC V1Y 0B5
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Tori Heckart, EIT
Project Engineer

Date

APPROVED BY

2022-06-29

Trevor Dykstra, B.Eng, PE, P.eng, PMP
Director, Water & Wastewater

Date

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Mechanical Designer	Jose Jabla, AScT

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

1.1 BACKGROUND INFORMATION

The District of Lake Country (The District) currently supplies water to residents, agriculture, and businesses located within the District through a series of water systems. These District owned water systems provide water from one of four sources: Beaver Lake, Oyama Lake, Kalamalka Lake, and directly from Okanagan Lake. The District's upland sources, Beaver and Oyama Lakes, capture freshet runoff which is then used for both community water supply and environmental flows. This report will focus on the Beaver Lake system.

The Beaver Lake system has been a water source for the District for over 100 years, serving residential, commercial, and agricultural customers. The District stores water in Beaver Lake during the fall to spring months and releases water during the summer. The Beaver Lake system has a rated capacity of 750 L/s, based on the low lift pumping capacity at the Eldorado site. Primary components of the Beaver Lake system include:

- **Vernon Creek Intake** – Raw water intake building with mesh screens located at an approximate elevation of 820 m.
- **Eldorado Reservoir Site and Hydroelectric Generation Site** – Raw water flows to the facility by gravity from the Vernon Creek intake via a 6 km raw water transmission main. A hydroelectricity plant (a pass-through process) recovers energy from the raw water as it fills a 30,000 m^3 open raw water reservoir. The raw water is pumped from the open reservoir to a 6,000 m^3 treated water reservoir using a low lift pumping station. The raw water is disinfected with chlorine gas prior to entering the treated water reservoir and then flows by gravity into the distribution system.

The Beaver Lake system water does not currently meet provincial and federal drinking water quality guidelines due to the limited treatment and seasonal water quality variations.

The Beaver Lake system is interconnected to the Okanagan Lake system, where water can be supplied from one or both systems, depending on the time of year and the District's maintenance schedule. The Okanagan Lake system is a pumped source and utilizes 12% hypochlorite injection and UV disinfection to provide two stage disinfection. The Okanagan Lake system has a rated capacity of 460 L/s.

During the spring freshet, Beaver Lake water quality degrades rapidly, and the District typically relies on the Okanagan Lake system to supply potable water to both systems. During discrete water quality events, the District is also able to bypass the open reservoir and draw on the 30,000 m^3 of storage until the water quality event has passed. As the District's service population continues to grow, the current operational approach for the Beaver Lake and Okanagan Lake systems will be challenged to meet the total system demands while maintaining potable water quality throughout the network.

The District is therefore looking to advance a feasibility study to establish the scope for providing treatment at the Beaver Lake Source to meet regulatory drinking water standards.

1.2 REPORT OBJECTIVES

The Beaver Lake water system requires additional levels of treatment to meet health guidelines for treatment of surface water and to meet the growing water demands within the District's overall water system. In consultation with the District, four primary objectives were established to inform the development Beaver Lake Water Treatment Plant Feasibility Study. These include:

1. **Meet Regulatory Requirements:** Provide treatment to meet provincial and federal regulatory objectives for treatment of surface water;
2. **Phased Approach to Long Term Treatment Strategy:** Develop a treatment solution capable of meeting the long-term treatment needs while including provision for a phased implementation of infrastructure to meet the

treatment and growth needs of the District's water systems. This includes continuity and integration with the District's overall water supply framework;

3 **Maximize Functional Benefit of Facility:** Provide a facility the centralizes the District's water utility resources and provides opportunities to engage the public and water users; and

4 **Stewardship:** Provide a cost effective and energy efficient design through integration of function, aesthetics, and innovation.

Each of these objectives will be used to inform the sizing, selection, and siting of the proposed water treatment facilities for the Beaver Lake system. Subsequent planning and design development should further refine these objectives to ensure that remain aligned with the District's vision for the project.

1.3 REPORT STRUCTURE

This report documents the feasibility study conducted by WSP to evaluate treatment alternatives for a proposed treatment plant for the Beaver lake water source. The remainder of this report is subdivided into several sections as follows:

— **Section 2 – Existing Infrastructure** presents an overview of the existing water system components, water licenses, water availability, historical system demands, and historical water quality;

— **Section 3 – Design Criteria** assesses future demands on the combined system and outlines treatment objectives based on regulatory requirements;

— **Section 4 – Treatment Options** assesses the filtration and disinfection alternatives for the proposed facility based on the demands and treatment criteria established in previous sections;

— **Section 5 – Treatment Evaluation** summarizes the evaluation of different treatment alternatives and the selection of the proposed treatment process based on non-cost considerations;

— **Section 6 – Proposed Water Treatment Plant** builds upon Section 5 and provides a detailed discussion of the proposed primary and secondary treatment processes, geotechnical considerations, civil design, mechanical design, electrical design, and recommended process instrumentation;

— **Section 7 – Preliminary Cost Estimates** provides a Class D cost estimate for the proposed treatment plant as well as an estimation of annual operating costs for the proposed facility; and

— **Section 8 – Conclusions and Recommendations** provides a final summary of key conclusions from the feasibility study and the recommendations contained herein.

2 EXISTING INFRASTRUCTURE

2.1 LAKE COUNTRY WATER SYSTEM OVERVIEW

The District currently supplies water to most of its residents, agricultural users, and other businesses through a series of watersheds surrounding the District's boundary. All these contributing watersheds ultimately flow to Okanagan Lake, however, before reaching Okanagan Lake a portion of runoff water is diverted and stored in Oyama, Beaver, Crooked-Dee, Kalamalka, Duck, Damer, and Wood Lakes. Four of these lakes, Beaver Lake, Okanagan Lake, Oyama Lake, and Kalamalka Lake, are currently used by the District to supply their water systems. The water is used for consumptive and non consumptive purposes for homes, businesses, and irrigation (agricultural and non-agricultural).

Figure 2-1, which was provided by the DLC and is accessible online through the District's MyWater Map, displays the various water sources within the District and their associated distribution zones.

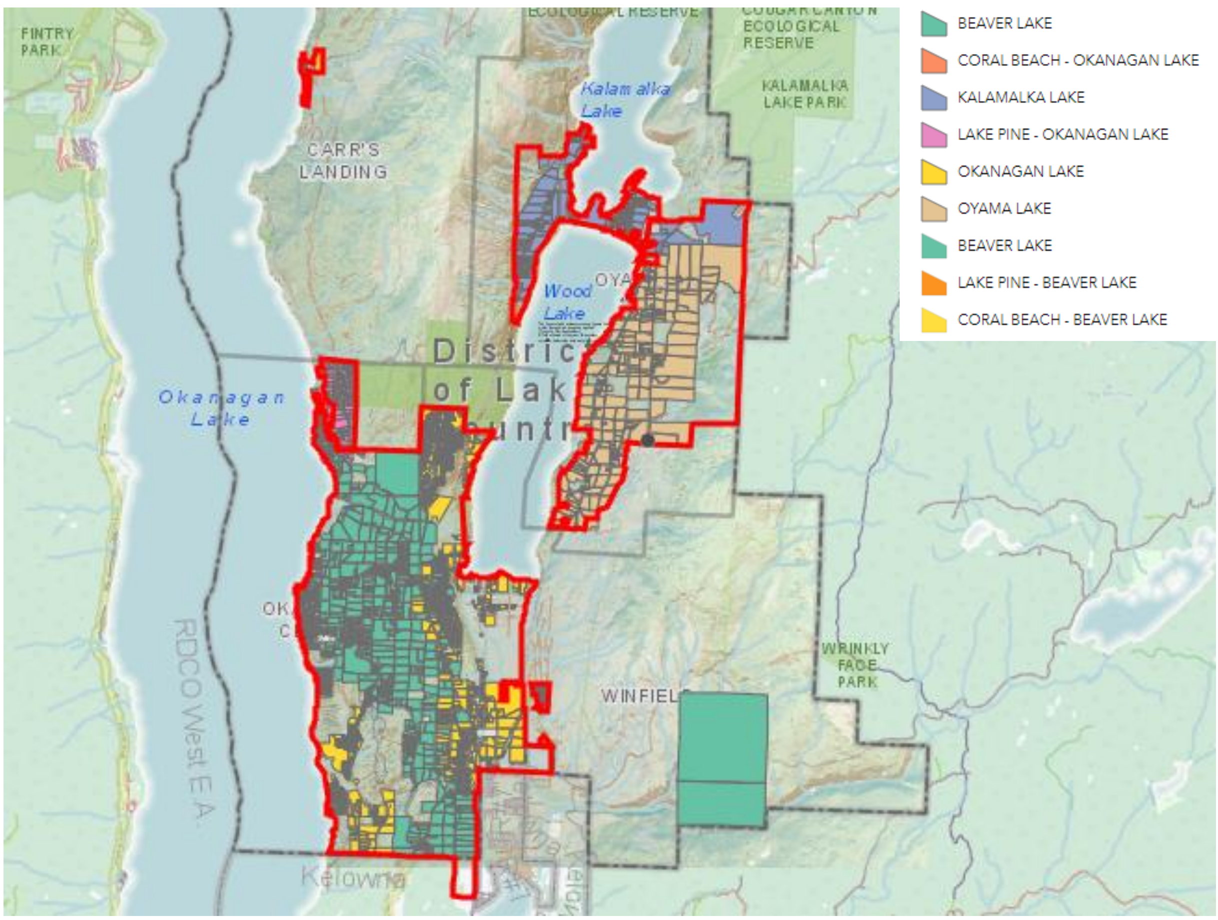


Figure 2-1: Overview of Lake Country Water Sources and Distributions Zones

The combined Beaver Lake water system (teal) and Okanagan Lake water system (yellow) in **Figure 2-1**, are the focus of the remainder of this report.

2.2 EXISTING WATER SUPPLY INFRASTRUCTURE

The Beaver Lake and Okanagan Lake water systems are interconnected at the vicinity of the Glenmore Booster Station, located on Seaton Road near its intersection with Read Road. From the Eldorado Reservoir and hydroelectricity plant site, an 800 mm steel pipe supplies water from the Beaver lake system to its point of interconnection with Okanagan Lake system. This interconnection can supplement the water demands for both the Beaver Lake and Okanagan Lake sources during emergencies. During events of low water quality at Beaver Lake, this interconnection can also be used to service the domestic drinking water demands of the Beaver Lake system with Okanagan Lake source water.

The interconnection between the Beaver Lake source and the Okanagan Lake source, as well as other pertinent pieces of existing infrastructure for these two water systems are shown in **Figure 2-2**.

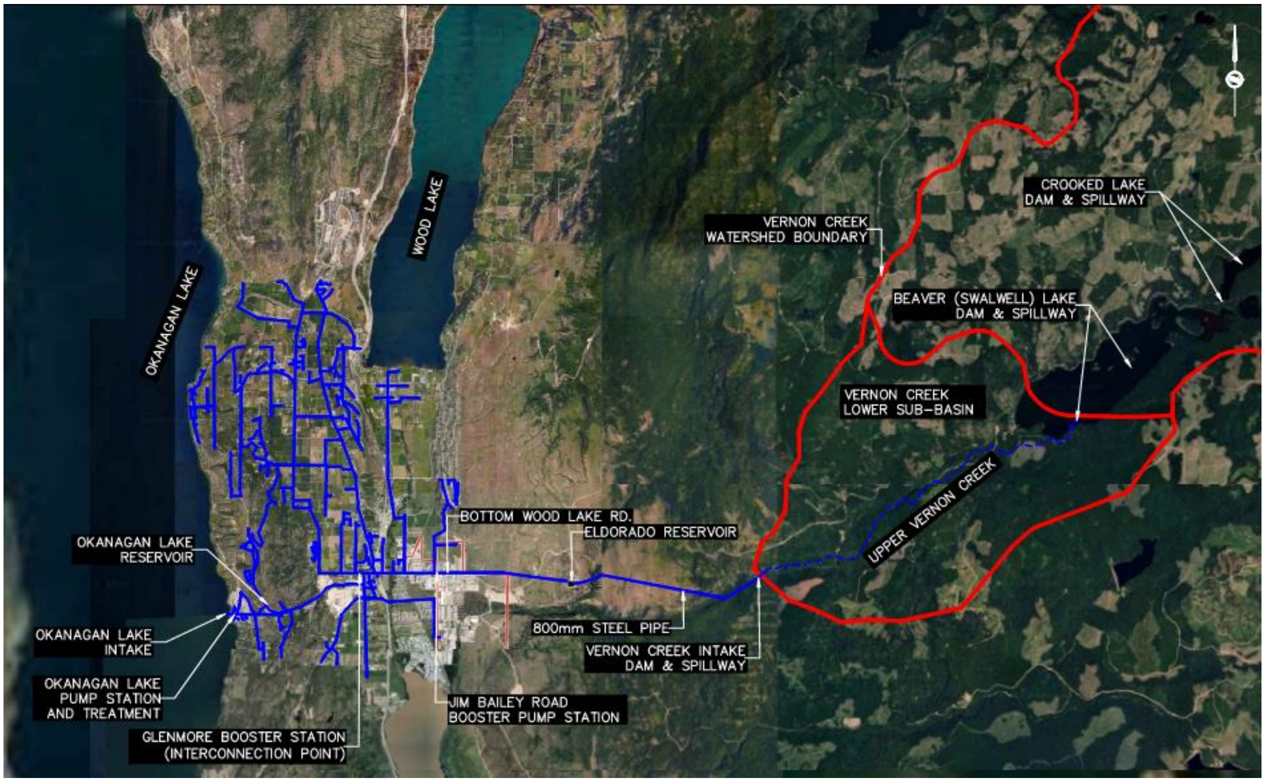


Figure 2-2: Map of Major Infrastructure- Beaver Lake and Okanagan Lake Water Systems

The major components of the Beaver Lake water system include:

- Vernon Creek Intake;
- Eldorado Raw Water Storage Reservoir;
- Eldorado Low Lift Pump Station;
- Eldorado Treated Water Storage Reservoir; and
- Eldorado Chlorination Building.

Figure 2-3 and **Figure 2-4** show the Site Plan and the Process Flow Diagram (PFD) respectively.

Figure 2-3: Eldorado Reservoir and Chlorination Facility Site Plan (Background Image Courtesy of Google)

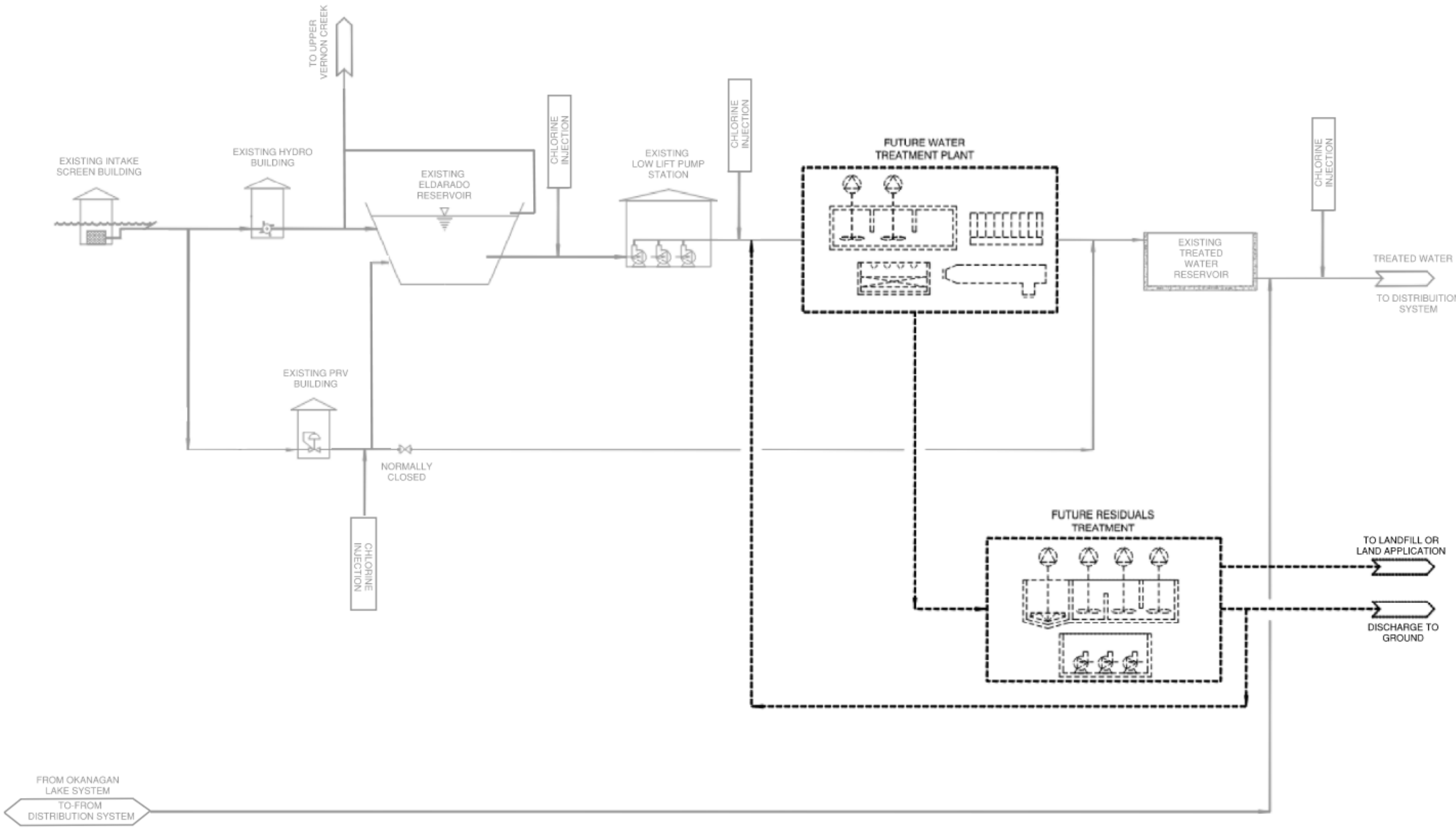


Figure 2-4: Process Flow Diagram- Eldorado Water System Existing Facilities

In the event of an emergency, the District has the ability to supply water from the Vernon Creek intake to the treated water reservoir via the pressure reducing valve (PRV) station in the chemical building. The District can also bypass the low lift pump station and treated water reservoir, providing chlorinated water directly from the raw water reservoir to the distribution system.

2.2.1 VERNON CREEK INTAKE

The current intake structure sits along Upper Vernon Creek and consists of a 22 m^2 concrete block building, which houses the intake works and screens, as well as a solar-powered level indicator for the intake pond. The intake structure consists of No. 30 mesh inclined screens, with a total screening area of 12 m^2. The screening surface is installed approximately 0.6 m below the spillway. After screening, water from the Vernon Creek Intake is conveyed to the Eldorado Reservoir site, where flows enter the raw water pond either through the hydroelectric generation facility or through the PRVs contained in the chemical building via an 800 mm transmission main.

Additional specifications for the existing intake screens are provided in **Table 2-1**.

Table 2-1: Vernon Creek Intake Screens

PARAMETERS	VALUES
Existing Design Flowrate	1,000 L/s
Screen Type	Slanted submerged flat screen
Number of Screens	18 screens- 30 mesh SS flat top cloth c/w 5 mesh 2.6 mm diameter wire SS backing cloth, flat top weave
Screen size and Surface Area	1.4 m (L) x 0.66 m (W), 0.924 m^2
Spillway Elevation	819.24 m

WSP was previously engaged by the District to assess options for upgrading the existing screens to reduce the associated operation and maintenance costs and increase the screening capacity. Refer to the Technical Memorandum (TM) titled ‘Vernon Creek Intake Screen Cleaning Improvement- Evaluation of Selected Options’ published in August 2021.

The TM provided recommendations to replace the existing screening structure and with Coanda Screens, provide onsite standby power to accommodate automated valve operation, and to conduct an environmental scoping study to determine the regulatory requirements necessary to facilitate the proposed works.

Major changes to the existing layout recommended in the TM are shown in **Figure 2-5**.

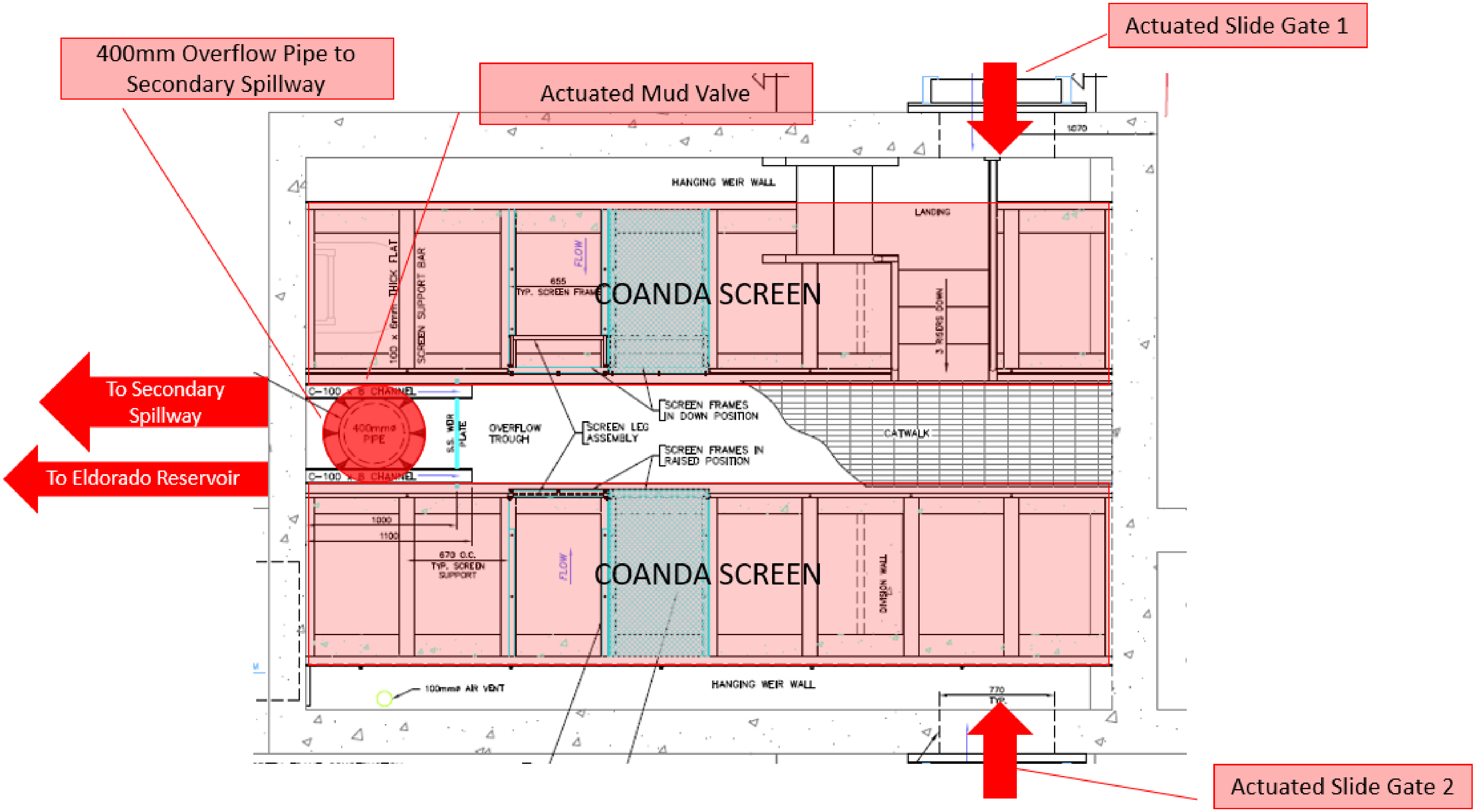


Figure 2-5: Upgrade recommendations to the Vernon Creek Intake Screen (WSP Technical Memorandum, 2021)

2.2.2 ELDORADO RAW WATER RESERVOIR

From either the hydroelectric facility or the PRVs, screened water from the Vernon Creek intake flows into the Eldorado Raw Water Reservoir, an open reservoir with 30,000 m^3 of storage. The reservoir was originally constructed in 2005 and is located at an elevation of 624 m. Since the construction of Eldorado Reservoir, there have been noticeable water quality benefits, specifically related to outlet turbidity values. The storage provided by this reservoir also allows the District to bypass high turbidity events in Vernon Creek.

A summary of the reservoir parameters is detailed in **Table 2-2**.

Table 2-2: Eldorado Raw Water Reservoir

PARAMETER	DESCRIPTION
Size	30,000 m^3
Inlet	750 mm pipe from the Intake mainline takeoff to the Hydroelectric Facility. 1500 mm tailrace channel from Hydrogeneration Station into Reservoir (EL 623.81).
Outlet	750 mm pipe to Low Lift Pump Station.
Overflow	Overflow from the Reservoir is directed back to Upper Vernon Creek
Top Elevation of Berm	624.50 m.
Water Level	Maximum : EL 623.75 m ; Normal : EL 623.3 m ; Minimum : EL 619.0 m.

2.2.3 LOW LIFT PUMP STATION

The low lift pump station was constructed in 2017 and supplies water from the Eldorado Reservoir to the treated water reservoir via a 750 mm pipe. The pump station building is located at the western end of the Eldorado reservoir and consists of a concrete building, with a separate electrical room. The dimensions for the concrete building where the pumps are located are 12.7 m x 8.8 m with a height of 5.2 m.

The low lift pump station consists of 3 identical pump trains, with 2 duty and 1 standby pump. All the pumps are installed with the variable frequency drives (VFDs) and are fed through a common 900 mm manifold. Each pump discharges into a 500 mm pipe which in turn feds into a 750 mm manifold.

Table 2-3 provides details of the pumps located inside the pumpstation building.

Table 2-3: Low Lift Pumps Parameters

PARAMETER	DESCRIPTION
No. of Pumps	3 (2 duty, 1 standby)
Pump Type	Horizontal Centrifugal Split Case
Model	G&L Pump A-C Series 9100
Pump Capacity	375 L/s at 10 m TDH with one (1) pump 750 L/s at 10 m TDH with two (2) pumps in parallel
Pump Efficiency	79.1%
Motor	75 HP, 900 rpm

Figure 2-6 shows the low lift pump station building adjacent to the Eldorado Reservoir.

Figure 2-6: Low Lift Pump Station (Eldorado Reservoir)

As shown in **Table 2-3**, the three pumps are identical and run in 2 duty and 1 standby configuration. The pumps have a 16.5 inch impeller and can operate between 270 rpm to 900rpm. The selected duty point for the 2 pump operation is 750 L/s at 10 m of total head, as shown in the pump curve **Figure 2-7**. Provision to increase the impeller diameter was considered in the original pump selection, which would permit further increasing the pumping capacity of the pump station.

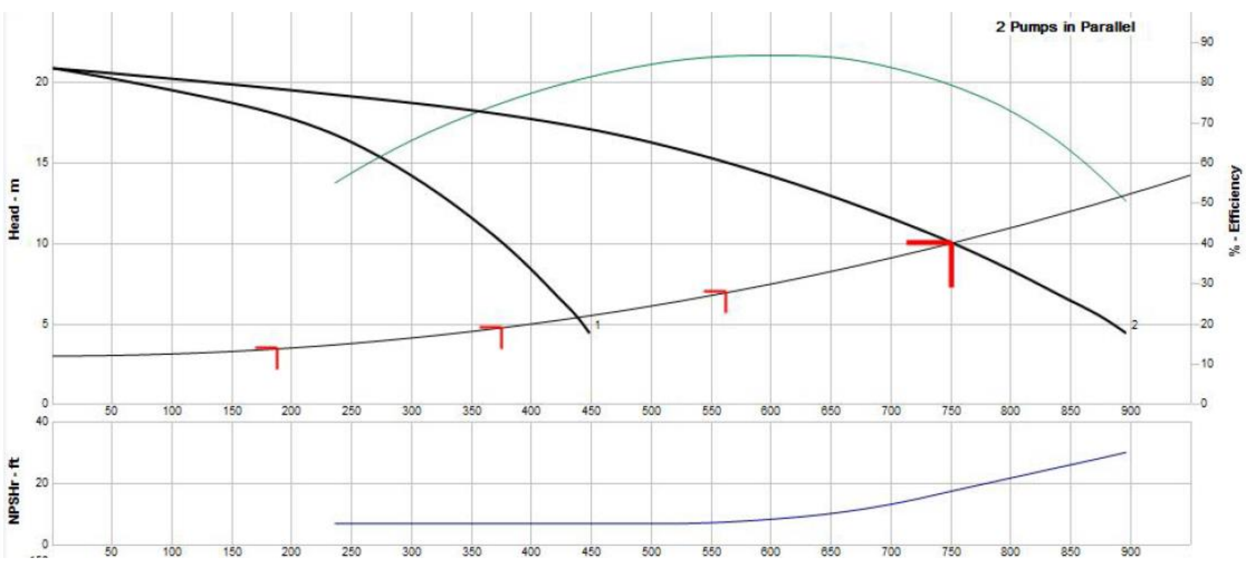


Figure 2-7: Low Lift Pump System and Pump Curve

2.2.4 CHLORINATION SYSTEM

The chlorination system is located near the hydroelectric building, east of the Eldorado raw water reservoir. The current chlorination system has nine (9) tonners inside the chemical building to provide gas chlorination for main injection and trim chlorination. Main chlorination is provided inside the low lift pump station building and the trim chlorination is applied after water leaves the treated water reservoir.

In total there are 5 chlorinator systems, two 500 pound per day (ppd) systems and one 100 ppd system for the main chlorination injection, and one 50 ppd system for the trim chlorination.

Table 2-4 provides details of the chlorine gas systems located inside the chemical building.

Table 2-4: Chlorine Gas System Parameters

PARAMETER	DESCRIPTION
No. of Chlorinators	2-226 kg/d (2-500 lbs/d); 1-45 kg/d (1-100 lbs/d); 1-22 kg/d (1-50 lbs/d)
Rated Dosing Capacity	293 kg/d (assumes largest chlorinator is out of service)
Cylinder Storage	9-ton cylinders (8,164 kg)

Figure 2-8 shows the photo of the gas tonners and chlorinators inside the Eldorado Chemical Building.

Figure 2-8: Eldorado Gas Chlorine Systems (Chemical building)

2.2.5 TREATED WATER RESERVOIR

The treated water reservoir was constructed in 2017 and consists of two cells, with provisions for a third cell in the future. Water enters the treated water reservoir from the low lift pump station via a 750 mm watermain, and discharges to the distribution system through a 750 mm watermain. In the event of an emergency, the District does have the ability to bypass the low lift pump station and treated water reservoir to provide chlorinated water directly from the raw water reservoir to the distribution system.

The treated water reservoir cells are configured in a serpentine flow path to provide chlorine contact for 4-log virus inactivation and 3-log Giardia inactivation prior entering the 750 mm distribution main. A common pipe gallery is located on the north end of the reservoir cells to control flow in and out of the reservoir.

Table 2-5 summarizes key characteristics of the treated water reservoir.

Table 2-5: Treated Water Reservoir Parameters

PARAMETER	DESCRIPTION
Size	6,000 m^3 (3,000 m^3 per cell)
Operating Level (Elevations)	Top of Water Level = 625 m; Low Water Level = 621 m
Inlet	750 mm pipe from Low Lift Station (Invert EL 622.512)
Outlet	750 mm pipe to Distribution System (Invert EL 621.00)
Overflow	750 mm pipe to Balancing Reservoir (Invert EL 625.00)
Drain	300 mm pipe to de-chlorination chamber and then discharge to Upper Vernon Creek

Figure 2-9 shows a portion of the Overall Site Plan, including the location of reservoir cells in relation to the existing and future infrastructure.

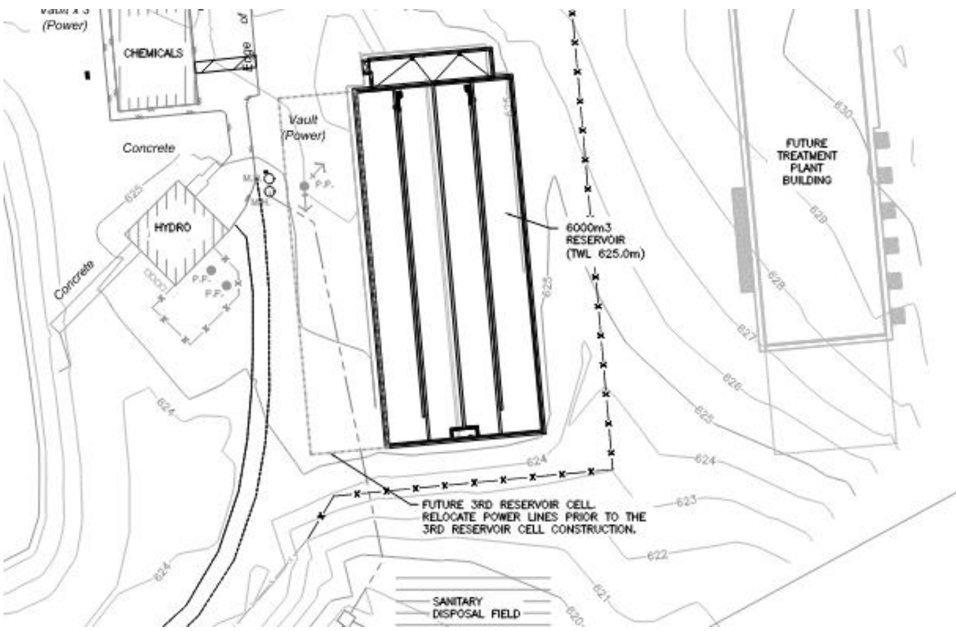


Figure 2-9: Eldorado Treated Water Reservoir (extracted from 2018 Eldorado Treated Water Reservoir and Glenmore Booster Station Record Drawings, AECOM)

2.3 BEAVER LAKE WATER SYSTEM

The District has utilized water from the Beaver Lake Source for over 100 years. This source was historically operated by Winfield Okanagan Centre Irrigation District prior to District's incorporation. The Beaver Lake Source is supplied by the Vernon Creek watershed. This watershed has a surface area of 63 km^2, has the highest elevation of the District's water sources, and provides water to the largest service area, including Okanagan Centre and Winfield. The Beaver Lake service area is bound by the City of Kelowna to the South, elevated lands to the East, Okanagan

Lake to the west, and Wood Lake to the north. Beaver Lake is historically the source with the highest demand, with agricultural needs accounting for most of the water usage.

The Beaver Lake service area includes approximately 1,400 residential connections, 30 commercial and industrial connections, 200 multi-family and strata units, and 870 hectares of irrigated land. The system provides a gravity supply of water into the distribution system and is interconnected at various locations with the Okanagan Lake water source, with the Glenmore Booster station being the largest point of interconnection. There are numerous pressure reducing stations within the system, allowing water to be supplied to the most elevated regions within the system.

2.3.1 WATERSHED

The Beaver Lake system is supplied by the Vernon Creek watershed located to the East of the District. The watershed includes two dammed storage reservoirs, Crooked Lake and Beaver Lake, which rely on snowmelt to fill. The storage capacities of Crooked Lake and Beaver Lake are 2,939 ML and 11,880 ML respectively. Water flows from Crooked Lake into Beaver Lake, where it is released into Vernon Creek before flowing into the Vernon Creek holding pond and intake screen approximately 6 km downstream and at an elevation of 820 m. The water then enters the Eldorado Reservoir with a top of water elevation of approximately 623.75 m, where raw water is stored before being pumped into a treated water storage reservoir with a top of water elevation of 625 m. The raw water is disinfected prior to entering the treated water reservoir. Water flows by gravity from the treated water reservoir into the distribution system.

The watershed between the Beaver Lake Dam and the Vernon Creek intake is known as the Upper Vernon Residual. This area is highly vulnerable to landslides, soil erosion, and water quality contamination, all of which pose significant threats to the water quality at the Vernon Creek intake. Under normal flow conditions, the estimated contaminant travel time from the outflow of the Beaver Lake dam to the Vernon Creek intake is 5-6 hours. The raw water quality constituents of the greatest concern are turbidity, colour, organic carbon, and pathogenic organisms. A summary of activities which present risks to the watershed are shown in **Table 2-6**.

Table 2-6: Vernon Creek Watershed Major Risks

THREAT	JUSTIFICATION	DESCRIPTION OF IMPACT
Landslides and soil erosion	- Upper Vernon Residual is susceptible to landslides and soil erosion, with numerous instances of recent historic slope failures. - Vernon Creek holding pond and intake building are also located in a canyon with highly erodible soils.	- Landslides / soil erosion are the most significant threat to water quality and may also cause infrastructure damage. - There is a permanent water quality advisory in place for the Beaver Lake system as the average source water turbidity (1.2 NTU) is greater than the CGDWQ Health Based Guideline of 1.0 NTU.
Human and Animal Activity	- Camping sites and cattle grazing areas are present within watershed. - Homes with septic systems are present in the watershed.	- Increased soil erosion. - Presence of pathogenic organisms (specifically *E.coli.* and *Cryptosporidium*).
Mountain Pine Beetle (MPB)	- MPB infestation is expected to cause significant loss of forest cover.	- Increased channel instability from increased erosion, higher peak flows, and reduced water quality.

THREAT	JUSTIFICATION	DESCRIPTION OF IMPACT
Climate Change	- Mean annual temperatures are projected to increase 2-4 C, resulting in less precipitation as snow, earlier snow melt peaks, and longer growing seasons with increased agricultural demand. - The severity of wildfire and the length of fire season are expected to increase.	- Increased flow during winter/spring, and decreased flow during summer when irrigation is required (drought). - Increased use of fire suppressants and associated nutrients in source water.
Algae	- Algal blooms release microcystic toxins, which are harmful to human health.	- Eutrophication degrades water quality and increases frequency of algal blooms. Algal blooms have periodically been documented in the Vernon Creek watershed, although not a substantial problem to date. -

2.3.2 WATER LICENCES & WATER AVAILABILITY

Review of water availability for Beaver and Okanagan Lake sources was completed in the 2012 Water Master Plan (WMP) and 2020 WMP Update, both completed by Urban Systems. The WMP referenced a 1977 detailed hydrology study conducted by the BC Ministry of Environment titled "Winfield and Okanagan Centre Irrigation District Water Supply" (Letvak, 1977).

This study indicated that the Beaver Lake Source has an average annual runoff of 13,150 ML and 1:33 year low runoff volume of 6,350 ML, which was recorded in 1970. The total storage volume of Beaver Lake is 11,880 ML; however, 1,750 ML of water is required to be released annually from the total storage volume of Beaver Lake to meet fish flow requirements. Watershed runoff is collected in Beaver Lake and stored by the District during fall to spring months and released during the summer to help meet increased seasonal demands. The released water is used to produce electricity in the hydrogeneration building and then discharged into the Eldorado Reservoir, where it then enters the Beaver Lake water supply system. Releases are closely monitored for water conservation and the District ensures that fish flow and system demand requirements are met after flowing through the hydroelectricity facility.

Okanagan Lake is a much larger source, which is divided into three basins by underwater sills. The District's intake is located in the largest and deepest of these three basins. The Lake level is controlled by a dam outlet gate structure located at Penticton, and the water surface elevation typically ranges between 341.2 and 342.5 m. Apart from water demand from these two systems, there are no competing water uses such as fish flows for the Okanagan Lake source.

Existing water licenses for Beaver Lake and Okanagan Lake are subdivided into two main categories: waterworks and irrigation. Okanagan Lake water licensing is primarily comprised of water works licenses, with only one license for irrigation of lawns, fairways, and gardens. The Beaver Lake system water licenses analysis (comprised of both Vernon Creek and Beaver Lake source licenses) included waterworks, domestic, and incidental-domestic water licenses as "water works" and both private and local provider irrigation as "irrigation". The split for licencing for Beaver Lake is approximately 87% irrigation and 13% domestic.

Table 2-7 summarizes the water licensing information by category, irrigation or waterworks, and compares the licensed volumes to the demands for each system to assess the total water availability. Watershed yields, fish flow requirements, and estimated operational waste values were provided by the WMP and Updated WMP from 2012 and 2020 respectively.

Table 2-7: Beaver Lake and Okanagan Lake Water License Capacity Availability

PARAMETER	BEAVER LAKE	OKANAGAN LAKE
Existing Water License		
Irrigation (ML/year)	8,194	1.85
Waterworks (ML/year)	1,207	11,126
Total, (ML/year)	**9,401**	**11,128**
Water Availability [1]		
Watershed Yield, (ML/year)	9,868	10,997
Fish flows, (ML/year)	-1,750	0
Estimated Operational Waste, (ML/year)	-617	0
Total, (ML/year)	**7,501**	**10,997**
Calculated Average Daily Withdrawal Allowance, MLD (L/s)	**20.5 (237)**[2]	**30.1 (348)**[2]

[1] "District of Lake Country Water Master Plan", Urban Systems, Kelowna, British Columbia, November 6, 2021.

[2] Maximum Daily Withdrawal Limits provided in L/s are based on an assumed 24 hours per day of operation

Comparing licensed water uses with availability, the volume of water allocated to the District through existing water licenses for both Okanagan Lake and Beaver Lake exceed the watershed yields, as shown in **Table 2-7**. The average daily withdrawal limit for the Okanagan Lake source is 348 L/s which is higher than the average daily demand of the system but lower than the design capacity of the existing treatment system (460 L/s). The calculated average daily withdrawal limit from Beaver Lake source is 237 L/s, which is greater than the current average flowrate at the Eldorado Reservoir of 104 L/s (refer to Section 3.1).

A more detailed breakdown of the licensing information obtained from the provincial license data base for the Okanagan and Beaver Lake systems is summarized in **Figure 2-10** and **Table 2-8.**

Water licensing for the Beaver Lake system shown in **Table 2-8** and **Figure 2-10** is a combination of the District's available water licenses for the Beaver Lake, Crooked Lake, and Vernon Creek sources (for diversion locations upstream of the Eldorado site). There was only one water license for the Crooked Lake source, which was dedicated to non-power storage, therefore this water license was not utilized in the assessment for the Beaver Lake system. The District's Okanagan Lake water licences were more straight forward, with the majority of the licenced capacity being attributed to waterworks and only a single irrigation licence for lawn/fairway/garden watering. Appendix C summarizes the water license numbers, associated uses, and allocation volumes used for the analysis.

Table 2-8: Water Licensing Summary

SOURCE	LICENSE TYPE	TOTAL ALLOCATED VOLUME (ML/YEAR)
Beaver Lake (Beaver Lake & Vernon Creek Licenses)	Irrigation: Local Provider	7,903
	Irrigation: Private	291
	Waterworks: Local Provider	1,199
	Domestic	4.06
	Incidental- Domestic	4.14

SOURCE	LICENSE TYPE	TOTAL ALLOCATED VOLUME (ML/YEAR)
	TOTAL	**9,401**
Okanagan Lake	Waterworks: Local Provider	11,127
	Irrigation (Lawn, Fairway, and Garden Watering)	1.85
	TOTAL	**11,129**

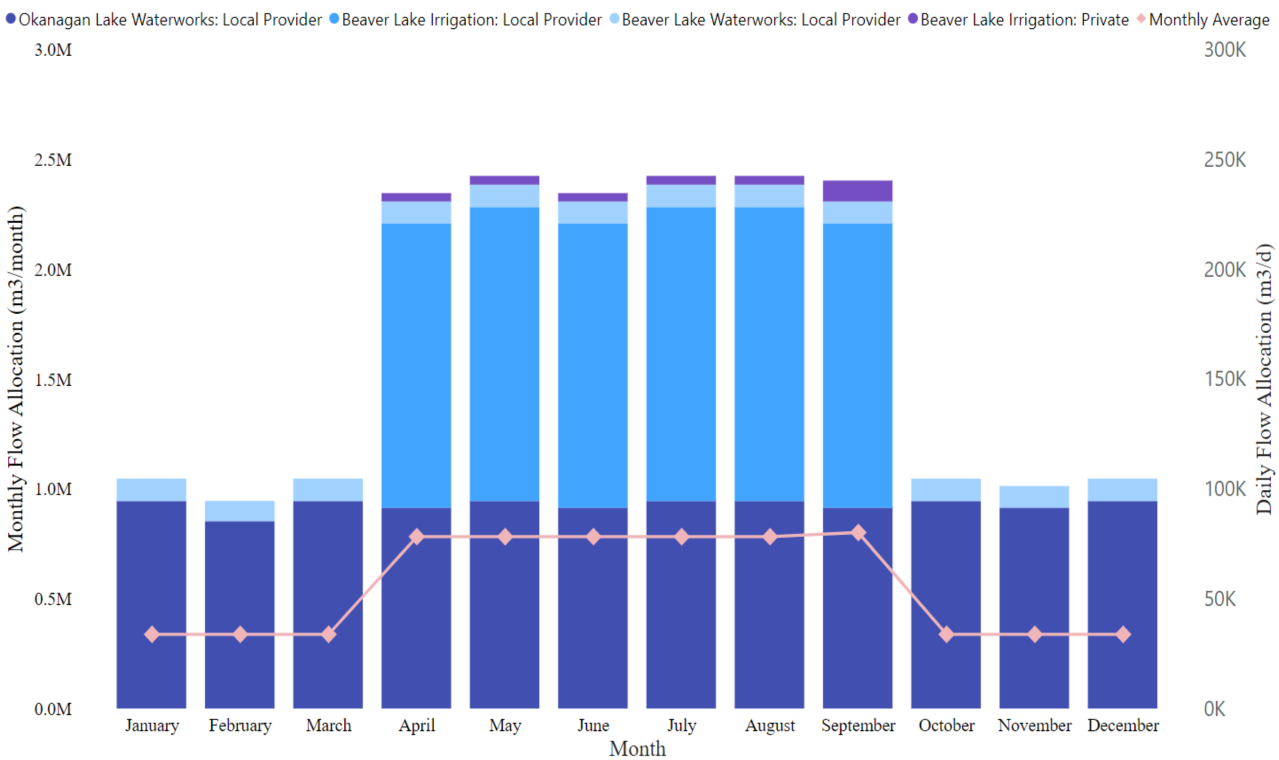


Figure 2-10: Water Licenses Summary by Use

2.3.3 HISTORICAL RAW WATER QUALITY

The District provided WSP with the historical raw water quality from Vernon Creek and the water entering the Eldorado low lift pump station prior to disinfection and distribution. The water quality data provided included daily inlet and outlet turbidity readings, daily residual chlorine, and daily pH readings from 2016-2021. Quarterly hardness, quarterly total organic carbon (TOC) (2018-2021), monthly true colour, weekly E.coli, and weekly total coliform readings were provided from 2012-2021. Periodic total dissolved solids (TDS), total suspended solids (TSS), conductivity, and temperature readings were also provided between 2012 and 2020. **provides** a summary of key raw water characteristics of Beaver Lake including inlet turbidity (turbidity prior to Eldorado raw water reservoir), outlet turbidity (turbidity at low lift pumpstation), hardness, conductivity, total dissolved solids, E. coli, and total coliforms taken at the raw water reservoir.

Table 2-9 provides a summary of key raw water characteristics of Beaver Lake including inlet turbidity (turbidity prior to Eldorado raw water reservoir), outlet turbidity (turbidity at low lift pumpstation), hardness, conductivity, total dissolved solids, E. coli, and total coliforms taken at the raw water reservoir.

Table 2-9: Summary of Beaver Lake Raw Water Quality Characteristics

PARAMETERS	TOTAL SAMPLES	MINIMUM	MAXIMUM	AVERAGE	MEDIAN	95TH PERCENTILE
Inlet Turbidity (NTU)	1979	0.1	19.9	1.4	0.7	5.0
Outlet Turbidity (NTU)	1965	0.1	6.5	0.8	0.8	1.7
Hardness (mg/L)	46	8.8	100	47	40	80
TOC (mg/L)	11	6	9	8	7.7	8.7
Colour (TCU)	392	5	140	40	35	72
Total Suspended Solids (TSS)	109	1	2770	36	2.5	40
Conductivity (S/m)	461	45	136	71	70	91
Total Dissolved Solids (mg/L)	316	33.6	102	50.8	50.8	68
E. coli (CFU/100mL)	540	1	500	9.6	1	11
Total Coliforms (CFU/100mL)	542	0	200	55.3	32	200

Figure 2-11 provides with the sampling location for each of these parameters.

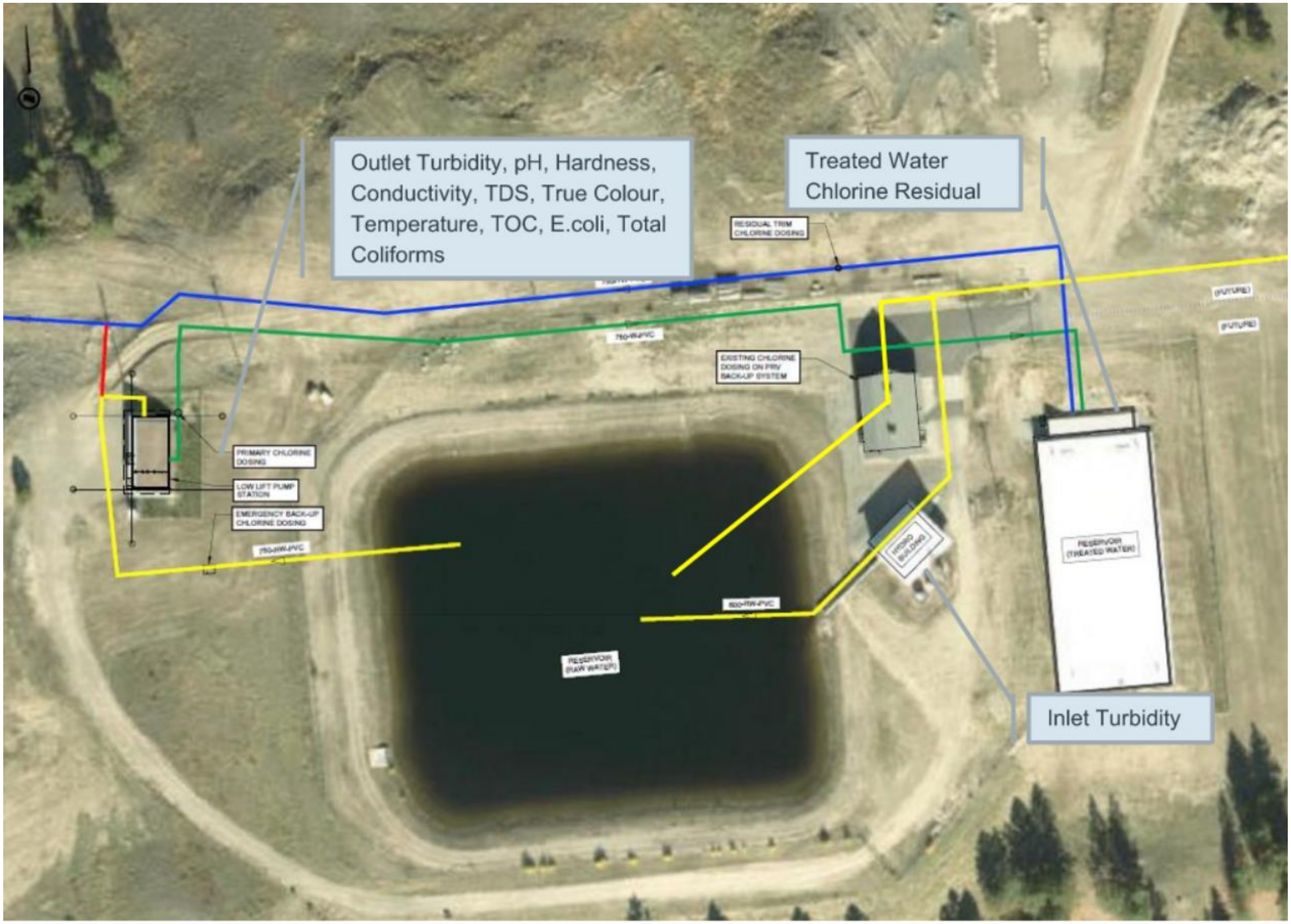


Figure 2-11: Sampling Locations for Water Quality Parameters

TURBIDITY

INLET TURBIDITY

The daily inlet turbidity readings provided were taken at the Eldorado hydroelectricity plant, and represent the raw water quality from Vernon Creek, prior to water entering the Eldorado Raw Water Reservoir.

Vernon Creek is prone to flash flood conditions and landslides (freshet), which can result in deteriorated raw water quality such as elevated turbidity values as high as 20 NTU. When turbidity is higher than 5 NTU, the District stops diverting water into the Eldorado Raw Water Reservoir.

Figure 2-12 shows the Vernon Creek raw water inlet turbidity as measured at the hydro plant prior to discharging into the Eldorado Reservoir.

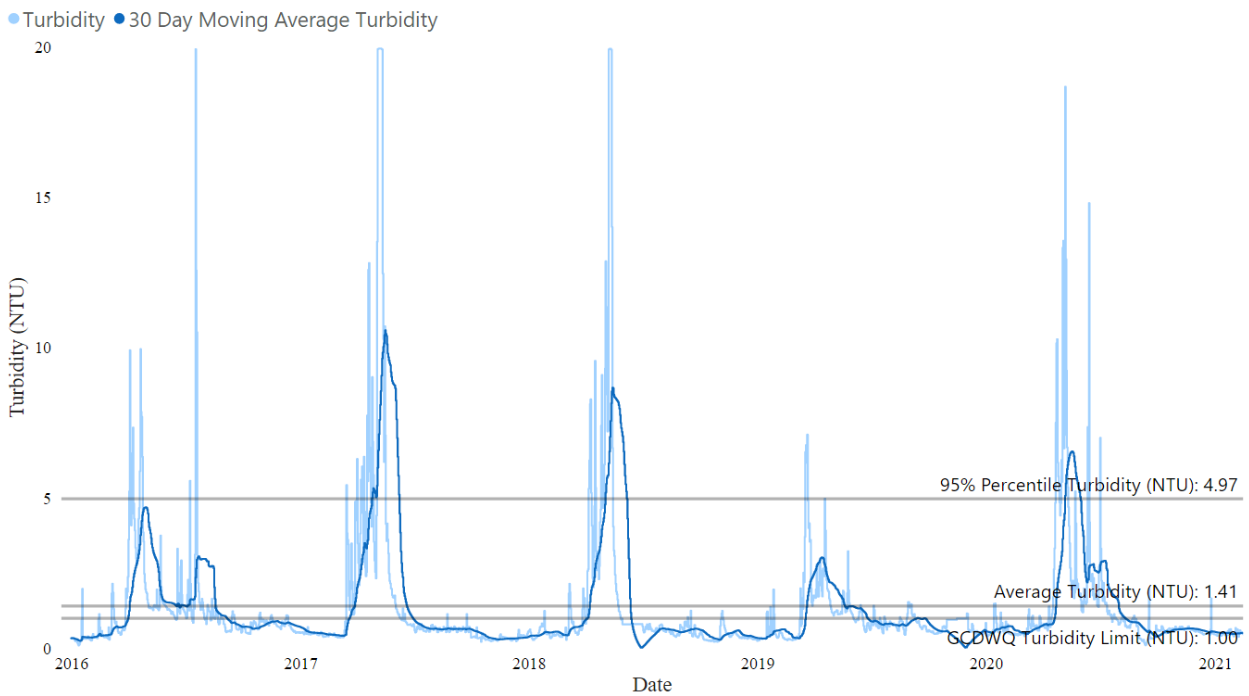


Figure 2-12: Vernon Creek Daily Turbidity (2016-2021)

The average daily inlet turbidity from the 2016-2021 data sets is 1.41 NTU, while the 95-percentile is approximately 4.97 NTU. The daily inlet turbidity varies cyclically, with a high turbidity (>10 NTU) event occurring during the freshet each year. As shown in **Figure 2-12**, daily turbidity typically rises between 5 and 20 NTU during the spring months and then steadily declines during the summer, fall, and winter months. Once the snowmelt subsides, daily inlet turbidity consistently decreases below 2 NTU. To better visualize seasonal variations in inlet turbidity values, **Figure 2-13** provides monthly averages for inlet turbidity between 2016 and 2021.

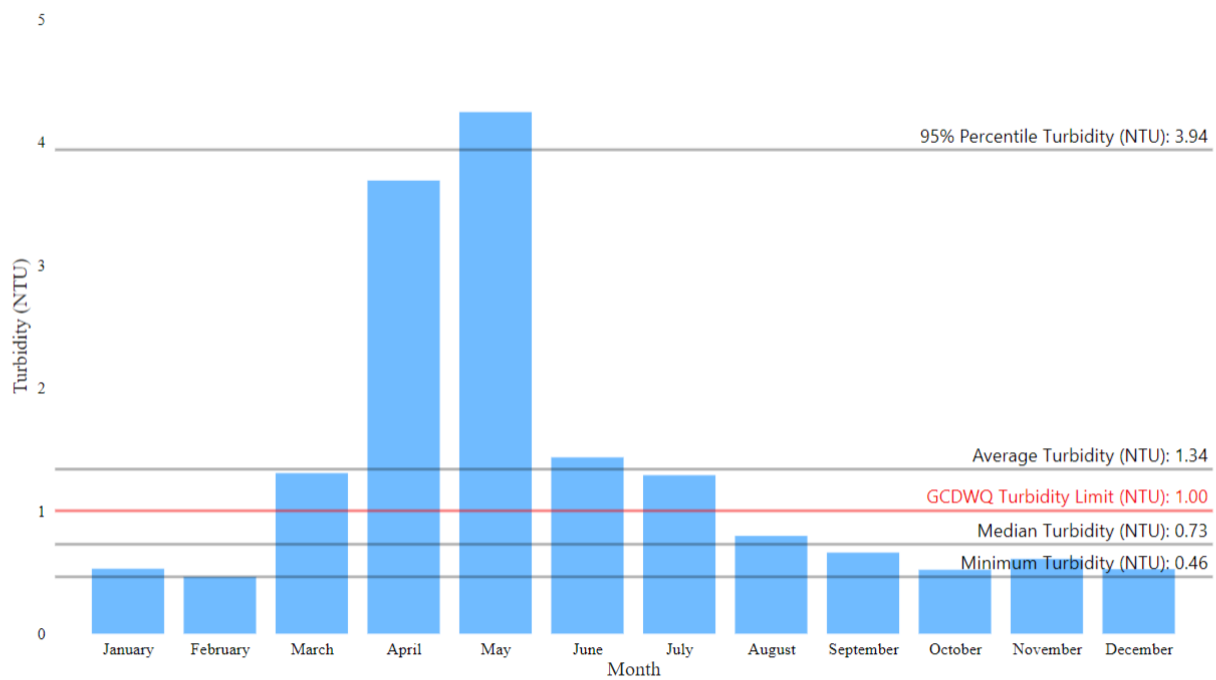


Figure 2-13: Vernon Creek Average Daily Turbidity Levels per Month (2016-2021)

As seen from **Figure 2-13**, the daily turbidity increases during March-May, with a peak average monthly turbidity of 4.2 NTU occurring in May, while the lowest average monthly turbidity of 0.46 NTU occurs in February.

The average monthly turbidity 1.34 NTU (2016-2021) and daily turbidity of 1.41 NTU exceed the Guidelines for Canadian Drinking Water Quality (GCDWQ) value of 1 NTU.

Table 2-10 provides further insights into the daily inlet turbidity data.

Table 2-10: Distribution of Daily Inlet Turbidity Values 2016-2021

PARAMETER	NO. OF SAMPLES	PERCENTAGE OF TOTAL
Samples (Total Daily Average Inlet Turbidity Data points)	1,979	-
Daily Inlet Turbidity Value >1 NTU and < 5 NTU	558	28%
Daily Inlet Turbidity Value > 5 NTU	101	5%

OUTLET TURBIDITY (AVERAGE)

Outlet turbidity is measured at the inlet of the low lift pump station at Eldorado Raw Water Reservoir. **Figure 2-14** displays the daily outlet turbidity values between 2016 and 2020.

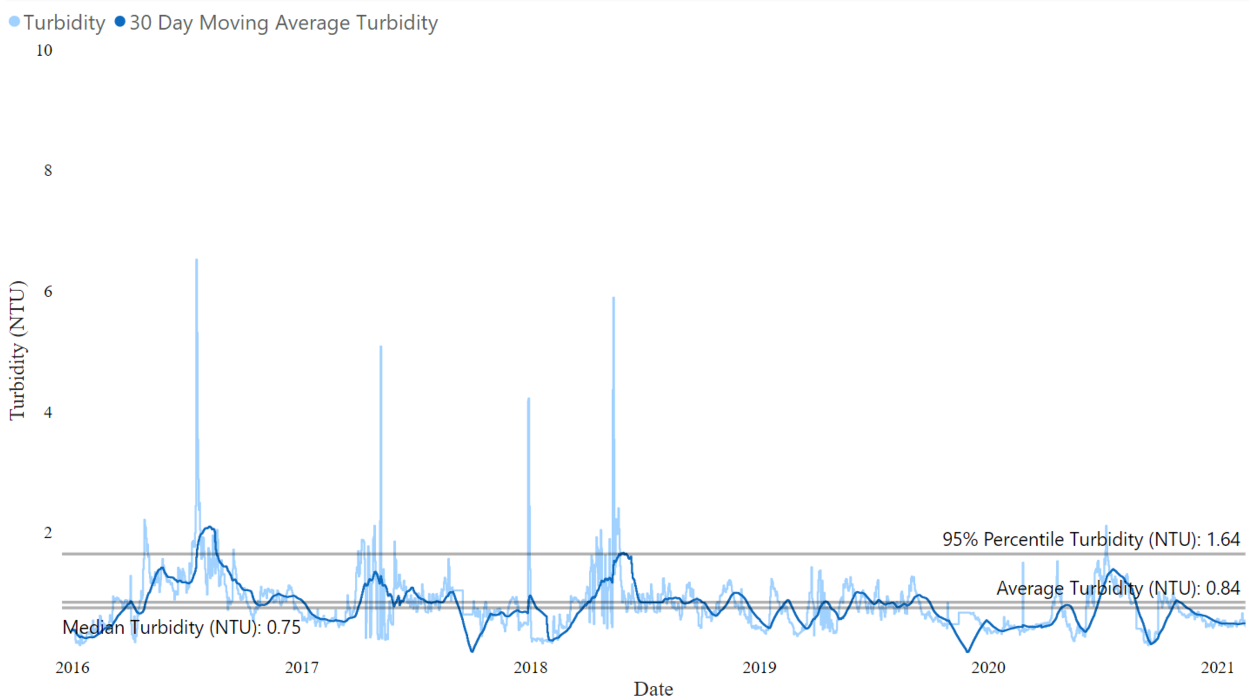


Figure 2-14: Daily Outlet Turbidity- 2016-2020 (Low Lift Pump Station)

Comparing **Figure 2-12** and **Figure 2-14**, the daily outlet turbidity values are approximately 50% lower than the average inlet turbidity, at 0.84 NTU compared to 1.41 NTU. The peak outlet turbidity during freshet season was significantly lower than the inlet turbidity at greater than 20 NTU and less than 7 NTU, respectively.

Table 2-11 provides summarizes the distribution of outlet turbidity values used in this analysis.

Table 2-11: Distribution of Daily outlet Turbidity Values 2016-2021

PARAMETER	2016	2017	2018	2019	2020	2021	TOTAL
Samples (Total Daily Outlet Turbidity Data points)	366	335	364	335	353	212	**1,965**
Daily Outlet Turbidity Value >1 NTU and < 2 NTU	150	64	72	52	63	119	**520**
Daily Outlet Turbidity Value > 2 NTU and < 5 NTU	10	5	8	0	1	6	**30**
Daily Outlet Turbidity Value > 5 NTU	2	1	1	0	0	0	**4**

Approximately 28% of the outlet turbidity samples exceed 1 NTU, with most values falling between 1 NTU and 2 NTU. A total of 34 daily turbidity values exceeded 2 NTU with only 4 above 5 NTU.

Comparing seasonal fluctuations in outlet turbidity, **Figure 2-15** shows the average monthly outlet turbidity for the Eldorado Reservoir.

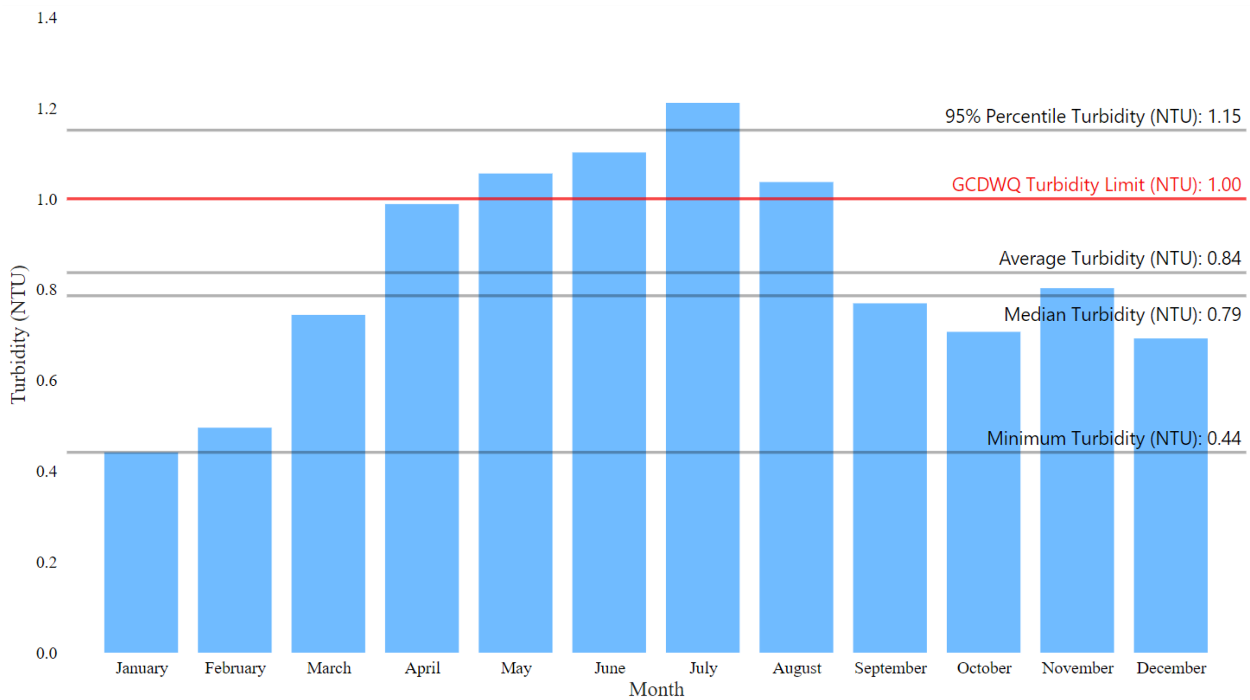


Figure 2-15: Average Monthly Turbidity: Outlet (2016- 2020)

Comparing **Figure 2-13** and **Figure 2-15**, peak inlet turbidity during April and May is mitigated by pumping Okanagan Lake water into the Beaver Lake system, and using the storage capacity of the Eldorado Reservoir. The highest outlet turbidity readings occur in June and July, when water quality in the creek has improved, and the pumping capacity of the Glenmore Booster station (200 L/s) can no longer keep up.

While the raw water reservoir provides opportunity for turbidity reduction from the Vernon Creek supply, the average outlet turbidity value exceeds the GCDWQ standard of 1 NTU:

GCDWQ Guideline Values: Drinking Water Turbidity shall be below 1 NTU.
Treatment is required to meet the GCDWQ Guidelines values. Reducing turbidity values will increase the disinfection effectiveness.

PH

pH is a measure of the acidity/basicity of water and should be monitored for greater efficiency of the water treatment processes and corrosion control in the distribution system. For drinking water systems, the recommended pH range is 7.0-10.5.

The average pH for the Beaver Lake system between 2016 and 2021, sampled at the low lift pump station, is approximately 7.01 pH units which is near to the minimum acceptable value of 7.0 pH units. However, the median pH value of the water is 6.95 pH units. Out of the 1,936 samples provided for this analysis, 1,213 samples were below 7.0 pH units, or below GCDWQ standards, which represents approximately 72% of the total samples:

GCDWQ Guideline Values: MAC values not available. Other values suggest pH should be between 7.0-10.5.
pH adjustment is recommended for optimized coagulation and water stabilization prior to entering the distribution system. pH control will improve treatment effectiveness, corrosion control, and reduce leaching in distribution system and plumbing components.

HARDNESS

Hardness, or the concentration of multivalent cations in water, is a water quality parameter that quantifies the scaling potential of a water source and is an important parameter for treatment selection.

In freshwater, calcium and magnesium are the principal hardness causing ions, however, all multivalent cations such as iron, barium, manganese, and strontium can also contribute. Hardness levels between 80 and 100 mg/L (represented as Calcium Carbonate) are generally considered to provide acceptable balance between corrosion and incrustation. Water with hardness levels greater than 200 mg/L are considered poor whereas levels greater than 500 mg/L are unacceptable for domestic use purposes.

Water samples for hardness were provided regularly from 2012-2019, and 2 samples were provided for 2020, for a total of 46 readings. The average hardness from this data set is 47 mg/L, with a 95-percentile value of 80 mg/L; meaning, 95% of the values provided were lower than the recommended range of 80-100 mg/L.

The hardness and alkalinity of the water is to be considered during pilot testing to properly account for coagulation chemistry and ensure there is sufficient buffering to maintain stable water conditions prior to distribution.

GCDWQ Guideline Values: None.
Treatment should be considered to increase the hardness levels of water.
Hardness levels between 80mg/L -100mg/L are recommended.

CONDUCTIVITY

The measure of waters ability to pass an electric current is called conductivity. The presence of inorganic dissolved solids such as chloride, nitrate, sulphate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge) impact conductivity readings. Conductivity is important for water quality and treatment selection because it provides insight into the amount of dissolved chemicals, substances, and minerals in the water.

Of the 461 conductivity samples provided between 2012 and 2020, the average conductivity for the Beaver Lake system was 71 S/m and the 95-percentile was 91 S/m. The minimum conductivity was as low as 45 S/m and the highest conductivity value recorded was 136 S/m.

pH, conductivity, and hardness values can be combined to calculate the Langlier Saturation Index (LSI) of the source water, which defines the scaling potential of treated water inside the distribution pipeline. The calculated LSI for the Beaver Lake system raw water is -3.7, which defines water as undersaturated with calcium carbonate and could result in corrosion of metallic and concrete pipes within the distribution system.

GCDWQ Guideline Values: None.
Treatment should be considered to increase the conductivity levels of water to reduce potential of corrosivity of water in the distribution system.

TOTAL DISSOLVED SOLIDS

Like conductivity, total dissolved solids (TDS) measures dissolved organic and inorganic constituents. The principal components of total dissolved solids are usually cations like calcium, magnesium, sodium, and potassium and the anions carbonate, bicarbonate, chloride, sulphate, and nitrate. Conductivity and total dissolved solids follow a close relationship with an increase in conductivity resulting in overall increase of total dissolved solids.

For aesthetic value, the Canadian Drinking Water Guidelines for total dissolved solids recommend values less than or equal to 500 mg/L, with extremely low values (i.e., <10) being considered unacceptable due to its flat and insipid taste.

Figure 2-16 summarizes the 316 samples from 2012-2020 recorded at the low lift pump station.

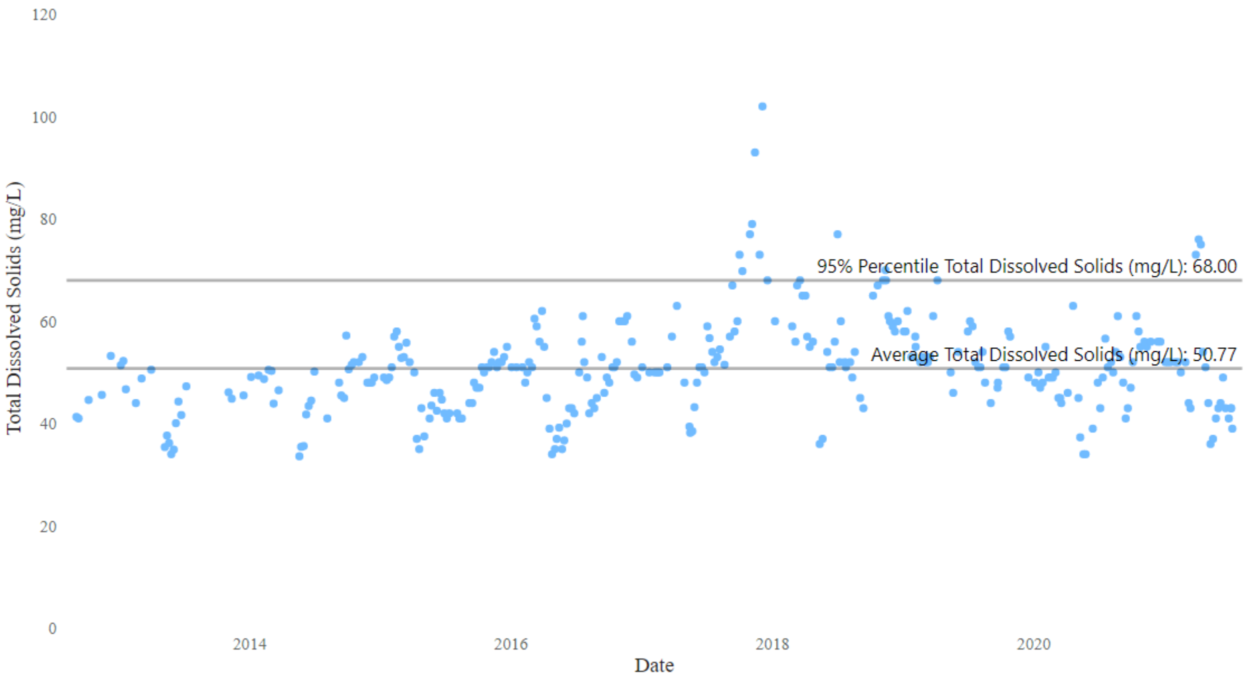


Figure 2-16: Source Water TDS Concentrations – 2012-2020 (Low Lift Pump Station)

The average TDS content for the source water is approximately 51 mg/L and the 95-percentile was 68 mg/L. Minimum TDS for the source water was approximately 34 mg/L, and the maximum TDS shown in **Figure 2-16** is 102 mg/L.

There were TDS values in the data set that exceeded 200 mg/L; these values are suspected to be due to the addition of Okanagan Lake source water into the Eldorado system and therefore were omitted from the data set.

Based on this information, the total dissolved solids levels are relatively low, and none exceeded the GCDWQ aesthetic guideline of 500 mg/L. Water stability should be assessed during pilot testing to determine whether chemical addition is required to reduce the corrosivity of the water prior to entering the distribution system.

GCDWQ Guideline Values: None. GCDWQ Aesthetic Value: <500mg/L
TDS directly correlates with conductivity, hardness, and pH. Increase in any of the above parameters will result in increase in TDS. Treatment should consider impacts of TDS on corrosion potential.

TRUE COLOUR

Colour presence in water acts as an indicator for the presence of organic substances such as soil runoff or metals such as iron, manganese, and copper.

GCDWQ and BC Provincial Drinking Water Guidelines have set an aesthetic guideline value for maximum true colour of 15 true colour units (TCU). This value was set because most people can visually detect water colour greater than 15 TCU.

The sample sets provided for true colour were collected on monthly basis between 2012 and 2020, with intermittent gaps between samplings. The average colour for the source water over this period is 40 TCU, which is more than double the guideline value as per GCDWQ. The 95-percentile colour value is approximately 72 TCU, and the median is 35 TCU; the median value indicates that 50% of the samples collected were more than double the aesthetic recommendation of 15 TCU for true colour.

Treatment is required to reduce colour levels below 15 TCU, both for aesthetic reasons but also to indicate organic reduction. Colour can impact or interfere with treatment efficacy such as disinfection. Treatment should target a TCU of less than 5 TCU.

GCDWQ Guideline Values: None. GCDWQ Aesthetic Value: 15 TCU
Treatment is required. Treatment shall consider reducing the colour in the raw water.
Colour impacts/interferes with disinfection, removal is important to ensure effective treatment. If filtration is considered a viable treatment, colour shall be lower than 5 TCU.

TEMPERATURE

Temperature influences each aspect of treatment and delivery of potable water, as chemical reactions and performance of unit process and disinfection systems are dependent on temperature. For example, with increasing temperatures, there is decreased retention of chlorine residual in the distribution system. Therefore, understanding the maximum and minimum water temperatures of the system are required for the successful design of treatment processes.

Additionally, GCDWQ and Water Quality Guidelines for the Province of BC have set aesthetic objectives for temperature at 15°C. The temperature data provided for this analysis varied seasonally. The observed variances are consistent with shallow water bodies (Eldorado Reservoir), with water temperature increasing up to 22°C during the summer and dropping to as low as 1°C during the winter. The average water temperature across the entire data set (2012-2020) was 8°C.

Temperature directly effects treatment, disinfection, corrosion control and formation of biofilms in the distribution system. Consideration shall be given to selection and sizing of the treatment system.

GCDWQ Guideline Values: None. GCDWQ Aesthetic Value: 15°C
Temperature directly effects treatment, disinfection, corrosion control and formation of biofilms in the distribution system. Consideration shall be given to size of the treatment system.

TOTAL ORGANIC CARBON

Total organic carbon (TOC) is a measurement of organic matter in water such as carbohydrates, amino acids, hydrocarbons, fatty acids and phenolics, and is highly correlated with colour and turbidity. TOC can be a useful indication of the degree of pollution of a water source, arising from activities such as effluent disposal or the decaying of natural organic matter. TOC levels serve as an indicator for disinfection formation potential, where high TOC’s values typically result in high concentrations of disinfection by-products.

The suggested maximum value for TOC is 4 mg/L for untreated water and 2 mg/L for treated water as per GCDWQ and BC Water Quality guidelines.

A total of 11 samples were provided for the source water from 2018-2021. The average TOC for these samples was approximately 7.7 mg/L, with a maximum TOC value of approximately 9 mg/L.

Based on the historical TOC sampling, the source water is non-compliant with GCDWQ standards and will require treatment to reduce the organics prior to disinfection. Treatment shall consider reducing the TOC values below 2 mg.

GCDWQ Guideline Values: 4mg/L for source water; 2 mg/L for treated water
Treatment is required. Treatment shall consider reducing the TOC values below 2mg/L
For treated water, TOC shall be lower than 2mg/L. Higher concentrations of TOC could result in formation of THM's upon reacting with chlorine which are carcinogenic in nature.

E. COLI

Escherichia coli (E. coli) is a species of bacteria that is naturally found in the intestinal system of humans and animals, and its presence in water is a useful indicator of fecal contamination. In drinking water monitoring programs, E. coli testing is used to provide information on the quality of the source water, the adequacy of treatment, and the safety of the drinking water distributed to the consumer.

E. coli readings were provided as weekly samples between 2012 and 2020, with intermittent gaps in the data, for a total of 540 samples. The maximum E. coli concentration recorded was 500 CFU/100 mL, the average was 10 CFU/100 mL, and the 90th percentile was 5 CFU/100 mL. Four samples from this data set had bacteriological concentrations that do not meet the filtration exclusion criteria of 20/100 mL for unfiltered source water and would require filtration to meet drinking water quality guidelines.

GCDWQ Guideline Values: Raw water to have <20/100 mL in source water (unfiltered source water); Nondetectable per 100 mL (MAC) in distribution system (All source water).
Filtration is required to reduce the incoming bacteriological levels prior to disinfection. Following disinfection, the concentration of E.coli shall be zero in regular sampling.

TOTAL COLIFORMS

Total coliform includes bacteria that are naturally found in soil, in water influenced by surface water, and in human or animal waste. Total coliform sampling is typically used to assess the efficacy of disinfection processes.

Weekly samples for total coliforms were provided between 2012 and 2020 with intermittent gaps in the data. A total of 542 samples were collected, with a maximum value of 200 CFU/100 mL, an average of 55 CFU/100 mL, and a 90 percentile of 180 CFU/100 mL. Based on these values, the source water bacteriological concentrations do not meet the filtration exclusion criteria of <100/100 mL in 90% of samples for unfiltered source water, and therefore will require, at a minimum, the additional of filtration to meet drinking water quality guidelines.

GCDWQ Guideline Values: Raw water to have <100/100 mL 90% of source water sampling (unfiltered source water); Nondetectable per 100 mL (MAC)
Filtration is required to reduce the incoming bacteriological levels prior to disinfection. Following disinfection, the concentration of total coliforms shall be zero in regular sampling.

2.3.4 HISTORICAL TREATED WATER QUALITY

CHLORINE RESIDUALS

Chlorine is used in drinking water for both primary and secondary disinfection. Typical free residual levels for drinking water ranges from 0.04-2 mg/L in the distribution system. At these concentrations, taste and odour issues related to the chlorine or its by products are generally considered acceptable.

Figure 2-17 summarizes the monthly average maximum and minimum chlorine residual levels in the system. The daily minimum and maximum chlorine residuals shown were collected just downstream of the treated water reservoir. The data used to create **Figure 2-17** were daily chlorine residual readings taken between 2018 and 2021.

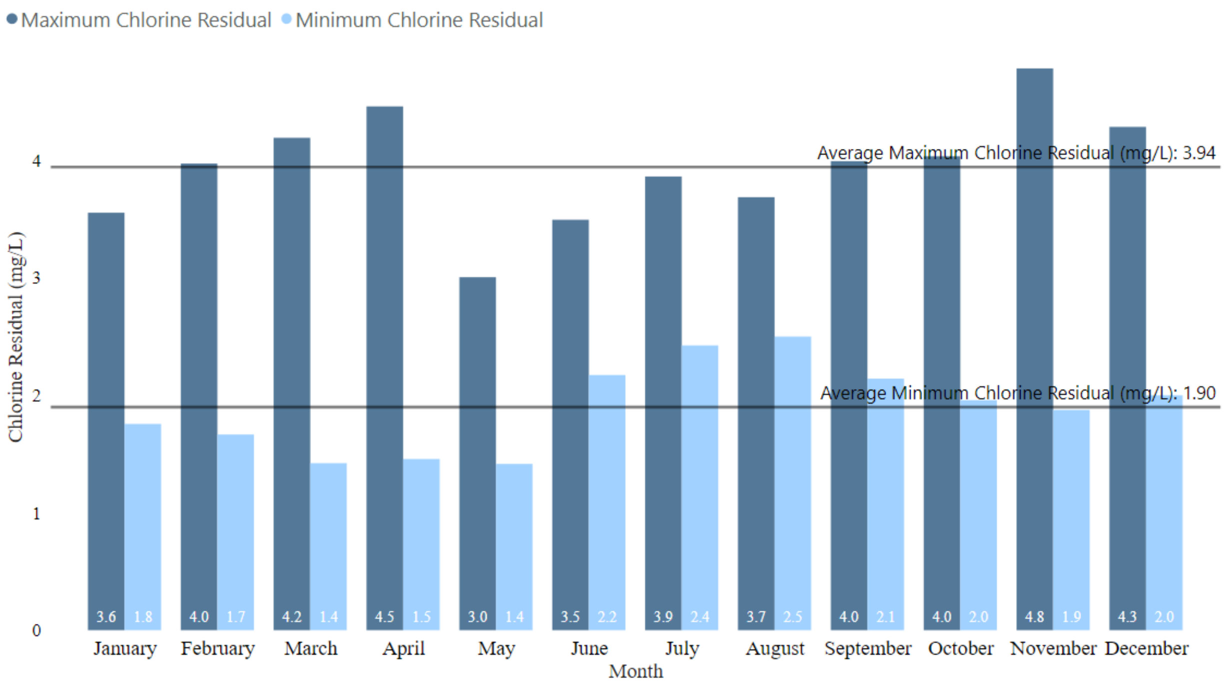


Figure 2-17: Treated Water Average Monthly Chlorine Residuals

While dosing chlorine for secondary disinfection and distribution residual, it is important to remain cognisant of the water's disinfection byproduct (DBP) formation potential. DBPs are mainly formed when disinfectants such as chlorine react with dissolved organic matter and inorganic compounds present in water. DBP formation potential in water is influenced by quality parameters such as TOC and temperature. DBPs can cause liver damage, increased nervous system activity, and in some cases can be carcinogenic. Regulatory bodies have established maximum allowable concentrations of different DBPs by balancing the health benefits of disinfected drinking water with the risk of exposure to DBPs. Two notable DBPs most commonly found in chlorinated drinking water are trihalomethanes (THMs) and haloacetic acids (HAAs). **Figure 2-18** and

Figure 2-19 summarize annual running averages of THM and HAA concentrations for all sampling locations in the Vernon Creek distribution system, for all years of available data.

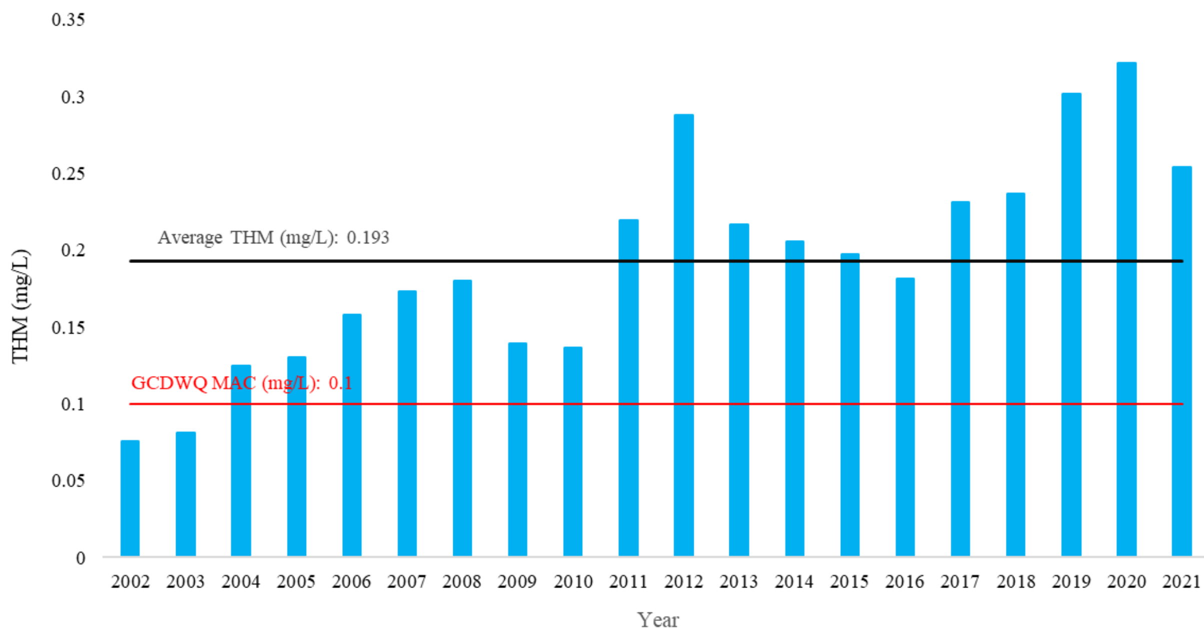
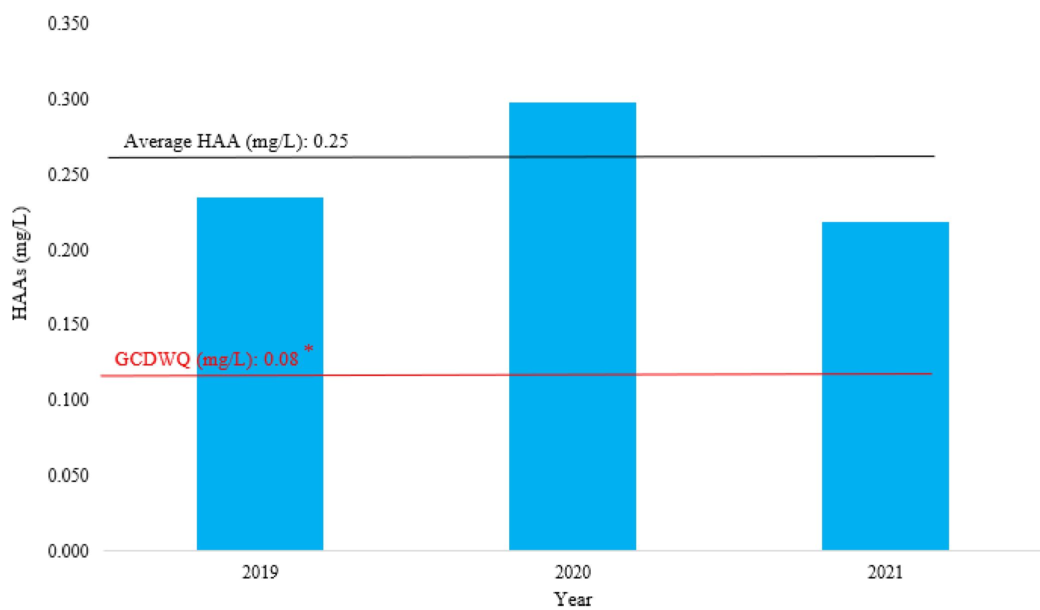


Figure 2-18 Trihalomethane Annual Averages (2002-2021)



*ALARA- as low as reasonably possible

Figure 2-19 Haloacetic Acid Annual Averages (2019-2021)

As shown, the current annual averages for THM and HAAs in the distribution system exceed GCDWQ requirements. The relatively high TOC concentration and temperature of the Vernon Creek source water may make balancing adequate chlorine dosing with mitigating DBP formation difficult; this should be analyzed in further detail during preliminary design and piloting phases.

3 WATER DEMANDS

3.1 HISTORICAL WATER DEMANDS

The District provided WSP with the following water flow data:

— monthly average, monthly maximum, and monthly minimum flows for the Beaver Lake and Okanagan Lake Systems from 2012-2021;
— maximum month demands from the Eldorado system from 2018-2021;
— daily flow data for the Eldorado low lift pump station from 2019 to 2021; and
— pump run times for the Okanagan Lake pumphouse from 2012-2021.

For the Beaver Lake system, flow data was provided for the Eldorado hydro plant, the PRV station, and the Eldorado Reservoir outlet. The Eldorado Reservoir outlet flows were used for assessment of the Beaver Lake and Combined System flows.

3.1.1 BEAVER LAKE SYSTEM FLOWS

The District recorded monthly totalised, monthly minimum, monthly average, and monthly maximum demands for the system. Totalised demands from the Beaver Lake Source between 2018 and 2020 are presented in **Figure 3-1**.

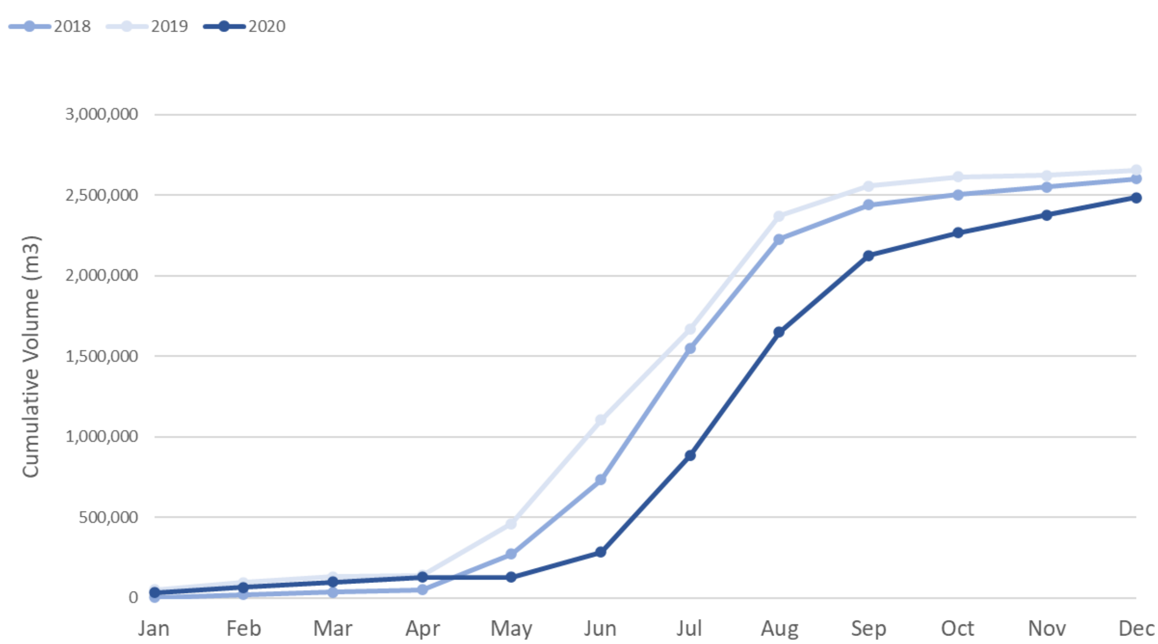


Figure 3-1: Cumulative Flow Demands for the Beaver Lake System

During these three years, the cumulative demands for the Beaver Lake system reached as high 2,660 ML in 2019 and dropped down to 2,500 ML in 2020, with an average, annual demand of 2,580 ML. The Beaver Lake source follows a consistent trend, with most of the demands occurring in summer months of June, July, and August due to irrigational use and higher waterworks demands.

Figure 3-2, which shows the average daily demand (ADD) for the system between 2019- 2021, captures the seasonal variations of the Beaver Lake system, with much higher demands in the summer months compared to winter months. The seasonal turndown ratio for the system is approximately 15:1. This is due to the reliance on Beaver Lake to supply the agricultural irrigation demands. The average daily flow for the system was calculated from the monthly totalised flowrates based on the number of days per month assuming 24-hour per day operation.

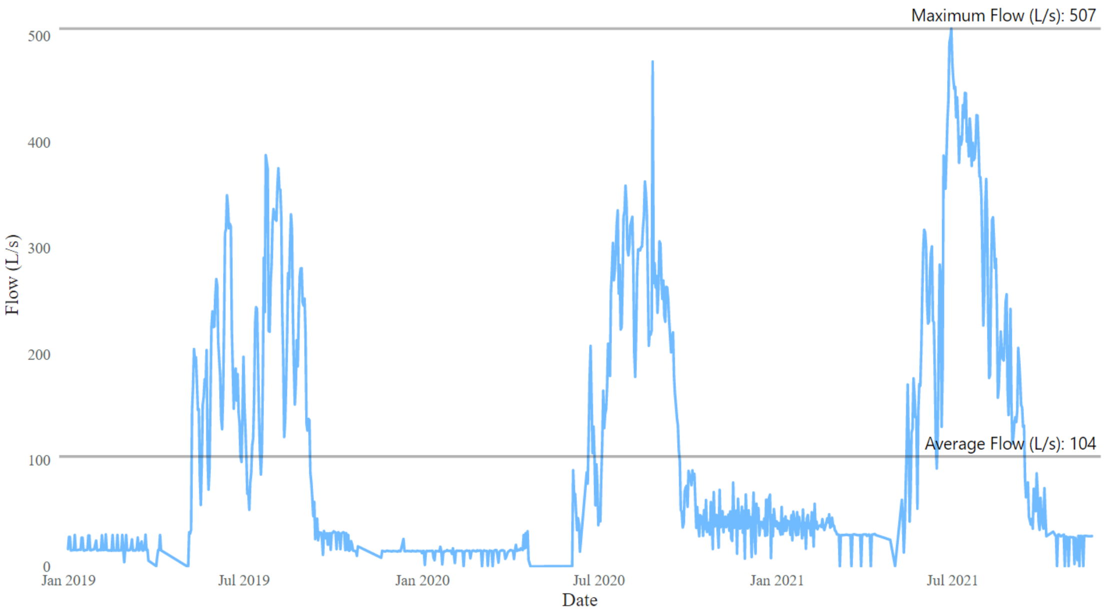


Figure 3-2: Beaver Lake Daily Water Demands (Eldorado Reservoir Outlet)

To better visualize these seasonal variations, **Figure 3-3** displays the average daily flow rates for each month between 2018 and 2021 for the Beaver Lake system.

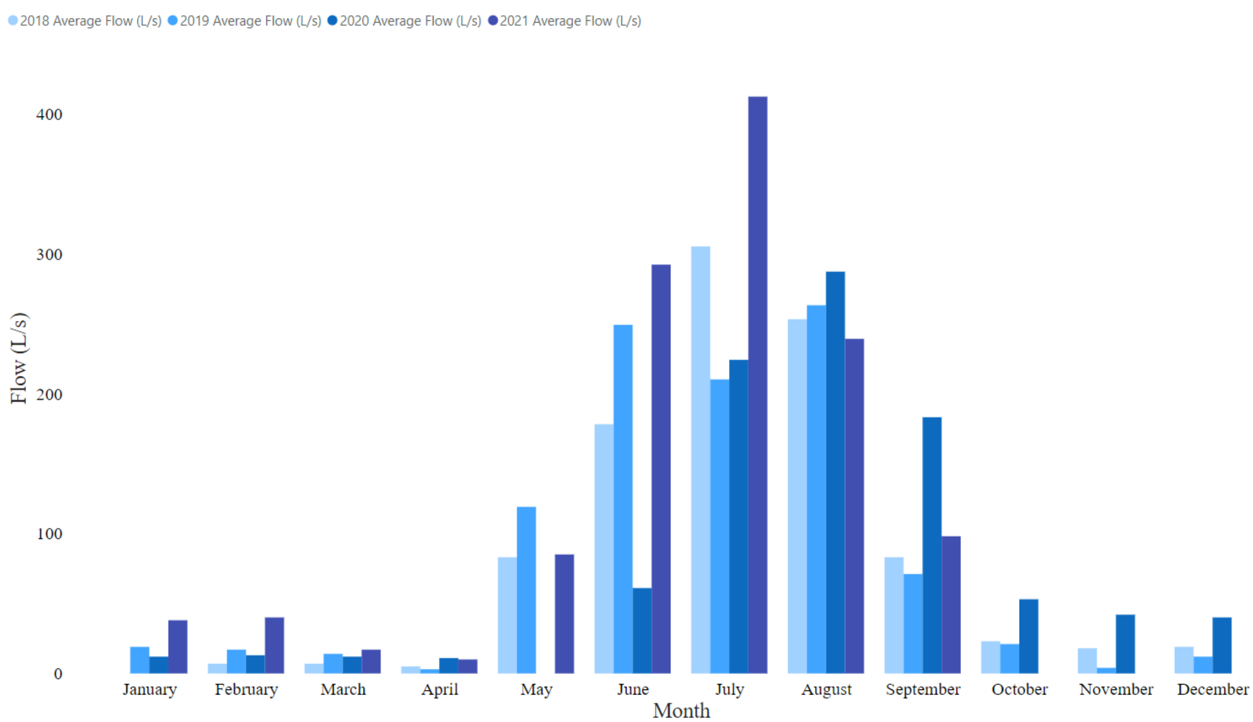


Figure 3-3: Beaver Lake Average Daily Water Demands Per Month 2018-2021 (Eldorado Reservoir Outlet)

As shown in **Figure 3-3**, the ADD during winter months is approximately 10 L/s – 60 L/s, whereas during the summer months the average flows consistently remain above 150 L/s and can be as high as 320 L/s. Similar trends are reflected in the maximum daily demands (MDD) as shown in **Figure 3-4,** which displays MDD per month between 2018 and 2021.

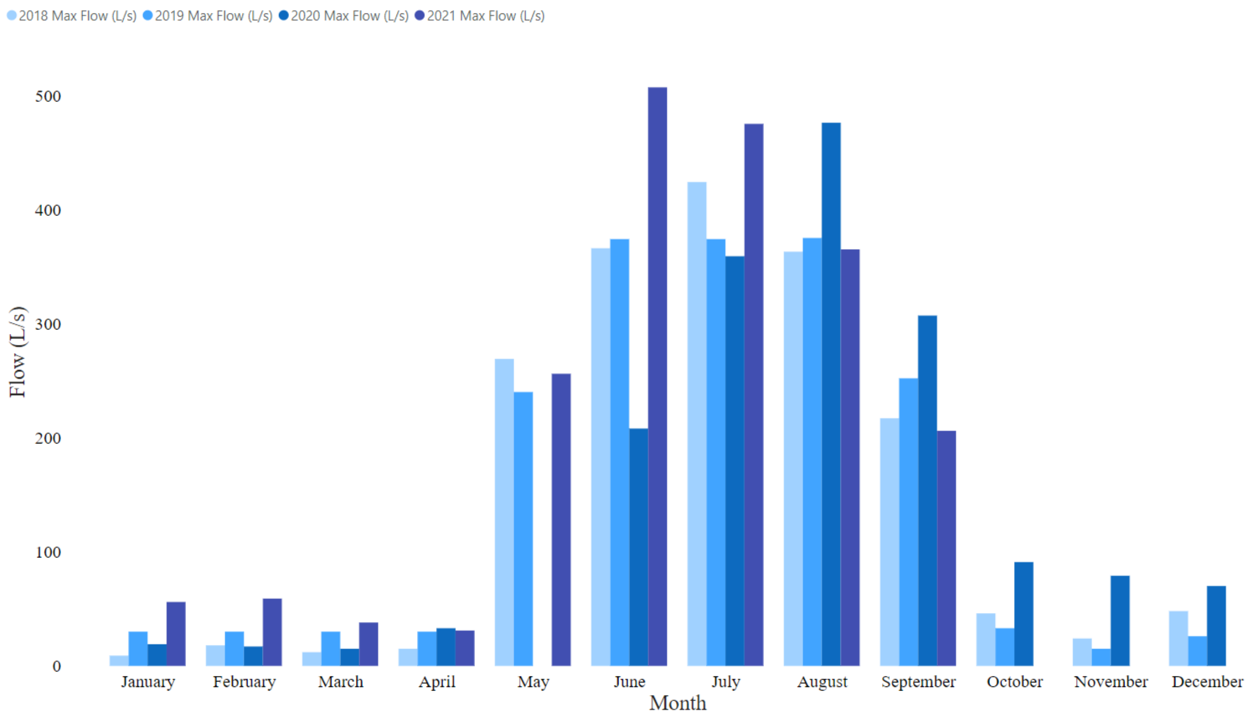


Figure 3-4: Beaver Lake Maximum Daily Water Demands Per Month 2018-2021 (Eldorado Reservoir Outlet)

The maximum daily flows per month generally match the seasonal pattern of average daily flows per month with peak daily demands occurring in July and August. The peaking ratio between the annual average daily demands and the maximum daily demand varies from 0.1-0.9 in the winter months (December-March) to 0.7-10 in the summer months (June-September). The average peaking ratio between maximum daily flow and annual average flow in the winter months is 0.32, compared to 3.9 in the summer months.

3.1.2 COMBINED OKANAGAN AND BEAVER LAKE SYSTEM FLOWS

This section of the report uses historical flow data for each independent system to estimate the combined water use for the Beaver Lake and Okanagan Lake systems. Section 3.2 will expand upon this analysis to project demands into the future for the ultimate combined system.

Combining cumulative monthly flow data for the Okanagan Lake and Beaver Lake systems from 2018-2020 results in the estimated demands of the Combined System presented in **Figure 3-5**.

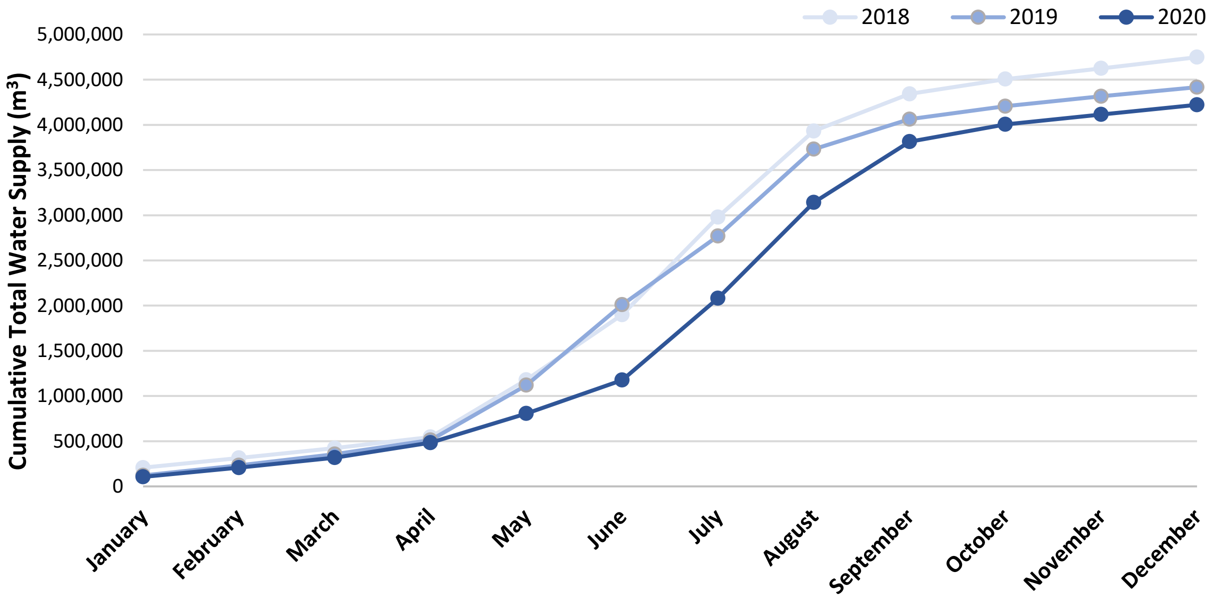


Figure 3-5: Okanagan and Beaver Lake Source Cumulative Demands

The cumulative flows of the combined system follow similar seasonal trends as the Beaver Lake system, with most of the demands occurring in summer months of June, July, and August. This is partially due to the consistency in Okanagan Lake demands over the year, as shown by the water licensing allocations in **Figure 2-10.** However, these trends are also consistent when compared with flows from other communities in the Okanagan Valley, with low monthly flows during the winter seasons, an exponential increase during summers due to increase in residential and agricultural irrigation demands, and a subsequent plateau after September when irrigation demands drop off. The cumulative demand for the Combined System peaked at 4.7 million m^3 in 2018 and dropped off in both the consecutive years of 2019 and 2020. This may be due to drier summers during the 2018 season in the Okanagan Valley which would have increased agricultural and residential demands for irrigation.

Based on the current water licenses held by the District for these two systems, as summarized Appendix C and **Figure 2-10**, the cumulative annual water allocation for the combined system is approximately 20.5 million m^3/year, for both waterworks and irrigation purposes. Comparing this total allocated volume to historic utilization, the cumulative demands from these two sources only account for approximately 20% of the water license allocations.

Table 3-1 summarizes the average annual contributions to combined system flows from each source, while **Figure 3-6** presents the average monthly distribution of water demands between the Okanagan Lake and Beaver Lake water systems from 2018 to 2021.

Table 3-1: System Contributions to Total Annual Flow (2018-2021)

	PERCENT CONTRIBUTION TO TOTAL ANNUAL FLOW			
SYSTEM	**2018**	**2019**	**2020**	**2021**
Okanagan Lake	45%	40%	41%	35%
Beaver Lake	55%	60%	59%	65%

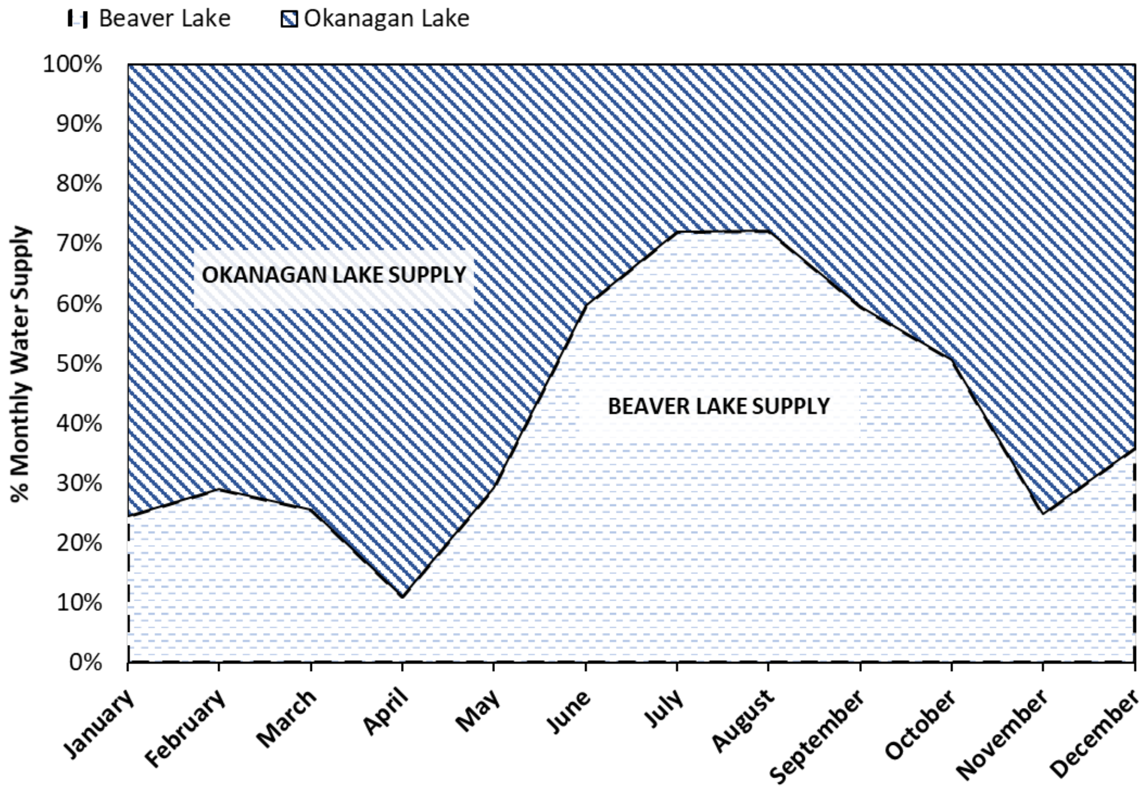


Figure 3-6: Monthly Distribution between Okanagan Lake vs Beaver Lake Systems

As shown in **Figure 3-6**, the District currently utilizes Okanagan Lake to supply most demands (>75%) during the winter months of January, February, and March. There is a noticeable reduction of Beaver Lake use in April, which is consistent with water quality degradation in Beaver Lake source due to the onset of the freshet season. As residential and irrigation demands pick up in summer months, the supply from Beaver Lake increases to between 50-70% of the total demand in the system. The District then transitions their reliance back to Okanagan Lake as irrigations demands drop off in the fall and winter months.

The source water management between Okanagan Lake and Beaver Lake water systems is generally consistent with the licenced water uses for each source. The reliance on the Beaver Lake water sources increases during the irrigation season to satisfy the agricultural users, while the bulk of the residential demands are supplied from Okanagan Lake.

The monthly flow data received from the District was used to calculate the combined monthly flows for the Okanagan and Beaver Lake systems using the following assumptions:

1. Average daily flows are based on number of days in each month;
2. Average daily flows are based on 24 hours of operation per day; and
3. Average daily flows for both systems can be added together to get the cumulative average daily flows for the combined systems.

Based on the assumptions discussed above, **Figure 3-7** presents the calculated average daily flow for each month of the combined system using 2018-2021 data sets (2021 data was available through September).

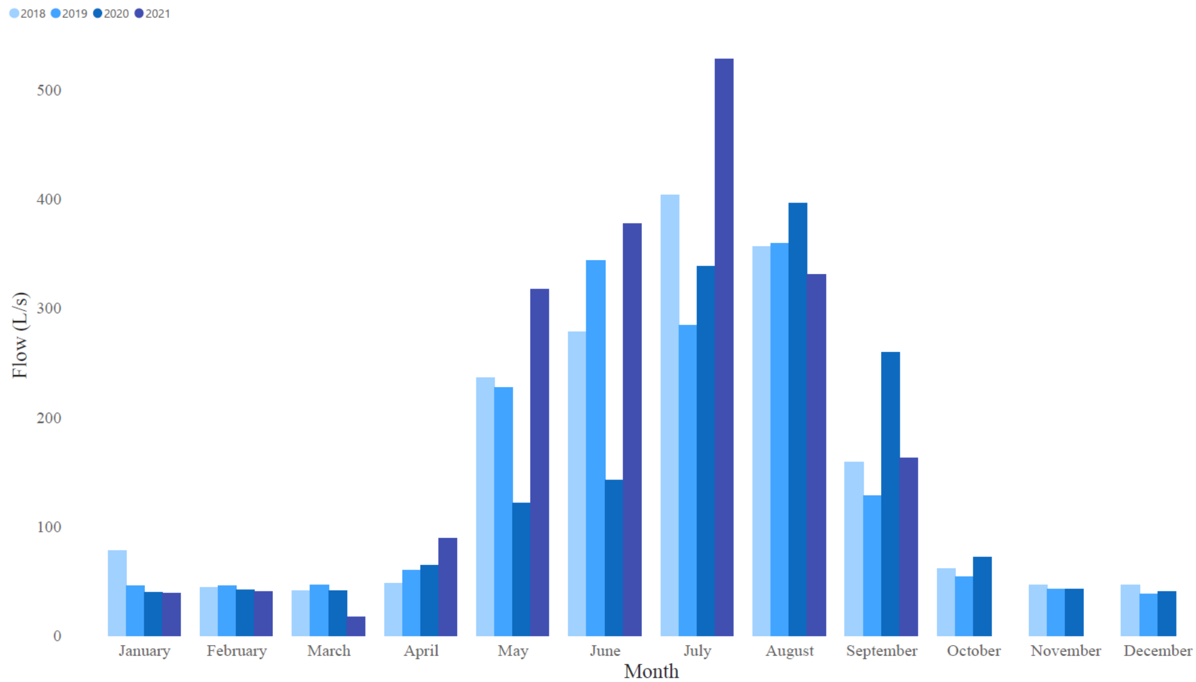


Figure 3-7: Estimated Average Daily Flows for the Combined System Using 2018-2021 Data Sets

Using historic flow data, the average daily flow projections for the combined system have a seasonal turndown of 10:1 between the summer peak demands and the low winter demands. The combined average daily demand peaks to as high as 560 L/s in July (utilizing the 2021 data set), and a low of 60 L/s in the winter months for all data sets.

3.2 PROJECTED WATER DEMANDS

Urban Systems completed an update to the District's WMP in 2020. The updated WMP, provided the ultimate ADD and MDD projections for the combined Okanagan/Beaver Lake system in 2041. These projections were based on anticipated growth in the area and assumed a year-on-year water demand increase of 1.51%. Applying this linear growth trend results in the estimated, ultimate ADD and MDD shown in **Table 3-2** for the combined system.

Table 3-2: Ultimate Demands Okanagan/Beaver Source Combined (Water Master Plan, 2020)

PARAMETER	FLOW (ML/DAY)	FLOW (L/S)
Ultimate ADD (2041)	20	231
Ultimate MDD (2041)	65.7	761

For both water systems, Okanagan Lake and Beaver Lake, average, minimum, and maximum daily flow data was provided for each month by the District. Flow data utilized in the analysis for the Okanagan Lake system demands were taken at the Okanagan Lake Pumphouse, while the Beaver Lake system flow data was recorded at the Eldorado Reservoir outlet. Due to the nature of the Combined System, the maximum monthly flow data provided could not be used directly to estimate the MDD of the entire system without artificially inflating that value; this is because it cannot be assumed that the maximum daily demand per month for each system occurred on the same day.

To estimate future MDDs from the combined system using 2017-2021 data sets, the annual average and maximum monthly flows for each system, in each month, were used to calculate monthly peaking factors (PF) for each year, following **Equation 1**.

$$Monthly\ Peaking\ Factor_{Month\ Y, Year\ X} = \frac{Maximum\ Monthly\ Flow_{Month\ Y, Year\ X}}{Annual\ Average\ Flow_{Year\ X}}$$

Equation 1

For example, the PF for January 2017 was calculated by dividing the maximum monthly flow for January 2017 by the average annual flow from 2017. The result of **Equation 1** was a monthly PF based on historic data for each month and each year from 2017-2021. The intention in calculating a monthly PF for each year of data was to properly capture seasonal variations in peak demand.

To project ultimate MDDs based on seasonal variations in peak demand for each system, these monthly peaking factors for each year of data (2017-2021) were then multiplied by the ultimate average daily flow rate for the combined system of 20 ML/day, as projected by Urban Systems and as shown in **Table 3-2**. This resulted in projected maximum daily demands for each system (Beaver Lake or Okanagan Lake), for each month, for each year of data (2017-2021). To avoid artificially inflating the Combined System’s flows, these MDDs for each system were then multiplied by each system’s contribution to the total annual flows from **Table 3-1**, as shown in **Equations 2** and **3**:

$$\frac{System\ 1\ Average\ Annual\ Flow_{Year\ X}}{System\ 1\ Average\ Annual\ Flow_{Year\ X} + System\ 2\ Average\ Annual\ Flow_{Year\ X}} = System\ 1\ \%\ Contribution\ _{Year\ X}$$

Equation 2

$$System\ 1\ \%\ Contribution\ _{Year\ X} * System\ 1\ Monthly\ PF_{Month\ Y, Year\ X} * 20\ ML = System\ 1\ Estimated\ MDD_{Year\ X, Month\ Y}$$

Equation 3

The result of Equation 3 is an estimated maximum daily demand for each system at the ultimate flow rate, based on each systems contribution to the combined annual flow that year and seasonal variations in peak demands. The resulting MDD for each system and each month resulting from **Equation 3** were added together to forecast the ultimate MDDs for the combined system. This series of calculations was completed for the 2017-2021 data sets, resulting in the demands shown in the columns of **Figure 3-8**. Given the variability of the forecasted values, the average monthly forecasted value was used for the treatment capacity sizing analysis for the Beaver Lake system, as shown by the black line on **Figure 3-8**.

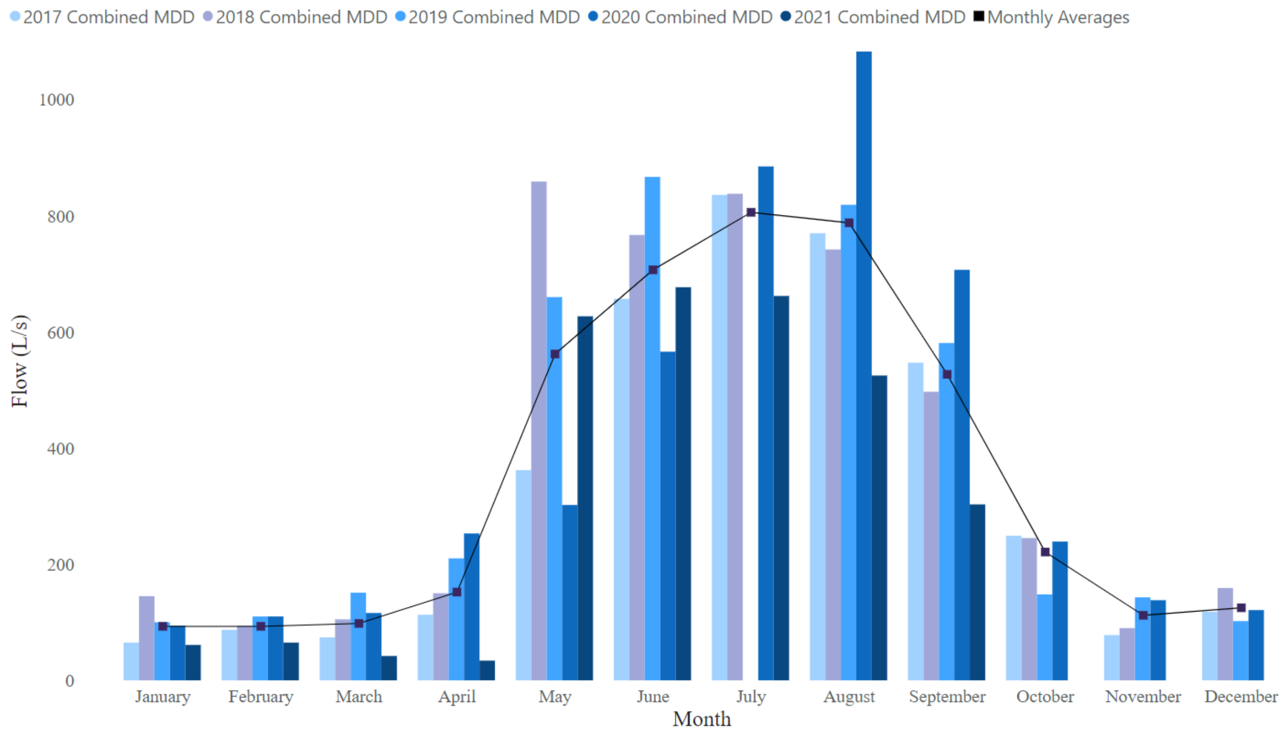


Figure 3-8: Forecasted Ultimate Maximum Daily Demand Projections for the Combined System (2041)

From **Figure 3-8,** the forecasted MDD for the combined Okanagan/Beaver system is highest in the month of July, at 806.5 L/s[1], with the minimum demands in January/February at approximately 93 L/s. The projected MDDs for July and August currently exceed the projected Ultimate MDD of 761 L/s from the 2020 Updated WMP. The average annual MDD from the analysis contained herein is 357 L/s, with a low MDD of 93 L/s predicted to occur in January and February. The calculated, ultimate MDD for each month is presented in **Table 3-3**.

Table 3-3: Forecasted Ultimate Combined Maximum Daily Flows per Month

MONTH	CALCULATED ULTIMATE MDD (L/S)	MONTH	CALCULATED ULTIMATE MDD (L/S)
January	93	July	806
February	93	August	788
March	98	September	527
April	152	October	221

[1] The forecasted MDD for July of 806.5 L/s was obtained from averaging projections from the 2017, 2018, 2020, and 2021 data sets, excluding 2019. The projection for MDD from the 2019 data set was 132.5 ML/day, almost double the projected ultimate MDD from the 2020 WMP. Comparing the July PF from the 2019 data sets for Okanagan Lake and Beaver Lake to that of other years, showed that the Beaver Lake system experienced unusually high flow conditions during July of 2019. The monthly PF calculated for Beaver Lake in July of 2019 was 10, compared to 3.5-5.2 in the other years. For these reasons this value was assumed to be an outlier and was excluded from the forecasting analysis.

MONTH	CALCULATED ULTIMATE MDD (L/S)	MONTH	CALCULATED ULTIMATE MDD (L/S)
May	562	November	112
June	707	December	125

4 DESIGN CRITERIA

4.1 WATER TREATMENT DESIGN CAPACITY

Pursuant to Project Objective 2 (**Phased Approach to Long Term Treatment Strategy),** the proposed design flowrate for the new Beaver Lake water treatment plant (WTP) considers the interconnectedness of the District's water system. The design capacity of the proposed Beaver Lake Water Treatment Plant is therefore considered in relation to the Okanagan Lake system capacity and the current and ultimate demands of the combined Beaver Lake and Okanagan Lake water systems. For this reason, the design capacity of the Beaver Lake WTP does not need to fully meet the projected 2041 MDD (Section 3.2) or provide a 100% treatment capacity to the overall system demand. The existing Okanagan Lake pumping system capacity at the Glenmore Booster Station of 200 L/s (with no redundancy) is assumed to be a consistent contributing supplier to the overall system demand next to the Beaver Lake WTP.

Table 4-1 presents the resulting system redundancies given a range of possible Beaver Lake WTP design flows between 470 L/s and 806 L/s.

Table 4-1: Resulting System Redundancies given Beaver Lake WTP Capacities at the Projected 2041 MDD and ADD

BEAVER LAKE DESIGN FLOW (L/s)	OKANAGAN CAPACITY (L/s)[1]	TOTAL SYSTEM CAPACITY (L/s)	SYSTEM REDUNDANCY-FUTURE DEMAND		SYSTEM REDUNDANCY-CURRENT DEMANDS	
			2041 MDD	2041 ADD	MDD	ADD
470	200	670	0.83	2.89	1.76	4.38
550	200	750	0.93	3.24	1.97	4.91
760	200	960	1.19	4.15	2.52	6.28
806	200	1,006	1.25	4.35	2.64	6.58

[1] Glenmore Booster Station capacity

The recent acceleration in population growth in the District was also a consideration in determining the appropriate level of system redundancy to adopt. A 470 L/s design flow will provide approximately 76% redundancy in the combined system's capacity for current demands, providing some additional flexibility to changes in future water demands. However, an ultimate capacity of 470 L/s would not be sufficient for the projected 2041 demands. Conversely, an 806 L/s design flow would offer a very conservative level of source supply redundancy for current system demands at approximately 164% redundancy, and approximately 25% redundancy for the ultimate system demands.

The 550 L/s WTP capacity option offers 97% system redundancy now, with no redundancy for the ultimate system demands. While the 760 L/s option (current Eldorado low lift pumping capacity) would provide approximately 152% system redundancy now, and 19% redundancy in treated water supply to the ultimate Combined System, resulting in limited flexibility to accommodate equipment malfunctions or major water quality events in one of the two water systems during peak summer demands.

To balance the desire to provide system redundancy and flexibility to meet current and future flow conditions with the desire to reduce capital costs associated with building a larger WTP initially, **Table 4-2** presents the proposed Stage 1 and Ultimate Treated Water Design Capacity for the new Beaver Lake Water Treatment Plant.

Table 4-2: Beaver Lake System Treated Water Design Capacity

STAGE 1 (L/S)	ULTIMATE (L/S)
550	760

The Stage 1 treated water design capacity of 550 L/s provides almost full system redundancy for current demands, while the ultimate design capacity of 760 L/s will provide partial system redundancy for future flow conditions. The Stage 1 capacity will be used for selection and sizing of the initial primary unit processes with provisions to expand the main treatment process to meet the Ultimate system capacity. Site layout, civil piping, and the administration area will be based on the Ultimate treated water design capacity as well as areas where future expansion would not be practical (e.g., chemical storage area).

The following additional design flow values will be used for the planning and design of the proposed water treatment facilities:

- The projected Average Daily Demand (ADD) = 153 L/s (Stage 1); 211 L/s (Ultimate)[2].
  - ADD is used to estimate the WTP's consumables, such as chemicals, power consumption.
- Maximum Monthly Demand (MMD) = 550 L/s (Stage 1), presented in Section 3.2,
  - MMD is used to size the chemical storage capacity in the WTP.

Figure 4-1 and **Figure 4-2** illustrate the resulting treatment redundancy using the proposed build-out MDD and ADD, respectively, in 2041.

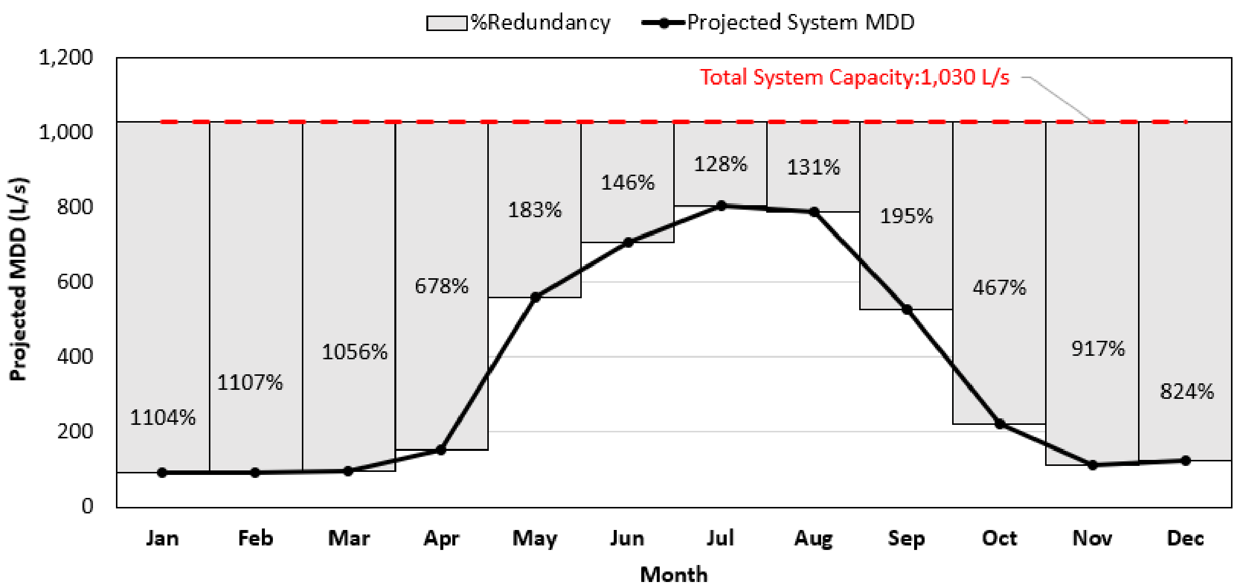


Figure 4-1: Resulting Total Treatment Redundancy at the Projected 2041 System MDD by Month

[2] 3.6 x MDD as defined in the Water Master Plan report (Urban Systems, 2020)

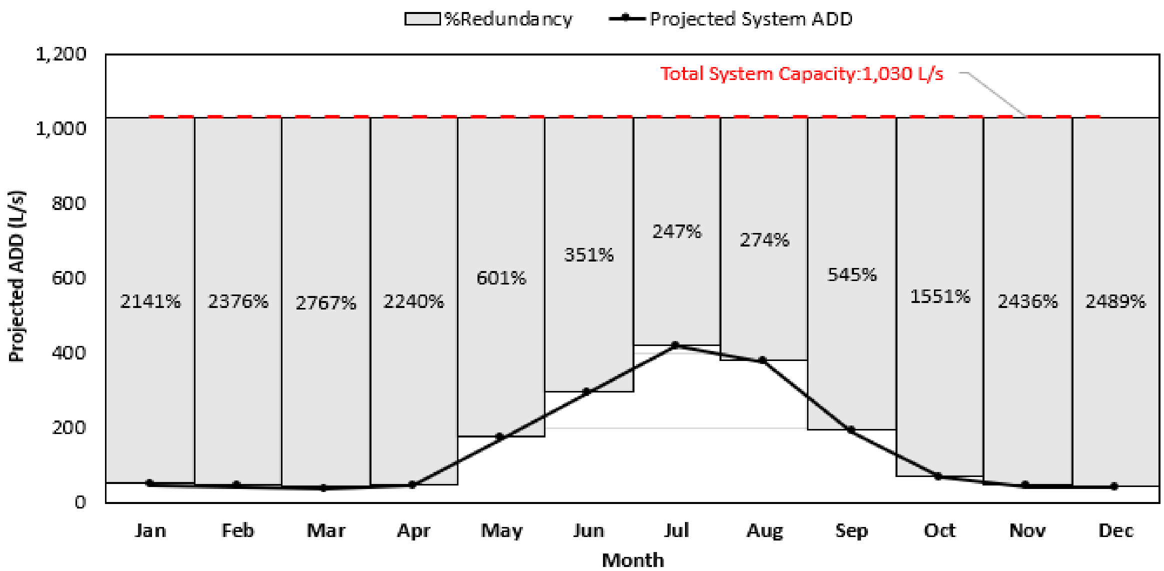


Figure 4-2: Resulting Total Treatment Redundancy at the Projected 2041 System ADD by Month

4.2 TREATMENT OBJECTIVES

The treatment objectives of the new water treatment plant will be to meet the potable water requirements per the Drinking Water Protection Act (DPWA) and the BC Design Guidelines, as mandated by the Drinking Water Officer (DWO) for a surface water source. Relevant standards and guidelines used to inform the development of the treatment objectives include:

- Drinking Water Treatment Objectives for Surface Water Supplies in British Columbia (March 2012)
- Guidelines for Canadian Drinking Water Quality (Health Canada, 2010)
- Draft Design Guidelines for Drinking Water Systems and British Columbia (February 2022)
- Draft British Columbia Guidelines for Pathogen Log Reduction Credit Assignment (February 2021)

As a minimum, treatment shall be provided to address microbial parameters, including enteric viruses, pathogenic bacteria, *Giardia* cysts, and *Cryptosporidium* oocysts. A comprehensive set of treatment objectives are presented in **Table 4-3**.

Table 4-3: Beaver Lake Water System Treatment Objectives

PARAMETERS	VALUE	COMMENTS
Alkalinity	> 30 mg/L as $CaCO_3$	Maintain adequate buffering capacity of the treated water to prevent unstable pH in the distribution system.
Aluminum	≤ 0.100 mg/L	Operational guideline for treatment processes relying on aluminum-based coagulants.
Hardness	> 50 mg/L as $CaCO_3$ < 150 mg/L as $CaCO_3$	Prevent corrosion Aesthetic objective to prevent scaling
pH	7 – 10.5	1 Optimize coagulation chemistry; 2 Maintain stable, non-corrosive water entering the distribution system.

PARAMETERS	VALUE	COMMENTS
Algae	< 2,000 counts/mL	AWWA M57 objectives
Cyanobacterial toxins	0.0015 mg/L	Algae related health toxins
Bacteria	0 detectable E. coli coliforms and total coliforms.	
Protozoa Reduction	3-log (99.9%) reduction for both Giardia and Cryptosporidium	Pathogen log reduction treatment credit
Viruses	4-log reduction	Pathogen log reduction treatment credit
Turbidity	≤ 0.3 NTU for Conventional or Direct Filtration. ≤ 1.0 NTU for slow sand and diatomaceous earth filtration ≤ 0.1 NTU for membrane filtration	Turbidity target based on selected filtration technology.
True Colour	≤ 15	Operational target to be 60% reduction through the treatment facilities.
Total Organic Carbon	< 2 mg/L	
Haelocetic Acids (HAAs)	≤ 0.080	
Trihalomethanes (THMs)	≤ 0.100	

5 TREATMENT OPTIONS

This section presents different established water treatment options which can be considered by the District to meet the treatment objectives presented in Section 4.2. The development of these treatment options was largely driven by the selection of the main filtration technology, which governs the requirements for pre-treatment and disinfection. Subsequently, this section discusses filtration options and recommends the most suitable technology to effectively meet the treatment objectives given the source water quality. Following selection of the main filtration process, options for the associated pre-treatment stage as well as disinfection are discussed.

The project objectives identified in Section 1.2 were used to inform the shortlisting and selection of the preferred treatment train. These are highlighted below for ease of reference.

1. **Meet Regulatory Requirements:** Provide treatment to meet provincial and federal regulatory objectives for treatment of surface water.
2. **Phased Approach to Long Term Treatment Strategy:** Develop a treatment solution capable of meeting the long-term treatment needs while including provision for a phased implementation of infrastructure to meet the treatment and growth needs of the District's water systems. This includes continuity and integration with the District's overall water supply framework.
3. **Maximize Functional Benefit of Facility:** Provide a facility that centralizes the District's water utility resources and provides opportunities to engage the public and water users.
4. **Stewardship:** Provide a cost effective and energy efficient design through integration of function, aesthetics, and innovation.

5.1 FILTRATION TECHNOLOGIES OVERVIEW

The three main filtration technologies that were reviewed and are discussed in the following sections include:

1. Rapid sand filtration (used in direct or conventional filtration treatment);
2. Slow sand filtration; and
3. Membrane filtration.

All three technologies were reviewed for their performance, complexity, footprint requirement, and suitability to treat the source water to meet the treatment objectives discussed in Section 4.2. **Table 5-1** provides an overview of the comparison.

Table 5-1: Filtration Options Overview Comparison

	RAPID SAND FILTRATION	SLOW SAND FILTRATION	MEMBRANE FILTRATION
Complexity	Moderate	Low	Moderate - High
Backwash Residual	Yes	None	Yes
Raw Water Turbidity Limitation[1]	3000 NTU[2] 15 NTU[3]	< 10 NTU	1,000-3,000 mg/L of total solids
Filtered Water Turbidity	0.1 – 0.5 NTU	≤ 1 NTU	≤ 0.1 NTU
Pathogens Removal *Cryptosporidium* / *Giardia* / Viruses	3 / 3 / 2[2] 2.5 / 2.5 / 1[3]	3 / 3 / 2	3 / 3 / 0-2[4]
UV Disinfection	Potentially[2,3]	None	None

	RAPID SAND FILTRATION	SLOW SAND FILTRATION	MEMBRANE FILTRATION
Chlorine Disinfection	Yes	Yes	Yes
Footprint Requirement	Moderate	50 to 100x Rapid Filtration	Most concise
Expansion	Site limited. Potentially hard to accommodate	Very hard to accommodate	Easy to accommodate

[1]Based on draft Design Guidelines for Drinking Water Systems in BC (2021)
[2]Conventional filtration
[3]Direct filtration
[4]Type dependant – ultrafiltration membranes typically achieve 0-log removal of viruses, however nanofiltration membranes may achieve up to 2-log removal of viruses.

5.1.1 RAPID SAND FILTRATION

Rapid sand filters are used in both direct and conventional filtration processes. For both processes, raw water is chemically pre-treated in a coagulation-flocculation step to enhance turbidity removal by the filter media. Following this stage, flocculated water is settled in a sedimentation basin prior to conventional filtration. Whereas, in a direct filtration, flocculated water is directly applied to the filters without sedimentation.

At the filtration step, water is passed through 1 to 2 metres of specially designed filter media where solids are captured and retained in the media layer. Rapid sand filtration requires backwashing every 24 to 48 hours to remove the captured solids, and the spent backwash water must be sent to waste or secondary treatment.

The number of filters and their size would be determined so that when one filter is out of service (i.e., for backwashing) the filtration rate of the remaining units will not exceed the maximum allowable filtration rate. The maximum loading rates typically vary between 15 metres per hour (m/hr) to 20 m/hr. The filters generally consist of an underdrain (for collection of filtered water and distribution of backwash water), sand media, and anthracite coal media and inlet distribution troughs. In some cases, garnet or a gravel support layer under the sand is used.

Pros: Rapid sand filtration is a well-established technology that produces high quality water. Allowance for expansion is possible but would be a consideration and could possibly provide limitations in site selection.

Cons: Higher turbidity events may result in shorter filter runs, requiring more frequent backwashing, and more intensive residuals management. A moderate to high level of operational expertise is required. For chemical pre-treatment with low alkalinity water, focus on chemical usage will be critical to avoid high volumes of sludge and wastewater. UV disinfection would still be required if direct filtration is used to meet the minimum 3-log inactivation of protozoa.

The moderate level of complexity of the technology, as well as the high treatment reliability makes this technology the most suitable to treat the District's source water and therefore, is recommended to be further developed.

5.1.2 SLOW SAND FILTERS

Slow sand filtration provides both biological and physical treatments to the raw water as water is passed through a fine sand filter at very low rates. During operation, a biological layer forms in the top 1 to 3 centimeters, called a *Schmutzdecke*. This biological layer provides the necessary filtration to achieve potable water following the filtration stage. Slow sand filters are effective for the removal of bacteria and protozoa, and low levels of turbidity (~10 NTU or less). When the head loss through the filter exceeds approximately 2 metres, the filter is taken off-line and the *Schmutzdecke* layer is scraped off and disposed. Filters are designed such that scraping occurs every 30 to 60 days, depending on water quality and plant flow. The scraping process is repeated until the wear layer (typically 600 mm) is removed, and the sand bed is re-filled. Loading rates vary between 0.1 to 0.2 m/hr.

Pros: Operationally the simplest technology. No backwash water is produced; therefore no residuals handling, treatment or disposal would be required. UV disinfection would be not absolutely required to meet the minimum protozoa inactivation requirements.

Cons: Limited to source water with turbidity less than 10 NTU. Higher turbidities will require more frequent scraping or a pre-treatment step. Surface loading rates are 50 to 100 times lower than rapid filtration, resulting in a significantly larger footprint which may not be accommodated by the existing site.

Due to the large footprint requirement and limited expansion ability, we do not recommend advancing this filtration technology further.

5.1.3 MEMBRANE FILTRATION

Membrane filtration water treatment is a process where raw water is forced by a hydraulic pressure gradient to flow through a thin membrane surface containing many microscopic pores. When water flows through the pores of the membrane surface, materials suspended in the water that are larger than the membrane pore size will be retained by the membrane due to pore-size exclusion. As the solids collect and build-up on the membrane surface it will form a thin filter-cake layer which must be periodically backpulsed (BP) from the membrane surface by briefly reversing the flow of water from the permeate side to the feed side. The dirty BP water is then flushed from the membranes to waste. For drinking water applications, a membrane integrity test (MIT) is periodically performed to confirm the membrane is free of defects and is sufficient to meet the required system log-reduction-value (LRV). This validation is typically achieved using pressurized air in a “pressure decay” test to detect holes or leaks in the membrane surface. Following the membrane filtration step, chemical disinfection occurs for maintenance of a chlorine residual within the distribution system.

Membranes with pore size from 0.002 to 0.1 microns are generally referred to as ultrafiltration (UF) and typically have operating pressure from 200 to 700 kPa (30 to 100 psi). Microfiltration (MF) is generally referred to membranes with pore size from 0.03 to 10 microns and typically have operating pressure from 100 to 400 kilopascals (kPa). Membrane filters are also available in a wide variety of membrane materials, configurations, and flow patterns.

Pros: Membrane filtration produces high-quality water with relatively high efficiency: 4 – 8% of the water passing through the plant will be wasted. UV disinfection would not be required. Allowance for expansion is relatively straight forward. Requires the least footprint of the three filtration options considered. No chemicals are added to the drinking water. Although it requires somewhat complex electrical-mechanical equipment, membrane filtration is simple in concept and operation, with many plants unmanned much of the time.

Cons: Operationally the most mechanically complex filtration technology of the options considered, requiring highly skilled operators. Backwash residuals must be handled. Care must be taken if chemical pre-treatment is used to prevent chemical fouling on the membranes. Natural organics in raw water can easily foul membranes. This technology has the highest energy requirements of the filtration technologies under consideration. The membranes need to be replaced approximately every 10 years, which results in a significant asset renewal cost.

Due to the high organics, low-to-moderate turbidity, and potential for algae in the raw water, it is likely that pre-treatment through a coagulation-flocculation-clarification stage prior to membrane filtration will be required. This will increase level of complexity of the plant, energy requirements, as well as the requirement for highly skilled operators. For these reasons, we do not recommend advancing this filtration technology further.

5.2 DEVELOPMENT OF SHORTLISTED TREATMENT TRAIN OPTIONS

This section compares three treatment combinations to further our recommendation of advancing rapid sand filtration technology from Section 5.1. These different combinations were reviewed for their treatment efficacy in treating high organic, colour, and algae the influent water, treatment reliability and complexity, as well as impact on footprint as shown in **Table 5-2**.

Table 5-2: Process Combination Overview Comparison

	DIRECT FILTRATION	DAF/FILTRATION	HIGH-RATE SEDIMENTATION/ FILTRATION	IN-FILTER DISSOLVED AIR FLOTATION (DAFF)
Complexity	Moderate	Low	Low	Moderate - High
Raw Water Turbidity Limitation	≤ 15 NTU Sensitive to variable turbidity	≤ 100 NTU Less sensitive to variable turbidity	≤ 3000 NTU Least sensitive to variable turbidity	≤ 30 NTU
Organic/ Colour Reduction	Limited	Excellent	Good	Excellent
Algae Resilience	Least resilient	Excellent	Good	Excellent
Filtered Water Turbidity	0.1 – 0.5 NTU	0.1 – 0.5 NTU	0.1 – 0.5 NTU	0.1 – 0.5 NTU
Treatment Credits *Cryptosporidium* / *Giardia* / Viruses	2.5 / 2.5 / 1	3 / 3 / 2	3 / 3 / 2	3 / 3 / 2
UV Disinfection Credit	0.5-log reduction	0	0	0
Chlorine Disinfection Credit	3	2	2	2

5.2.1 DIRECT FILTRATION

The direct filtration process involves coagulation to disperse the chemical coagulant quickly and uniformly throughout the raw water. An abbreviated flocculation step following coagulation is provided to create “pin-floc” for filtration. Flocculation for direct filtration requires a lower hydraulic retention time, as compared with conventional filtration, as the intent is to produce a smaller floc particle for removal by filtration as opposed to larger floc intended for downstream settling.

The filtration process serves as the final treatment barrier for the physical removal of particulate matter and pathogenic organisms. Direct filtration can accommodate moderate turbidity spikes with the usual result of shortened filter runs. The difference between direct filtration and conventional filtration is that direct filtration does not have a clarification step.

Direct filtration can provide up to 2.5-log reduction of *Giardia* and *Cryptosporidium* and 1-log reduction of viruses. Subsequently, filtrate disinfection would require UV disinfection to provide the remaining 0.5-log reduction for *Giardia* and *Cryptosporidium*, as well as chlorine disinfection to provide the remaining 3-log reduction for viruses per the GCDWQ and secondary disinfection for distribution. Refer to **Table 5-3** for treatment credits received through direct filtration by treatment unit.

Table 5-3: Direct Filtration Log Removal by Treatment Unit

	LOG REMOVAL			
CRITERIA	FILTER	UV	CHLORINE	TOTAL
Giardia	2.5	0.5	-	3.0
Cryptosporidium	2.5	0.5	-	3.0

	LOG REMOVAL			
CRITERIA	**FILTER**	**UV**	**CHLORINE**	**TOTAL**
Viruses	1	-	4	5.0
Turbidity (NTU)	<0.3			

A stream of residual will be created by the spent backwash from the rapid sand filtration system. This stream will account for approximately 5-10% of the total feed flow and must be handled and disposed of. **Figure 5-1** presents a typical process flow diagram of a direct filtration system.

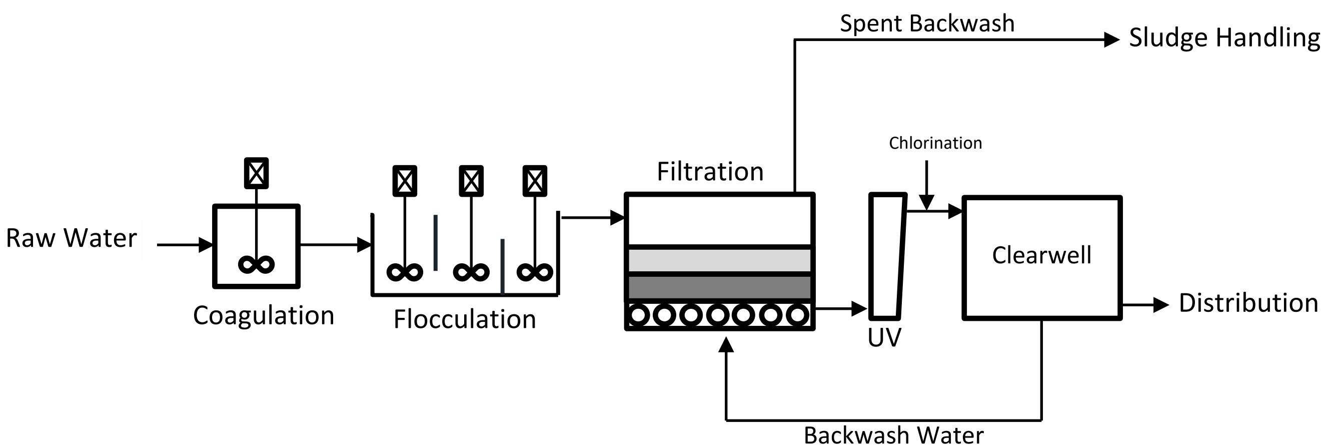


Figure 5-1: Typical Process Flow Diagram of a Direct Filtration System

Pros: Direct filtration is an established technology and provides a consistent treated water quality. Treatment expandability is possible if planned for in the initial stages of design.

Cons: Direct filtration is appropriate for low turbidity and coloured waters. Algae events will challenge filter performance and require skilled operators to correct changes in coagulation chemistry and increased backwashing. The low alkalinity water makes coagulant chemistry challenging. Direct filtration offers limited organics reduction.

Referenced treatment plants in BC: Seymour-Capilano Water Treatment Plant, Comox Water Treatment Plant, Salmon Arm Water Treatment Plant.

5.2.2 CLARIFICATION / FILTRATION

The conventional filtration option is similar to direct filtration in that it also involves coagulation, flocculation, and filtration. However, in conventional filtration, flocculated water is settled in a clarifier prior to being filtered. As such, conventional filtration is typically able to accommodate wider fluctuations in water quality. The combination of clarification and rapid sand filtration provides adequate log reduction credits that meet the GCDWQ for *Cryptosporidium* and *Giardia* and half of the required credits for viruses. Subsequently, disinfection requirements for the filtrate will be limited to chlorination to provide the remaining log reduction credits for viruses, as well as adequate secondary disinfection for distribution. Refer to **Table 5-4** for treatment credits received through conventional filtration by treatment unit.

Table 5-4: Clarification + Filtration Log Removal by Treatment Unit

	LOG REMOVAL			
CRITERIA	**CLARIFIER/FILTER**	**UV**	**CHLORINE**	**TOTAL**
Giardia	3.0	-	-	3.0
Cryptosporidium	3.0	-	-	3.0
Viruses	1	-	4	5.0
Turbidity (NTU)	<0.3			

There are several established clarification processes that are used in municipal water treatment. However, only high-rate clarification processes were considered for this study to minimize detention time and footprint of the process. Two high-rate clarifications were reviewed and discussed as follows:

5.2.2.1 DISSOLVED AIR FLOTATION (DAF)

Dissolved air flotation (DAF) basins are typically equipped with an aerator/ diffuser system and a float scraper. The aerator introduces micro-bubbles into the flocculated water, which then adhere to the floc particles in the water. The adherence of the bubbles effectively reduces the specific gravity of the flocs, causing them to float to the surface. The accumulated flocs on the surface will create a layer which then scraped and removed into a float collection trough to be conveyed to a residual handling system.

The clarified water is removed from the bottom of the tank through an underfloor baffle or a perforated pipe manifold into a clarified tank and overflows through an adjustable weir into the filtration stage. A portion of the clarified water is aerated and recirculated back to the front of the DAF basin to be pressurized into microbubbles. The loading rate of a DAF system is typically between 10 m/hr to 15 m/hr for conventional DAF and 20 to 40 m/hr for high-rate DAF. The DAF process is particularly good at treating water with high natural organic matter, high colour, low turbidity, and high algae content. **Figure 5-2** illustrates the typical process flow diagram of a DAF system.

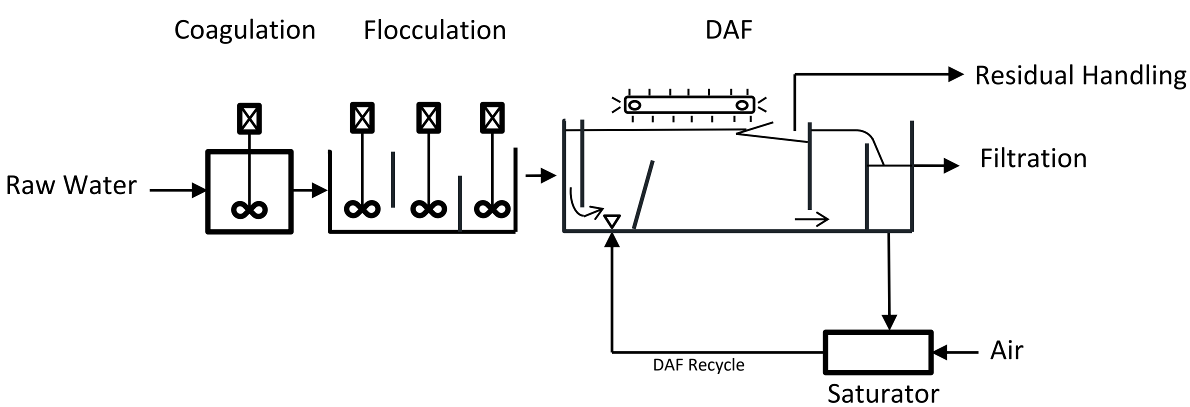


Figure 5-2: Typical Process Flow Diagram of a DAF System

Pros: Excellent for treating seasonal algal blooms and organics in water as the DAF process can be turned off seasonally. More efficient at removing low density particles than conventional settling. Requires slightly less footprint than conventional settling.

Cons: Limited to turbidities less than 100 NTU. More complex mechanical components and maintenance requirements.

Referenced treatment plants in BC: Penticton Water Treatment Plant (High-Rate DAF).

DAF is considered the most suitable clarification technology for this application given the low turbidity, high organics, and potential for algae in the Beaver Lake source water. Either high-rate or conventional DAF are suitable for further consideration.

5.2.2.2 HIGH-RATE SAND BALLASTED CLARIFIER

Sand ballasted clarifier involves the addition of ballast in a form of microsand during flocculation. This process is commercially known as Actiflo® which is patented by Veolia Water Technologies. Raw water is typically injected with a coagulant in the inlet pipe and rigorously mixed in a coagulant tank. The coagulation process is used to disperse the chemical coagulant quickly and uniformly throughout the raw water. Following coagulation, polymer and microsand is injected into and intimately mixed in the flocculation tank to accelerate the rate of particle collisions, causing the agglomeration of destabilized colloidal particles into settleable and filterable sizes.

The addition of the microsand increases the density of the floc particles which effectively increases the settling velocity of the floc particles and therefore, allows for a more compact design of the settling tank. In addition, the microsand addition also buffers the fluctuation in raw water quality, providing the system with process stability. The settling tank is typically equipped with lamella and a bottom scraper. In the sedimentation tank, the ballasted flocs quickly settle into the bottom of the tank, whereas the clarified water rises through the lamella and to the common effluent launder, to be conveyed into the filtration stage. The loading rate of an Actiflo® system is typically ranging between 80 m/hr to 100 m/hr depending on the raw water quality.

The settled ballasted flow in the bottom of the tank is scraped and pumped to a hydrocyclone for ballast-slurry separation. The recovered ballast reports to the underflow and is fed back into the flocculation tank, whereas the residual slurry reports to the overflow and is conveyed to the residual handling system. **Figure 5-3** illustrates a typical process flow diagram of an Actiflo® system.

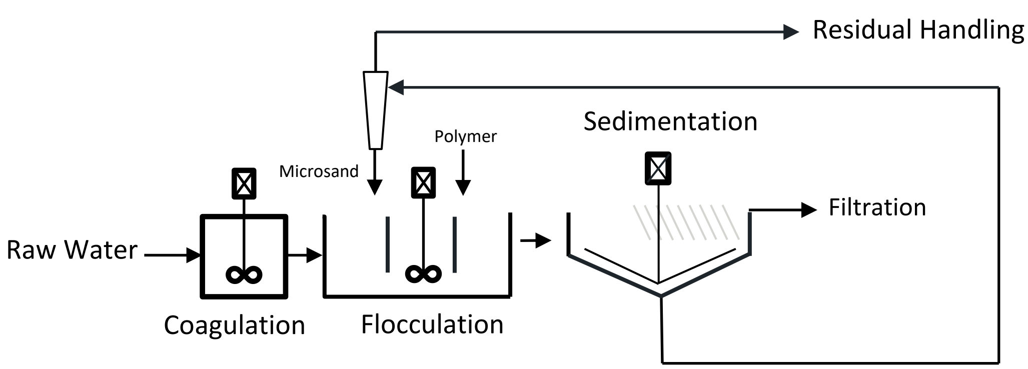


Figure 5-3: Typical Process Flow Diagram of an Actiflo® System

Pros: A quick process start-up (~15 minutes). Robust process that is not easily upset by changes in raw-water quality. Can handle high levels of raw water turbidity. Turbidity in the effluent may be as low as 0.5 NTU level. Lowest footprint of considered clarification technologies.

Cons: Heavy dependence on mechanical equipment. Higher coagulant dosage is typically required, as well as microsand and polymer which requires higher mixing energy. Microsand and polymer addition can lead to challenges in downstream processes, (i.e., filter blinding and reduced filter run time). Actiflo® is a proprietary process and can therefore limit competitive bidding.

Referenced treatment plants in BC: Summerland Water Treatment Plant.

Given the complexity of the system, additional chemicals/microsand requirements, relatively good source water quality, and the limited competitive bidding, this technology is not recommended to advance with the preferred clarification and filtration treatment train.

5.2.2.3 PREFERRED CLARIFICATION / FILTRATION TREATMENT TRAIN

Figure 5-4 illustrates the complete flow diagram of a treatment train with the recommended process of DAF clarification followed by filtration. A stream of residual will be created in the form of DAF float sludge as well as the spent backwash from the rapid sand filtration system. These streams will account for approximately 5% of the total feed flow and must be handled and disposed of.

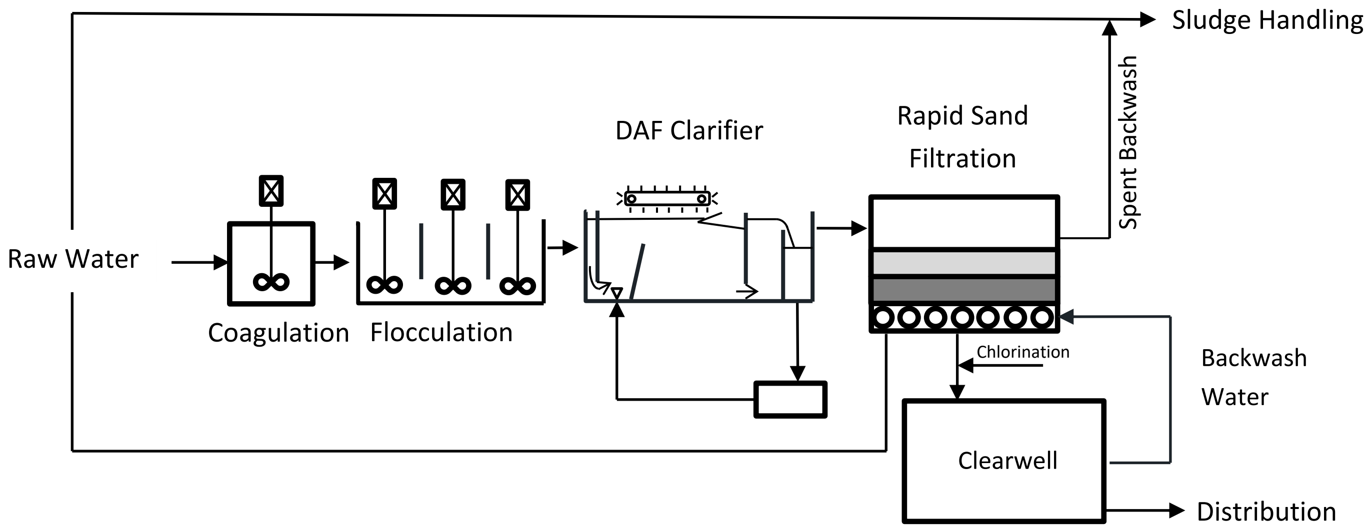


Figure 5-4: Typical Process Flow Diagram for DAF and Filtration Train

Pros: Well established technology. Works well in moderate- to high-turbidity waters. Clarification basin detention time allows for NOM, taste and odor, algae, and color removal. More operational flexibility than direct filtration. Can respond to changes in water quality, producing a consistent treated water. Can be expandable, if planned for during initial stages of design.

Cons: Turbidity events will result in increased sediment loading, requiring operator skill to correct changes in coagulation chemistry and increased backwashing. Low alkalinity water makes coagulant chemistry challenging.

The combination of DAF and filtration is well suited to address the source water characteristics based on the low turbidity, high organic content, and potential for algae.

5.2.3 IN-FILTER DISSOLVED AIR FLOTATION (DAFF)

In-filter dissolved air flotation (DAFF) combines DAF and rapid sand filtration processes in one common basin. Like the DAF process, flocculated water is introduced from a bottom baffle where pressurized recycle effluent is also introduced through a nozzle to create microbubbles that will bind with the floc particles and float through the lamella to create a floc layer on the surface of the basin. Unlike in DAF, the clarified water will continue to travel down through the filter media layer(s) and is recovered in the underdrain system.

The combination of the DAF and rapid sand filtration provides adequate log reduction credits that meet the GCDWQ for *Cryptosporidium* and *Giardia* and half of the required credits for viruses. Subsequently, disinfection requirements for the filtrate will be limited to chlorination to provide the remaining log reduction credits for viruses, as well as adequate secondary disinfection for distribution. Refer to **Table 5-2** for the treatment credits received on the pathogens of concern by in-filter dissolved air flotation.

A stream of residual will be created by the spent backwash from the rapid sand filtration system. This stream will account for approximately 10% of the total feed flow and must be handled and disposed of. **Figure 5-5** presents a typical process flow diagram of a DAFF system.

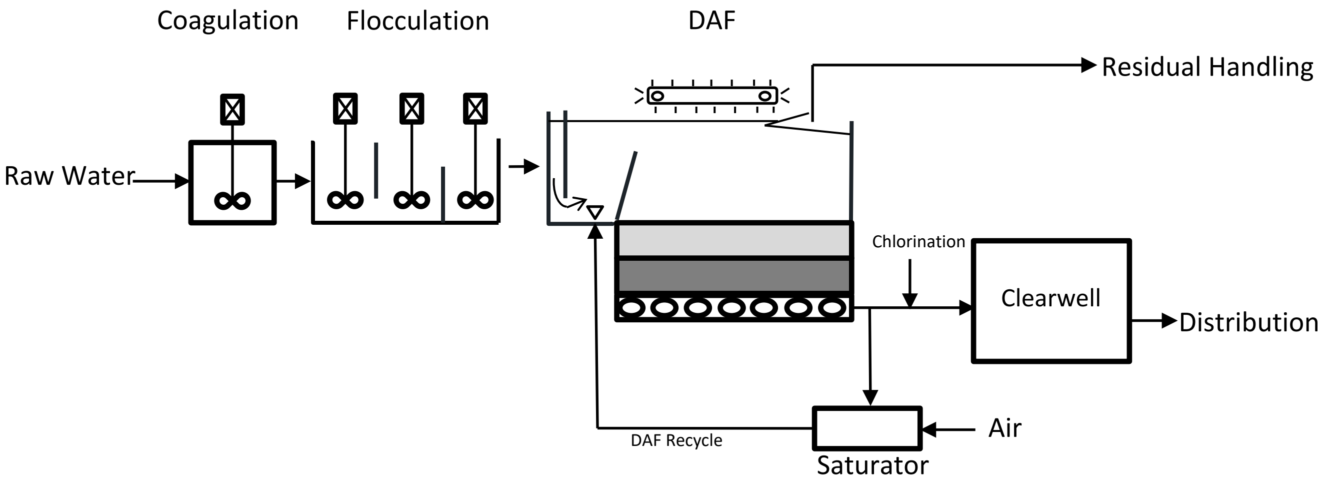


Figure 5-5: Typical Process Flow Diagram of a DAFF System

Pros: Less footprint than conventional filtration as the process combines clarification and filtration in one tank. Excellent for treatment of organics, colour, and algae.

Cons: Surface loading rate for the filtration is limited by the DAF process. Mechanically more complex than conventional filtration and requires more energy requirements than other high-rate clarification processes. Clarifier is taken offline during backwashing. System redundancy is reduced with the clarifier and filter unable to operate independently.

Referenced treatment plants in BC: Powers Creek Water Treatment Plant, West Kelowna, BC.

Infilter DAF is a suitable technology to meet the water quality challenges of the Beaver Lake source water and should be considered during subsequent treatment technology evaluations and pilot testing.

5.3 DISINFECTION TECHNOLOGIES

Two types of disinfection were considered: chlorine disinfection and UV disinfection. As a minimum, chlorine disinfection would be required to meet the 4-log reduction target in viruses. Chlorination would also have the secondary role of providing a residual in the distribution system. UV disinfection would only be required following direct filtration for meeting minimum protozoa inactivation requirements. Since direct filtration provides 2.5-log for reduction credits for *Cryptosporidium/Giardia*, an additional 0.5-log reduction would need to be achieved through UV to get the required 3-log reduction credit.

The District confirmed that they intend to continue to use the existing gas chlorination system for primary and secondary disinfection purposes. Provision for the future addition of a bulk hypochlorite or onsite hypochlorite generation system should be considered within the new treatment facility building and site planning.

UV disinfection is available in low-pressure-high-output and medium-pressure lamp technologies. UV would only be required if the District considered direct filtration or seasonally taking the DAF offline.

6 TREATMENT EVALUATION

This section summarizes the final evaluation of non-cost criteria and selection of treatment technology. Only the technical and operational criteria remain relevant in comparing the options. The technical and operational criteria (non-cost) and financial criteria were developed from the Project Objectives and consolidated into three groups which are described further in the following sections:

- **Meet Regulatory Requirements**
  - Treated Water Quality
- **Long Term Strategy with Phasing**
  - Reliability and Resilience
- **Stewardship**
  - Operation and Maintenance; and
  - Total Life Cycle Cost.

For each criterion, scoring metrics were defined to result in scores that are as objective as possible.

6.1 PRIMARY TREATMENT

6.1.1 TREATED WATER QUALITY

Water quality criteria captures the ability of the technology to both produce drinking water that meets the GCDWQ and be resilient to raw water changes based on the historical data and future predictions. The following tables present both the scoring metrics and the resulting scores by treatment technology.

Table 6-1: Water Quality Score Metrics

SUB-CRITERIA	RESILIENCE TO RAW WATER CHANGES	FINAL TREATED WATER PERFORMANCE
DEFINITION	Ability to handle sudden changes in water quality without plant modification (i.e., additional processes).	Ability to treat water to exceed GCDWQ guidelines for turbidity reliably.
1 = Less effective	Will not operate > 10 NTU.	Periodic excursions may be expected.
2 = Effective/ Acceptable	Will operate at > 10 NTU for very short periods.	Will meet the minimum performance.
3 = More effective	Will operate at > 10 NTU but requires more aggressive operation.	Will normally exceed the minimum performance with redundant measures.
4 = Most effective	Will operate at > 10 NTU with no noticeable impact to operation.	Will far exceed the minimum performance with redundant measures.

Table 6-2: Water Quality Scores

SUB-CRITERIA	DIRECT FILTRATION	DAF + FILTRATION	IN-FILTER DAFF
Resilience to raw water changes	— Effective with rapid and wide variations in turbidity up to 15 NTU. — Least ability to treat organics and algae.	— Most effective with rapid and wide variations in turbidity. Able to treat high turbidity up to 100 NTU. — Limited ability to treat organics and algae.	— Limited ability to treat turbidity, up to moderate turbidity of < 30 NTU. — Highly able to deal with high organics and seasonal algae.
Sub-Criteria Score	**2**	**4**	**3**
Final treated water performance	— Effective – high performance (quality) for turbidity removal (<0.3 NTU). — Requires additional UV disinfection for pathogen removal.	— Effective – high performance (quality) for turbidity removal (<0.3 NTU). — Meets requirements for pathogen removal.	— Effective – high performance (quality) for turbidity removal (<0.3 NTU). — Meets requirements for pathogen removal.
Sub-Criteria Score	**2**	**4**	**3**
OVERALL SCORE	**2**	**4**	**3**

6.1.2 RELIABILITY AND RESILIENCE

Reliability and resilience criteria capture the relative risks from normal equipment failures, number of treatment barriers, and relative ability to expand to changing treatment requirements. The following tables present both the scoring metrics and the resulting scores by treatment technology.

Table 6-3: Reliability and Resilience Score Metrics

SUB-CRITERIA	PLANT INFRASTRUCTURE RISK	TREATMENT BARRIERS	EXPANDABILITY
DEFINITION	Ability of system to continue operation even during individual system failure, adverse operating conditions, or interruption in chemical delivery.	Number of Barriers of Treatment and relative robustness of barriers.	Relative ease of expandability or adaptability.
1 = Less effective	Failure of single non-redundant device during adverse condition leads to plant non-conformance.	Less than 2 barriers can occur during normal operation.	WTP expansion beyond 140 ML/day, or additional treatment barriers infeasible or very difficult.
2 = Effective/Acceptable	Failure of single non-redundant device during adverse condition leads to higher risk.	Always two barriers of treatment.	Expansion is possible with some interruptions.

SUB-CRITERIA	PLANT INFRASTRUCTURE RISK	TREATMENT BARRIERS	EXPANDABILITY
3 = More effective	Failure of single non-redundant device during adverse condition has little risk.	Always two barriers of treatment where barriers are verifiable.	Expansion is possible with minimal plant interruption.
4 = Most effective	Failure of multiple non-redundant devices during adverse condition has little risk.	More than two barriers of treatment where at least two are verifiable.	Expansion is simple with zero plant interruption.

Table 6-4 Reliability and Resilience Scores

SUB-CRITERIA	DIRECT FILTRATION	DAF + FILTRATION	IN-FILTER DAFF
Plant Infrastructure (number, type, and reliability of equipment installed including consumables)	— Highly automated system with several devices and systems. — Less able to adapt to changes in raw water quality.	— Similar to Direct Filtration but slightly more electrical and mechanical systems. — Requires more energy than direct filtration. — Largest footprint.	— Filter and clarifier fail together. — Similar to Conventional Filtration in terms of mechanical and electrical requirements. — Similar in footprint to Direct Filtration.
Sub-Criteria Score	**3**	**3**	**2**
Multi-barrier Treatment	— Filtration (<0.3 NTU), UV, and Chlorination. — Dual pathogen barrier but not absolute, depending on UV operation. — Single physical treatment barrier	— Filtration (<0.3 NTU) and Chlorination. — Dual pathogen barrier but not absolute.	— Filtration (<0.3 NTU) and Chlorination. — Dual pathogen barrier but not absolute.
Sub-Criteria Score	**2**	**4**	**3.5**
Expandability	— Easy to expand or modify the process to suit future conditions. — Provision to add clarification increases phasing of capital investment	— Easy to expand or modify the process to suit future conditions. — Unit processes could be added or modified to meet changing treatment needs.	— Easy to expand the process with the addition of future trains. — Difficult to modify the clarification unit process. — Cannot expand clarification or filtration capacities independently.
Sub-Criteria Score	**3**	**3**	**2**
OVERALL SCORE	**2.7**	**3.3**	**2.2**

6.1.3 OPERATIONS AND MAINTENANCE

Operation and maintenance criteria capture the relative risks from normal equipment failures, number of treatment barriers, and relative ability to expand to changing treatment requirements. The following tables present both the scoring metrics and the resulting scores by treatment technology.

Table 6-5: Operation and Maintenance Score Metrics

SUB-CRITERIA	EASE OF OPERATION	EASE OF MAINTENANCE
DEFINITION	Number of resources and required training level expected to operate the facility (i.e., staffing, training, and adjusting to conditions).	— Number of trades and level of skill required to perform maintenance tasks. — Relative number of devices that can fail or require maintenance.
1 = Less effective	Operation requires significant training, or places significant strain on resources which is unsustainable for long term, or both leading to increased risk of operator mistakes.	Maintenance requires full-time (i.e., on-call) and specialized staff where interruption to CMMS or robust maintenance program could lead to risk of major failure. Maintenance will adversely affect operation.
2 = Effective/Acceptable	Operation requires additional training but is within resource capacity of organization within project implementation.	Maintenance requires full-time staff with some specialization or specialized training. Maintenance could adversely affect operation.
3 = More effective	Additional training, within resource capacity of organization, some time for measuring and tracking KPI's.	Most maintenance can be performed by operations staff normally supported by one specialized trade (e.g. electrical) on call. Only major maintenance would affect operation.
4 = Most effective	Some training, within resource capacity of organization, significant time for measuring and tracking KPI's.	Maintenance is normally performed by operations staff and specialist can be scheduled without urgency. Maintenance schedule does not affect operation.

Table 6-6: Operation and Maintenance Scores

SUB-CRITERIA	DIRECT FILTRATION	DAF + FILTRATION	IN-FILTER DAFF
Ease of Operations	— Facility is automated, including on-line monitoring – with requisite programming requirements and knowledge of software interlocks. — Except for coagulation chemistry, relatively routine operations.	— Similar to Direct Filtration, facility is automated and requires relatively routine operations, except for coagulation chemistry. — Slightly less programming and maintenance requirements, as UV is not a requirement. — May be prone to more downstream issues due to higher polymer/coagulant use.	— Filtration rate is limited to that of allowed by DAF. — Upsets in DAF will directly affect filter performance.

Sub-Criteria Score	**3**	**4**	**2**
Ease of Maintenance	— Moderate level of complexity. — Less number of moving equipment that is prone to failure.	— Similar to Direct Filtration with slightly more mechanical maintenance and cleaning requirements.	— Most complex as access and maintenance of the filter will be challenged by the DAF process.
Sub-Criteria Score	**4**	**3**	**2**
OVERALL SCORE	**3.5**	**3.5**	**2**

6.1.4 TOTAL LIFECYCLE COST

Total lifecycle costs (TLC) from Table 6-7 are a mandatory consideration in the technology selection. Metrics for this score are directly proportional to the TLC calculated as the minimum TLC divided by the TLC for that option on a 4-point scale. The presented life cycle costs below assume a 25-year present worth at 3% interest rate.

Table 6-7: Total Lifecycle Cost Scores

	DIRECT FILTRATION	CONVENTIONAL FILTRATION	IN-FILTER DAFF
Total Lifecycle Cost ($M)	$103.6	$107.6	$95.7
OVERALL SCORE	**3.5**	**3.0**	**4**

6.1.5 SUMMARY OF EVALUATION

Table 6-8 summarizes the evaluation results. The following sections discuss the criteria and the scoring for each of the alternatives.

Table 6-8: Equal Weighting Method Result

	DIRECT FILTRATION	DAF + FILTRATION	IN-FILTER DAFF
Water Quality	2.0	4.0	3.0
Reliability/Resilience	2.7	3.3	2.2
Operations and Maintenance	3.5	3.5	2.0
Total Lifecycle Cost	3.5	3.0	4.0
Equal Criteria Weighting Result [a]	**73%**	**86%**	**70%**
[a] Shown as percent where total of scores is divided by maximum score of 16 points.			

Based on the foregoing evaluation, the DAF followed by filtration treatment alternative offers the best value for the Beaver Lake water system. Infilter DAF is ranked second due to the reduced operational flexibility and redundancy by not having the DAF and filtration basins independent.

6.2 RESIDUAL TREATMENT

A residual stream will be produced from the recommended DAF clarification and rapid sand filtration that will require management either on-site or offsite. Approximately 90% to 95% treatment efficiency is expected for conventional filtration, direct filtration and/or DAFF with daily backwashes. Refer to **Table 2-4** in Section 7.2 for the estimated amount of treatment residual at the buildout MDD as well as the ultimate flowrates.

On-site management can be achieved through further clarification and dewatering processes of the residual stream, whereas off-site disposal would mean direct conveyance to the District's wastewater treatment plant (WWTP). The following sections discuss the two options and the corresponding design implications.

6.2.1 DIRECT CONVEYANCE TO THE WASTEWATER TREATMENT PLANT

A direct conveyance of the residual stream from the treatment to the existing WWTP can be provided with a new gravity sewer under the existing road infrastructure. The WWTP is located northwest of the Eldorado Reservoir with a linear distance of approximately 3.5 km. The elevation of the Eldorado Reservoir will provide a positive hydrostatic head of 200 m for gravity conveyance.

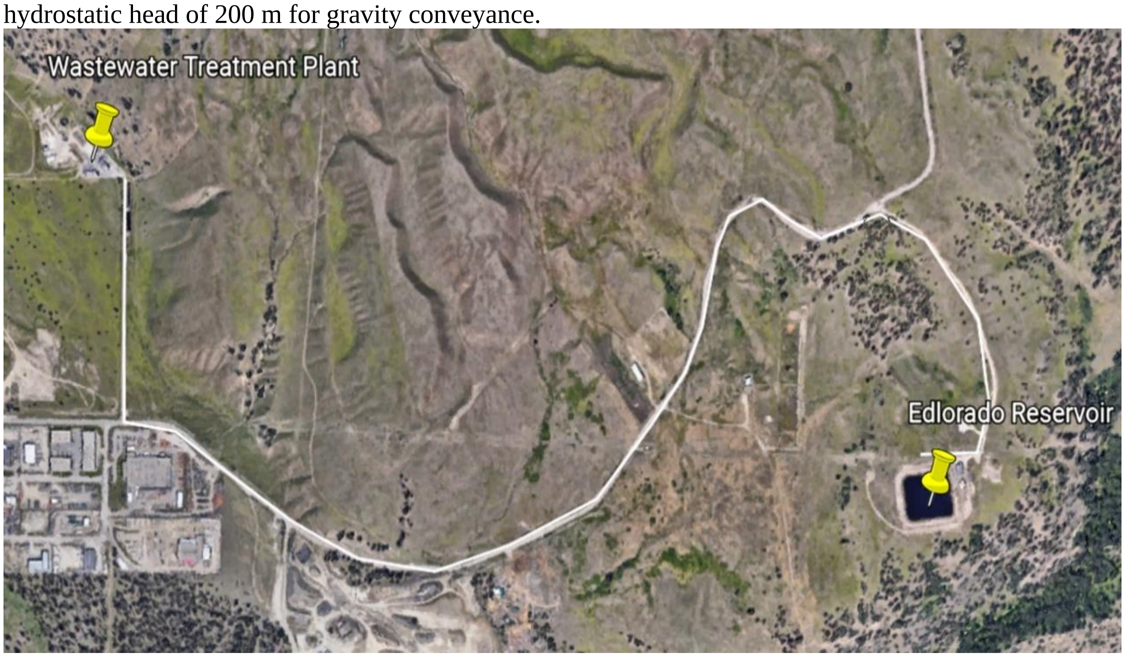


Figure 6-1 depicts the location of the WWTP with respect to the new WTP site.

Figure 6-1: Lake Country Wastewater Treatment Plant Location with respect to the Water Treatment Plant

This option presents an inherent value to the District as it provides high flexibility to WTP operations and eliminates the need to construct, operate, and maintain an on-site residual handling system. This alternative also reduces the long-term costs associated with residual solids management and disposal at the WTP, as solids would be combined with biosolids from the WWTP already requiring disposal. The existing WWTP has a design capacity of approximately 126 L/s peak wet weather flow (PWWF) and 46-56 L/s peak dry weather flow (PDWF). Direct conveyance of the treatment residual would require an upgrade to the WWTP by the amount of residual produced – approximately 30 L/s, as presented in **Table 2-4** – aside from the new sanitary conveyance line. A 200 mm gravity sewer will provide 60% of its capacity for inflow and infiltration. Estimated capital costs for this option are presented in **Table 6-9**. A 50% estimation accuracy is currently assumed given the early level of design and the associated uncertainties.

Table 6-9: Estimated Capital Cost for Direct Conveyance to the Wastewater Treatment Plant

ITEM	QTY	UNIT PRICE	EST. COST
New 200 mm PVC gravity pipe and road replacement	3500 m	$800/m	$3,000,000
WWTP Upgrade by 30 L/s	LS	-	$5,000,000
		SUB-TOTAL	**$8,000,000**
		50% Accuracy	$4,000,000
		ESTIMATED TOTAL	**$12,000,000**

6.2.2 ON-SITE RESIDUAL HANDLING SYSTEM

An on-site residual handling system may include a lamella clarifier followed by a mechanical dewatering system, such as a centrifuge, a filter press, or a screw pump. The mechanical dewatering system is intended to further concentrate the solids and reduce the liquid volume in the residual stream to a sludge consistency. The supernatant from the dewatering process can be disposed to overland drainage or an onsite process pond, whereas the sludge is disposed to an off-site solid handling facility or a landfill. However, additional work would need to be completed during the preliminary design phase to ensure that the soil composition of the proposed process pond location offers sufficient infiltration capacity and favorable hydrogeologic conditions for onsite supernatant disposal. **Figure 6-2** illustrates a typical process flow diagram of a residual handling system.

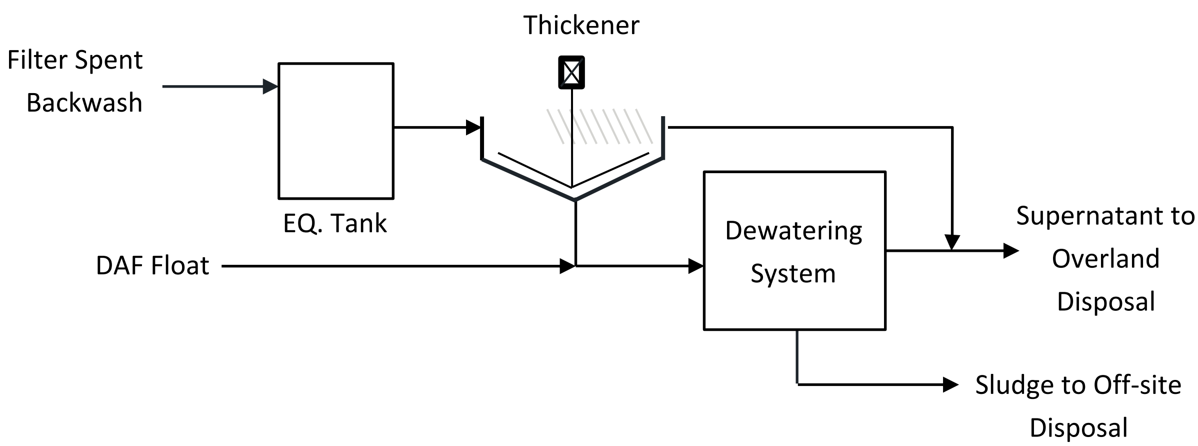


Figure 6-2: Typical Process Flow Diagram of a Residual Handling System

This option will require additional footprint and building structure to house the system. In addition, two sub-grade sludge holding tanks and two sub-grade spent backwash tanks will also be required. **Table 6-10** presents the approximate footprint required for an on-site handling system.

Table 6-10: Estimated Footprint for On-site Residual Handling System

STRUCTURE	# OF UNITS	DIMENSIONS
Sub-Grade Structure		
Spent Backwash EQ Tank	2	16 m (L) x 16 m (W) x 4.5m (H)
Sludge Holding Tank	2	13 m (L)x 11 m (W) x 4.5 m (H)
Above-Grade Structure		
Residuals Handling Building	1	17.5 m (L) x 11.5 m (W) x 5 m (H)
ESTIMATED TOTAL FOOTPRINT		**800 m^2**

The estimated capital costs for this option are presented in **Table 6-11**. A 50% estimation accuracy is currently assumed given the early level of design and the associated uncertainties.

Table 6-11: Estimated Capital Cost for On-site Residual Handling System

ITEM	QTY	UNIT PRICE	EST. COST
Building	1	LS	$1,068,000
Sub-grade tanks	4	-	$2,017,000

Equipment (Mechanical and Electrical)	1	LS	$3,608,000
		SUB-TOTAL	**$6,693,000**
		50% Accuracy	$3,347,000
		ESTIMATED TOTAL	**$10,040,000**

In addition to initial capital costs, this alternative would also require ongoing operational costs associated with trucking filter cake to an offsite disposal location. Using **Table 2-5** from **Section 7.2** provides an estimated amount of sludge that can be anticipated from the residual system, while **Table 6-12** estimates the frequency of truck trips based on two standard truck sizes.

Table 6-12 Residuals Hauling Estimates

	TRUCK TRIPS PER WEEK	
DEWATERED RESIDUALS	**22 CUBIC YARDS/TRUCK**	**11 CUBIC YARDS /TRUCK**
MDD	2.2	3.2
Ultimate	4.3	6.4

Currently, on-site residuals treatment is incorporated into this feasibility design to ensure adequate site planning if the District were to pursue this alternative. However, it is recommended that additional work be completed in the preliminary design phase to refine solids production estimates, further quantify the costs associated with upgrading the wastewater treatment plant, quantify WWTP impacts from direct conveyance, ensure the WTP site offers favorable hydrogeologic conditions for onsite supernatant disposal, and to compare the life cycle costs for the District under each alternative.

6.2.2.1 *THICKENING AND CONVEYANCE*

Another alternative for residuals disposal would be to install a thickener onsite for backwash water in lieu of an entire dewatering train. Remaining residuals (DAF float and thickened sludge) could let be sent to the sewer for direct conveyance to the WWTP. This would result in a smaller volume of residuals requiring treatment at the WWTP and would require less on-site infrastructure and equipment to support a full residual handing system. However, this alternative would require the capital costs associated with both alternatives: constructing the gravity sewer line to the WWTP, potentially upgrading the WWTP capacity, and installing a thickener onsite for backwash water. Opportunities for phasing the residuals management aspect of this design can be further explored in the preliminary design phase.

7 PROPOSED WATER TREATMENT PLANT

This section discusses the design criteria of the proposed Beaver Lake Water Treatment Plant Project, which consists of a new treatment plant building, a residual handling building, and a backwash supply pump station. This proposed WTP was designed for an initial capacity of 550 L/s and will require facility expansions for the ultimate capacity of 760 L/s. The minimum daily, average daily, and maximum daily flows used for the feasibility stage design of the proposed Stage 1 WTP are 41 L/s, 150 L/s, and 550 L/s, respectively.

7.1 PRIMARY TREATMENT SYSTEM

The primary treatment system of the WTP reflects the recommended conventional filtration technology as assessed in Section 6.1. The proposed Stage 1 treatment plant consists of the following major unit processes in a sequential order:

1. Flash mixing of the coagulant dosing
   - Coagulant and other pre-treatment chemicals will be injected into the raw water inlet to the WTP.
   - Duty-standby flash-mixing pumps will quickly disperse the chemical prior to the flocculation process.
2. Flocculation
   - Provides high-energy mixing to create large and fluffy floccs for floatation in the DAF.
   - Flocculation process consists of three duty and 1 standby flocculation trains with two cells each.
3. DAF clarification
   - Three duty and 1 standby clarification basins.
4. Rapid sand filtration
   - Four duty and 1 standby filter basins with mixed anthracite and sand media.
5. Chlorination
   - Gas chlorine will be injected at the inlet to the treated water reservoir and the trim adjustment will occur at the existing chlorine injection manhole, at the reservoir outlet to the distribution line.
   - The existing chlorine system is sufficient for the Stage 1 design capacity and therefore a new chlorine system is not proposed.

The feasibility-level design criteria of the above unit processes are presented in the following sections and should be refined in the next design stages once pilot testing has been completed.

7.1.1 COAGULANT DOSING AND FLASH-MIXING

Coagulant is added into the raw water via direct injection into the flocculation inlet pipe. Flash mixing will be provided in the pipe by duty-standby flash-mixing pumps to quickly disperse the chemical prior to the flocculation process. The addition of coagulant is to aid flocculation for floatation in the DAF clarification stage. The most common coagulant in water treatment is aluminum sulfate (“alum”) and is therefore assumed herein. A provision for pH adjustment will be provided to achieve optimum coagulation chemistry. Jar tests are to be conducted in a later phase to confirm the coagulation requirements and chemistry, including optimum pH, as well as coagulant type and dosage. **Table 7-1** summarizes the design criteria for the coagulant, pH adjustment, and flash-mixing systems.

Table 7-1: Feasibility-level Design Criteria: Pre-treatment Chemicals and Flash-Mixing Systems

DESCRIPTION	DESIGN CRITERIA
pH Adjustment	
Chemical	Sodium Hydroxide (Caustic Soda)[a]
Dosing rate, mg/L	10
Neat Concentration	25%
Consumption at ADD, L/day	460
Dosing System	
Dosing Rate, L/h	5 to 62[b]
Turndown ratio	15:1
No of Pumps	2 Duty + 1 Standby
Storage	
Storage Volume, m^3	43.9 (30 Days MMD)
No. of Tanks	2
Safety Factor	1.2
Volume per Tank, m^3	26.4
Coagulation	
Chemical	Poly-aluminum Chloride (PAC)
Dosing rate, mg/L	10 to 35
Neat Concentration	50%
Consumption at ADD, L/day	780
Dosing System	
Dosing Rate, L/h	8 to 125[c]
Turndown ratio	15:1
No of Pumps	2 Duty + 1 Standby
Storage	
Storage Volume, m^3	50.7 (30 Days MMD)
No. of Tanks	2

DESCRIPTION	DESIGN CRITERIA
Safety Factor	1.2
Volume per Tank, m^3	30.5
Flash-Mixing Pumps	
Flow range, L/s	20
Total hydraulic head, m	7.5
Type of Pumps	End suction
No of Pumps	2 (duty + standby)

[a] While caustic soda has been incorporated into this feasibility level design, hydrated lime and/or soda ash could also be piloted

[b] Caustic soda dosing rate at ultimate design is estimated to be 122 L/h.

[c] Coagulant dosing rate at ultimate design is estimated to be 145 L/h.

7.1.2 FLOCCULATION

After the water treatment chemical(s) are added, flocculation provides a relatively short, high-energy mixing period to create small and low-density flocs. Typically, the hydraulic residence time (HRT) ranges between 15 to 20 minutes. A two-stage flocculation process is proposed for the build-out MDD. The proposed flocculation basin will be equipped with an inclined baffle at the effluent side to direct the bubble-floc agglomerate toward the surface of the flotation tank.

Each stage of the flocculation will be equipped with one vertical shaft, pitched-blade impellers that provide the mixing energy for flocculation. The mixing energy or velocity gradient is tapered as the water passes through the stages. A mixing energy (G) of 30 to 120 s^{-1} is typical.

Periodic maintenance will be required for removal of solids from the bottom of the flocculation basins, depending on raw water quality and inlet flow rate. Removal of solids from the flocculation basins is typically accommodated by a train shutdown draining of each basin and hosing of the solids to a sump. **Table 7-2** provides a summary of the design criteria for the flocculation basins.

Table 7-2: Flocculation System Criteria

DESCRIPTION	DESIGN CRITERIA	
	MDD	ULTIMATE
Flocculation Train		
No. of Duty Trains	3	4
No. of Standby Trains	1	1
Number of stages per train	2	
Hydraulic Retention Time, min[1]	40	
Cell Dimensions, W x L x D, m (ft)	5.8(19) x 5(16.4) x 3.1 (10.2)	
Flocculation Mixers		

DESCRIPTION	DESIGN CRITERIA MDD	ULTIMATE
Flocculators per cell, No.	1	
Drive Type	VFD	
Motor size (Stage 1, 2)	0.5, 0.2	
Velocity Gradient "G" (Stage 1, 2)	100, 60	
[1] During "turn-down" of 5 MLD, HRT is 135 minutes.		

7.1.3 DAF CLARIFICATION

A total of four DAF trains are proposed for the Stage 1 MDD, while a total of five DAF trains (4 Duty + 1 Standby) are proposed for the ultimate plant design. The proposed process trains are designed with an assumed recycle ratio of 12% and a DAF loading rate of 15 m/h. Typically, this number ranges between 15 to 20 m/h (6 to 8 gpm/ft^2). A lower loading rate was used to develop the preliminary design criteria to be conservative. **Table 7-3** summarizes the design criteria for the DAF clarification.

Table 7-3: Feasibility-Level Design Criteria: DAF Clarification

DESCRIPTION	DESIGN CRITERIA MDD	ULTIMATE
Recycle ratio	12%	
No. of duty trains	3	4
No. of standby trains	1	1
Size of train (W x L x D), m (ft)	5.8(19) x 10 (32) x 3(9.8)	
Loading rate, m/h (gpm/ft^2)[1]	14.2 (5.8)	14.7 (6.0)
Detention Time, mins[1]	13	12

[1] During "turn-down" of 5 MLD, only 1 train would be in operation, resulting in a loading rate of 2.8 m/h (1.2 gpm/ft^2) and a detention time of 64 minutes.

7.1.4 RAPID SAND FILTRATION

The clarified water will enter the filter trains through a common filter inlet channel, controlled by an automated butterfly valve. The channel will be tapered for an even flow distribution to each filter. The level indicator on the filter will modulate the filter effluent control valve. As the pressure head builds on the filter media, the effluent valve will open to maintain the filter throughput. Periodically, the filters will be backwashed to remove foulants that accumulate in the filter media over time. Backwashing typically occurs when the headloss across the filters becomes too high, or if the filters breakthrough in terms of turbidity is detected by the online analyzers. To allow backwash, the filter train is taken offline and drained. Air scouring is then applied through the filter media to loosen concentrated debris through the filter media, followed by a reverse-filtration flow to remove the debris by overflowing it to the backwash weirs located at the surface of the filter tank. The backwash loading rate was designed for 50% bed expansion.

A total of five rectangular dual-media filter tanks, consisting of anthracite and medium sand layers, are proposed for the current MDD, while a total of 7 filters will be required for the Ultimate MDD of the facility. The filters were designed based on a maximum loading rate of 14 m/h at the MDD. The filters will also be designed to have a filter-to-waste capability to assist during commissioning and start-up. **Table 7-4** presents the design criteria for the rapid sand filter. Note that these criteria should be confirmed through a pilot program.

Table 7-4: Feasibility-Level Design Criteria: Rapid Sand Filter

	DESIGN CRITERIA	
DESCRIPTION	**MDD**	**ULTIMATE**
Filter		
Type	Dual Media	
Number of filters operating	4 (+1 standby)	6 (+1 standby)
Cells per Filter	1	
Size of Cell (W x L), m (ft) x m (ft)	4.5 (14.8) x 8.8 (28.8) x 5.2 (17)	
Media Area per Filter, m^2	40	
Filtration Rate, m/h	14.0 [a]	13.0 [a]
Filter Media		
Anthracite		
Depth, m	0.9	
Effective size, mm	1.4	
Sand		
Depth, m	0.3	
Effective size, mm	0.5	
Total Depth, m	1.2	
Total L/d	1,224[b]	
Filter to Waste		
Design rate, m/hr	12	
Anticipated Duration, min	5 to 10	
Anticipated Volume, m^3	25 to 50	
Filter Backwash System		
Type	Pump backwash with air scour	
Backwash loading rate (max), m/hr	67[c]	
Backwash duration (typical water wash), min	10 to 20	

DESCRIPTION	DESIGN CRITERIA MDD	ULTIMATE
Design Volume per backwash, m^3	450	890

[a] During "turn-down" of 5 MLD, only 1 filter would be in operation, resulting in a filtration rate of 4.0 m/h.
[b] L/D is a ratio of the depth of the filter bed (L) and size of filter media (D). For coarse, deep filter beds the target range is 1,200 – 1,500.
[c] Backwash loading rate based on a 50% bed expansion.

The filter aid polymer is proposed to be dosed into each filter feed channel with an individual feed system. The filter aid polymer will be dispersed through a static mixer or through turbulent injection into the inlet of the filters. **Table 450-1** describes the design criteria for the filter aid polymer including the feed rates. Note that the design criteria for the chemical dosage and consumption is based on the average plant demand.

Table 450-1: Feasibility-Level Design Criteria: Filter Aid Polymer

DESCRIPTION	DESIGN CRITERIA
Chemical	High molecular weight non-ionic polymer
Neat Concentration	50%
Day Tank Concentration	1%
Specific Gravity, neat/ day tank	1.4 / 1.0
Storage	
Storage Duration, days	30
Storage Volume, m^3	4.0
No. of Tanks	2
Factor of Safety	1.2
Volume per Tank, m^3	2.5
Chemical Dosage	
Target Dose, mg/L	0.01 to 0.05
Feed Rate, L/h/filter	0.7 to 8.0
Dosing System	
Capacity, L/h	1.0 to 6.0
Turndown Ratio	15:1
No. pumps (per filter)	2 DUTY + 1 STANDBY

7.1.5 CHLORINATION

Filtered water from the rapid sand filtration will be injected with chlorine gas prior to storage in the reservoir. The exact injection location is to be determined in the next design phase. The existing chlorine dosing system, located in the Eldorado Water Treatment Building is understood to have sufficient capacity to meet a residual target of 2.0 mg/L at the build-out MDD. **Table 2-1** presents the estimated daily consumption of chlorine gas at the WTP.

Table 2-1: Feasibility Level Design Criteria: Chlorination

DESCRIPTION	DESIGN CRITERIA
Residual Target, mg/L	2.0
Chemical	Chlorine Gas
Average Daily Consumption, kg/d	26[1]

[1]Average daily consumption was based on ADD of 13 MLD.

2.1.6 RESERVOIR

Disinfected water is stored in a treated water reservoir to meet the required contact time (C x t) for a 4-log virus removal in a 5°C water and pH of between 6.0 and 9.0. This log removal target exceeds the requirement for conventional filtration. **Table 2-2** presents the CT requirements for the clearwell, whereas

Table 2-3 presents the minimum storage requirement to allow sufficient operations of the plant, which includes the minimum chlorine contact volume, three hours of treated water at the maximum demand, and two consecutive backwashes. Fire flow requirements are currently excluded from the sizing of the clearwell and should be developed with consultation with the District.

Table 2-2: CT Volume Requirements for Clearwell

DESCRIPTION	DESIGN CRITERIA
Minimum Water Temperature, °C	1.0
Target log removal Viruses	4-log
CT Virus, mg/L-min	12.0
Chlorine residual, mg/L	2.0
T_{10}/T Baffle Factor	0.5
Min. Chlorine Contact Volume (MDD / ULTIMATE), m^3	400 / 550

Table 2-3: Clearwell Operating Volume

DESCRIPTION	DESIGN CRITERIA	
	STAGE 1	ULTIMATE
Minimum Contact Volume for Virus, m^3	400	550
Balancing Storage (3 hours at max. demand), m^3	6,000	8,250
Backwash Volumes (2), m^3	1,300	1,300
[1]Minimum Clearwell Volume, m^3	**7,700**	**10,100**

[1]Estimated minimum storage does not include fire flow.

The proposed minimum volume can be built upon the existing storage in the reservoir which equates to 6,000 m^3. According to the 2017 Issued for Tender drawing, the west side of the existing reservoir is intended for one additional future cell, which will increase the storage capacity by 50% to a total storage volume of 9,000 m^3. The additional cell will provide the minimum clearwell volume at the 2041 MDD and up to 2.5 hours of fire flow at 156 L/s. Another cell will be required to accommodate the ultimate flow rate, and particularly if fire flow storage is required at this site.

Once constructed, the new clearwell cell should be equipped with a drain, overflow protection, and inverted U-shape vents. The lowest elevation of the clearwell floor should be placed above the 200-year flood elevation, and where possible at least 600 mm above the ground water table.

Based on discussions with the District, expansion to the existing reservoir cells will not be pursued during the Stage 1 design of the Beaver Lake WTP. However, reservoir expansions will be required for the ultimate WTP capacity.

7.2 RESIDUAL TREATMENT

For feasibility study purposes, the proposed site development includes an on-site residuals handling building to treat the residuals from DAF and sand filters, as depicted in **Figure 6-2**. The secondary treatment will be housed in a separate building, adjacent to the WTP, and will include the following unit processes:

— Backwash equalization (EQ) tank

Influent	: Filter Spent Backwash
Quantity	: 2
Volume per tank	: 1,000 m^3
No. of pumps per tank	: 2 (1 duty + 1 standby)

— Clarifier or Thickener

Influent	: Settled Filter Spent Backwash from Backwash EQ tank
Quantity	: 2
No. of Flocculation Cells	: 2 (1 per clarifier thickener)

— Sludge Holding Tanks

Influent	: Thickener Centrate/ Clarifier Sludge
Quantity	: 2
Volume per tank	: 500 m^3
No. of pumps per tank	: 2 (1 duty + 1 standby)
No. of mixer per tank	: 1

— Dewatering System (Centrifuge)

Influent	: Thickener Centrate/ Clarifier Sludge from sludge holding tanks
Quantity	: 2 (1 duty + 1 standby)
Max. hydraulic load	: 14 m^3/h

— Final Cake Loading Zone

Influent	: Final Cake from centrifuge

Table 2-4 presents the estimated residual streams that will be produced by the proposed WTP that will have to be processed on-site, whereas **Table 2-5** provides an estimated amount of sludge that can be anticipated from the residual system. The daily solids in spent backwash were estimated using the Eldorado Raw Water Reservoir outlet’s minimum and maximum turbidity values of 0.1 NTU and 5.0 NTU, respectively and an assumed NTU:TSS ratio of 1:1.5 in mg/L, per the industry practice; a 25% safety factor has been added to the residual estimates at this stage in the design. The estimation assumed that the spent backwash from the filter will be directly fed to the residual clarifier/ thickener and the DAF float from the DAF will be combined with the centrate of the residual clarifier to feed the downstream centrifuge unit. The anticipated solids content in the final cake produced by the centrifuge is 15%-20%.

Table 2-4: Feasibility-level Mass Balance: Residual Streams Produced by Water Treatment Plant

DESCRIPTION	%R	DESIGN CRITERIA MDD MLD	MDD Solids (kg/d)	ULTIMATE MLD	ULTIMATE Solids (kg/d)
WTP Overview					
Raw Water	100%	52	107	72	148
Coagulant			512		781
Sedimentation					
DAF Influent		52	619	72	929
DAF Float	0.02%	0.01	196	0.01	271
DAF Effluent	99.98%	52	764	72	1148
Rapid Sand Filtration					
Filter Influent	100%	52	764	72	1148
Spent Backwash	5%	2.7	1021	2.8	1,526
Filtrate[1]	95%	49.5	22	69.5	31
Residual Stream					
Total Treatment Residual[2]	5%	2.7	1,217	2.9	1,797

[1]Filtrate solids are estimated using an assumed maximum turbidity of 0.3 NTU.
[2]Total Residual Stream is the sum of DAF Float and Spent Backwash. A factor of Safety of 1.25 was used in the estimate.

Table 2-5: Feasibility-level Mass Balance: Residual Handling System

DESCRIPTION	DESIGN CRITERIA MDD M^3/D	MDD SOLIDS (KG/D)	ULTIMATE M^3/D	ULTIMATE SOLIDS (KG/D)	%SOLIDS
Settled Spent Backwash to Thickener	77	995	76.8	1,498	0.5% - 2%
DAF Float to Dewatering System	10	196	13.56	271	3%
Thickener					
Solids Recovery	90%				
Centrate to Dewatering System	48	895	67.41	1,348	0.1% – 0.5%

DESCRIPTION	DESIGN CRITERIA				
	MDD		ULTIMATE		
	M^3/D	SOLIDS (KG/D)	M^3/D	SOLIDS (KG/D)	%SOLIDS
Recycled Supernatant to Backwash EQ	28	99	9	150	0.05% - 2%
Dewatering System					
Solids Recovery	95%				
Feed to Dewatering System	58	1,091	81	1,619	2%
Polymer		8		12	
Recycled Supernatant to Thickener	61	55	85	82	0.1%
Est. Final Cake	**5.2**	**1,044**	**7.7**	**1,550**	**20%**

7.3 GEOTECHNICAL CONSIDERATIONS

There were two reports used as the basis for the geotechnical evaluation by WSP: The Preliminary Geotechnical Investigation and Report for Proposed Eldorado Treated Water Reservoir dated April 19th, 2016, and the Eldorado Low Lift Station Geotechnical Site Visit Summary dated July 5th, 2007. Both reports were completed by Fletcher Paine Associates (FPA) and reviewed by WSP for their content. Based on the information in these reports, the following geotechnical summaries, comments, and recommendations for further assessments have been compiled.

7.3.1 SOIL AND GROUNDWATER CONDITIONS

The geotechnical report for the Eldorado treated water reservoir provides a sufficient description of the underlying soils encountered during the field investigation. The underlying material consisted mainly of compact to dense, dry gravelly sands, underlain by very dense, moist silty sands to the bottom of the boreholes. The two boreholes were conducted to limited depths of only 4.6 m where refusal of the drill rig was met. Groundwater was not encountered in either test hole. The borehole locations can be seen in the Proposed Eldorado Treated Water Reservoir Borehole Location Plan from the 2016 report and is shown for reference in **Figure 2-1**.

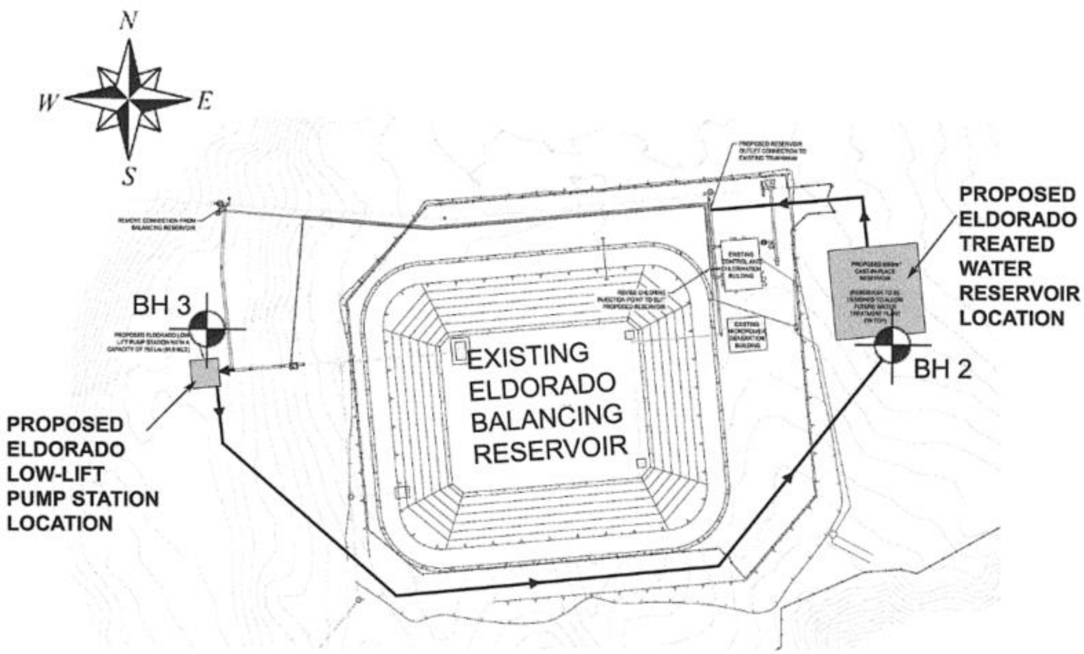


Figure 2-1: Proposed Eldorado Treated Water Reservoir Borehole Location Plan (2016 Geotechnical Report by FPA)

The soil logs provided in the reference reports contained sufficient detail on the underlying soil and groundwater conditions at the time of drilling, with one borehole providing Screw Driver Sounding (SDS) Cone Penetration Test data to about 4.6 m depth.

WSP recommends that additional boreholes be drilled at the location of any proposed structures to collect more detailed in-situ density values, such as Standard Penetration Test (SPT) data.

7.3.2 GEOTECHNICAL LABORATORY TESTS

There are moisture content determinations on all recovered samples, and two grain size analysis (sieve analysis) conducted on select samples that were included in the 2016 report. These results provide a thorough description and presentation of the grain size distribution of the samples collected from the boreholes.

7.3.3 SEISMIC CONSIDERATIONS

The 2016 report mentioned the site can be classified under the BC Building Code (unknown year) as Site Class ‘C’, which we can consider to be acceptable based on the density readings in the soil logs. Since the report was written in 2016, WSP assumes the seismic criteria referenced were based on the then-in-effect 2012 BC Building Code (BCBC). Update to the 2018 BCBC (present code) would be required. This should be updated to confirm the site class, as there is potential for the site may be considered Site Class ‘D’ depending on the overall conditions determined by a future investigation. The report did not provide a liquefaction analysis or discuss the potential for liquefaction at the site. Given the relatively high in-situ density of the gravelly sand and silty sand, and the gravel content shown in the lab samples, these materials to a depth of approximately 5 m are not considered to be of liquefaction potential. If a full liquefaction analysis is determined to be recommended, this requires test holes to at least 30 m or confirmation of bedrock/very dense continuous soils to this depth to confirm the presence/absence of saturated, loose sands underneath.

7.3.4 GEOTECHNICAL RECOMMENDATIONS

WSP considers the content in the 2016 report to be appropriate and may be used for reference in the design of a future structure development, on or adjacent to the site. However, depending on the type of facility to be constructed and the facility's overall size and configuration, additional geotechnical investigations with test holes to greater depths, including new analysis, review and subsequent assessment reporting is likely to be required. The scope of the investigation may be reduced given the information already present in the report, compared to a full investigation with no known information in the area.

Additionally, the 2016 report reviewed for this analysis referenced the Golder "Report On Geotechnical Investigation Proposed Eldorado Water Storage Reservoir and Facilities Beaver Lake Road District of Lake Country, Lake Country, BC" dated June 3, 2005. WSP recommends obtaining and reviewing this report to further assess the geotechnical details pertaining to the site.

TEMPORARY UNSUPPORTED EXCAVATION SLOPES & PERMANENT CUT AND FILL SLOPES, AND COMMENTARY ON EROSION CONTROL

The recommendations for the temporary unsupported excavation slopes are detailed in Section 8.0 of the 2016 report and provide adequate reference to compliance with WorkSafe BC regulations. The temporary cut slopes of 1H:1V recommended in the report seem appropriate for continued construction and excavation of the immediate site. The permanent cut and fill slopes for site grading outlined in Section 14.0 mention 2H:1V slopes, constructed in a benched (terraced) manner for slopes over 5H:1V appears appropriate for additional construction.

The erosion control dialogue, with respect to slope stability, is very vague – the report should provide minimum level of erosion control type required (i.e., non-woven geotextile, drain interceptors, etc.). This is touched on more in the perimeter foundation drainage section, as well as the Eldorado Low Lift Station Geotechnical Site Visit Summary Field Report, which discusses the need for drain rock need be enveloped by non-woven geotextile (Nilex 4535 or approved equivalent). However, further commentary on erosion control should be provided in more detail.

RECOMMENDATIONS FOR UTILITY INSTALLATION

The 2016 report provides general recommendations for utility installation beneath floor slabs and interior/exterior footings in Section 12.2. Allowable bearing resistances of 100 kPa (SLS) and 150 kPa (ULS) were specified for foundation design above the compact to dense gravelly sands, however, there is no mention to "thrust and anchor blocks". The recommended bedding and backfill material for trench excavations outlined in the report ask for the client to refer to local by-law requirements for type of backfill to use and compaction methods. These bylaws typically reference the MMCD Platinum edition guidelines to material type and compaction. Finally, the report mentions that "the silty sands and gravelly sands can be reused at the site as trench backfill…". Based on WSP's review of the soil description in the soil logs and lab data, we concur with this recommendation.

RECOMMENDATIONS FOR ENGINEERED FILL

The engineered fill recommended for surface fills and reservoir backfill consists of clean (less than 7% passing the 0.075 mm sieve), well-graded crushed 75 mm minus sand and gravel placed in thin lifts and compact to 100% (surface) or 95% (reservoir) standard proctor maximum dry density (SPMDD). For the low-lift pump station, the report recommended 25 mm minus imported sand and gravel or 25 mm fractured drain rock to 100 SPMDD. Otherwise, the report recommended clean 150 mm minus pitrun sand and gravels, or salvaged material approved by a geotechnical engineer, for backfill required outside the area noted zone.

WSP concurs with type and compaction requirements for the engineered fill in the various aspects of the reservoir construction. For the proposed additional development project at the reservoir, WSP recommends reviewing the detailed design of the project to specify the engineered fill recommended for the select locations.

FOUNDATION RECOMMENDATIONS FOR THE RESERVOIR

The foundation for the reservoir was to be on a monolithic concrete slab, and the low lift pump station to be founded on strip and pad foundations. The reservoir backfill (as mentioned in Section 9.4 of the 2016 report) specifies 75 mm minus sand and gravel compacted to at least 95% SPMDD. The stripping depths aren't specifically mentioned, however it is stated that the removal of the existing topsoil, uncontrolled fill, soft and/or loose and/or frozen materials are required to expose the natural sands below, to at least 300 mm below the base of the proposed underside of foundations, to an elevation of at least 1 m or 300 mm below the base of slab-on-grades for unheated and heated buildings respectively, and at least 1 m below adjacent finished outside grades.

The SLS, ULS and modulus of subgrade reaction are all provided sections 5.2 and considered to be appropriate based on the soil descriptions.

PAVEMENT STRUCTURE RECOMMENDATIONS

The report outlined a pavement structure of 100 mm Hot Mix asphalt or 150 mm MOTI 25 mm minus high fine surfacing aggregate, underlain by 100 mm of 25 mm minus crushed granular base course, underlain by 300 mm minus granular sub-base course, underlain by prepared subgrade. The aggregate types and compaction criteria all referred to the District guidelines. The road type was for District industrial road type classification, with a designed equivalent single axle load (ESAL) count of 560,000. Based on this information, WSP concurs with the recommended pavement structure minimum thicknesses. The report didn't specify any existing pavements to be reinstated.

7.4 CIVIL DESIGN

7.4.1 SITE DESCRIPTION

The proposed site is located immediately east of the existing Eldorado raw and treated water reservoirs and will include a new WTP building, a new residuals handling building, a new backwash supply pump station with a common wet well, four sub-grade tanks including two backwash equalization tanks and two sludge holding tanks. The proposed location is contained within the property boundary. Therefore, new land acquisition or a development permit is not required.

The existing elevation of the site varies between 625.0 m and 630.0 m, with a gentle upward slope at approximately 4% to the east and downward slope to the south at approximately 6%. Rough grading to meet the proposed site elevation of 628.0 m can be designed to achieve a quantity balance. Clearing and grubbing of approximately 7,200 m^2 in surface area is required prior to mass excavation to facilitate construction. Tree removal will be required as the site is partially forested.

New perimeter fencing and gate, which may be motorized as preferred, will be provided. The existing fencing around the reservoir will be removed and extended to include the proposed structures. Refer to Appendix B – Issued for Feasibility Study Drawing Package for proposed site plan.

7.4.2 BUILDING ELEVATION AND SITE DRAINAGE

A proposed finished floor elevation of 628.0 m will allow positive drainage away from the building at a minimum of 2%. A sidewalk will be provided along the north and south side of the building. Building roof leaders will drain on onto splash pads at a 2% grade away from the building. Ground elevations around the above-ground structures will be designed to allow melt water run away with no ponding.

7.4.3 VEHICLE ACCESS, ROADS, PARKING

The existing site is currently accessible through a gravel road with access located at 5000 Beaver Lake Road. Access to the site will require a tie-in to and extension of the existing access road. The new access road will be equipped with curb and gutter to provide drainage to road runoffs. The site driveway will be designed to accommodate the turning radius of a large vehicle (semi-trailer) and loading zones for regular equipment servicing, chemical deliveries, and potential hauling of residual solids (refer to Section 7.2), as well as sufficient parking stalls for the WTP staff and visitors. Refer to Section 0 for further discussions on site access and parking.

The site driveway and access to the south-end facilities will accommodate the turning radius of a TAC WB-21 (semi-trailer truck) design vehicle for large equipment deliveries. Maximum grade onsite will be limited to 6% for accessibility. The site design will accommodate 10 staff/visitor parking stalls and 1 accessible stall, and 2 loading zones by the east and west overhead doors. Traffic signs will be provided to inform speed limit, as well as parking and loading zones.

7.4.4 UNDERGROUND SITE SERVICES

Table 2-6 summarizes the underground site services and tie-in points that will be provided on-site.

Table 2-6: WTP Underground Site Services

SERVICE	DESCRIPTION
Raw Water	A 750 mm ø PVC pipe will convey raw water supply from the Low Lift Pump Station to the WTP. This new pipe will tie-in to the existing 750 mm ø PVC DR25 inflow pipe into the reservoir. The invert of the existing pipe is approximately 3.0 m below ground at 623.0 m.
Treated Water	A 750 mm ø PVC pipe will convey treated water from the WTP and to the existing treated water Reservoir. This new pipe will tie-in to the existing 750 mm ø PVC DR25 inflow pipe into the reservoir. The invert of the existing pipe is approximately 3.0 m below ground at 623.0 m.
Domestic Water	A PVC pipe will convey treated water from the nearest and most convenient water source to the WTP for domestic use. A suggested tapping location is the existing 750 mm ø PVC DR25 outflow pipe from the reservoir. The invert of the existing pipe is approximately 4.0 m below ground at 622.0 m.
Backwash Supply	A 600 mm ø PVC pipe backwash supply pipe will convey treated water from the treated water reservoir wet well to the filter backwash system at the WTP.
Spent Filter Backwash and Process Drain	A 750 mm ø PVC pipe Spent backwash will be gravity drained into the backwash equalization tanks, located at the south end of the Reservoir, and pumped to the residual treatment system inside the WTP.
Process Drain	A 200 mm ø PVC pipe process drain will be gravity drained into the backwash equalization tanks, located at the south end of the Reservoir, and pumped to the residual treatment system inside the WTP. The design infiltration capacity should be no less than 0.5 L/s of sustained flow. Calculation of design flows for the process drains should be determined in the next design phase based on full flow from all process hose bibbs, washdown nozzles, emergency showers, online analyzers, and other sources of floor drainage within the plant.
Overflow Drains	A 750 mm ø PVC common overflow drain will be used to collect overflow from the flocculation, DAF, filters, backwash equalization tanks. Overflow can be directed to either the existing raw water reservoir, or a common overflow manhole which would discharge to a process overflow pond. A process overflow pond is proposed to be located north of the Low Lift Pump Station.

SERVICE	DESCRIPTION
Sanitary Services	A sanitary sewer will convey sanitary waste from the building to a septic field disposal system located south of the Reservoir. The sewer will be sized to accommodate 5 full-time staff at the WTP building and occasional visitors up to 10 persons. Flow to the septic system will originate from the washrooms, kitchen, and wet lab. Based on the British Columbia Sewerage System Standard Practice Manual Version 3 (SPM) published by the Ministry of Health, design criteria for an office/ factory without a cafeteria is 50-75 L/day/person. Based on the maximum capacity of 15 persons, the daily design flow is 75 x 15 = 1,125 L/day. A 100 mm ø pipe will be adequate.
Underground Electrical Duct Banks	A set of buried conduits will carry power from a new power pole and a BC Hydro transformer, adjacent to the treatment plant, and into a metering box which will be located inside the WTP electrical room.

7.4.5 PROCESS OVERFLOW POND

Process overflow can either be directed to a dedicated process overflow pond, or back into the existing raw water reservoir. It is recommended that additional work is completed in the next phase of the design to assess the costs, risks, and benefits of each alternative. At the feasibility stage, a process overflow pond and associated costing has been included in the design to contain treatment overflows from the flocculation, DAF, filter, backwash equalization tanks, and the treated water reservoir. The pond is currently proposed to be located directly north of the low lift pump station. Sizing and design of the pond should be conducted in the next design phase.

7.4.6 STORMWATER MANAGEMENT

Stormwater will be managed by a system of overland flow and culverts around the proposed site. Roads and paved areas will crossfall away from structures and drain towards ditches or overland as practical. Culverts will be provided across roadways as required. Ditches around the site will tie-in with the existing ditches as practical. Stormwater pipes and catch basins may also be required to drain the paved areas.

7.5 ARCHITECTURAL AND STRUCTURAL DESIGN

The new WTP, Residuals Handling building, and the Backwash Supply Pump Station will be built in accordance with the National Building Code of Canada for a Post Disaster Facility. A metal panel building with a tilt-up concrete structure is proposed to match the existing facility on-site, such as the low lift pump station. Foundation will be as per recommendations of geotechnical engineer.

The building will be designed to be energy efficient and use passive strategies where possible. As such, openings for windows will be kept at a minimum to reduce heat loss but placed to maximize daylighting. Building insulation will be to R24 walls and R28 ceiling as required for BC Climate Zone 5. Exterior doors will be insulated steel doors with knockdown frames and emergency hardware. The direction of roof slopes will ensure large snow volumes will not be shed to exterior occupied areas. Roof drains, consisting of eavestroughs and downspouts, will be provided and sized per the National Building Code. The following sections discuss the proposed building layout of the new operation buildings.

7.5.1 WATER TREATMENT PLANT

The proposed WTP is a two-storey building with an overall footprint of 1950 m^2. The building will be north facing and be provided with egress points on the south and west sides of the building. Direct staircases to the second floor will also be provided on the west and south sides of the building. The WTP will include the following areas:

— a public entrance lobby,

- offices (six) for the District staff;
- an IT/ server room;
- a board/ meeting room;
- a change room and washroom stalls;
- a lunchroom;
- a control room;
- a wet lab;
- chemical rooms, including coagulant, polymer, and caustic soda;
- an electrical room;
- a mechanical room;
- a blower room;
- a workshop room;
- a process area, including flocculation basins, DAF, and filter tanks;
- an underground pipe gallery;
- miscellaneous rooms, including janitorial and storage rooms; and
- a green roof and patio area.

A building layout is available in Appendix B – Feasibility Level Design and is designed to provide maximum efficiency to the operations of the water treatment process.

7.5.2 BACKWASH SUPPLY PUMP STATION

The new Backwash Supply Pump Station is a one-storey, south facing building with an overall footprint of 20 m^2 and located on the south end of the existing reservoir. The building will house a new common wet well that will accommodate pumping of the treated water from two separate reservoir cells into the filter tanks in the WTP for backwash purposes. The pump station will also house the electrical, instrumentation, and control components of the backwash pumps. A building layout is available in Appendix B – Issued for Feasibility Study Drawing Package.

7.5.3 RESIDUALS HANDLING

The new Residuals Handling building is a one-storey, west facing building with an overall footprint of 122 m^2 and located east of the existing reservoir. The building is proposed to be built overtop of a sub-grade sludge holding tank and a backwash equalization tank. The building will house the residuals handling system to treat treatment residuals and overflows, including DAF floats, spent filter backwash, and all process drains and overflows from the WTP which are stored in the backwash equalization tanks. A building layout is available in Appendix B – Issued for Feasibility Study Drawing Package.

7.6 MECHANICAL DESIGN

7.6.1 PROCESS-MECHANICAL PIPING AND EQUIPMENT

Pipe sizes will be selected based on velocity and headloss calculations. Maximum pipe velocity will be 2.6 m/s, otherwise flow meters and control valves will be required for proper operation. Where new piping connects to existing piping, pipe sizing will be matched. For special conditions, maximum velocities up to 3.7 m/sec may be allowed. Pipe sizing for process commodities which have settleable solids will be designed to maintain a minimum scour velocity. Pump suction piping will be sized for a maximum of 1.5 m/s and pump discharge piping will be sized for a maximum of 1.8 m/s.

Pipe material will be selected for the process commodity accounting for pipe material strength, resistance to corrosion, operating temperatures, lining and coating compatibility, overall durability, and economics. The Project process commodities and default piping material selections are shown in **Table 2-7.**

Table 2-7: Process Piping Materials

SERVICE	SIZE (MM)	PIPE MATERIAL
Process/ Service Water	50 – 150	Schedule 80 PVC
Chemical Services (coagulant, caustic soda, polymer)	12 – 50	Schedule 80 PVC
Raw Water, Filtered Water	750	Stainless Steel 310 Schedule 10 or Lined and Coated Steel Schedule 40
Backwash Supply, Spent Backwash, Overflow	600	HDPE
Domestic Water	25 – 50	Municiapl Tubing
Process Air	100 to 200	316L SS
Process Drains	50 – 200	Schedule 80 PVC
Compressed Air	0.5 – 25	Extruded Aluminum or Type K Copper

All major piping systems will be correctly supported by designed pipe support systems. The support design will consider all the external and internal forces that may affect the pipe systems including expansion, seismic, and hydraulic. Pipe supports, guides, hangers and anchors will conform to the appropriate American Society of Mechanical Engineers Code. Pipe support materials will be selected for compatibility with the chemicals being served.

All major process-mechanical equipment, including process tanks, hot-water tanks, pumps and compressors, are to be provided with housekeeping pads for water protection and to accommodate floor cleaning. Lifting equipment will be provided in the process areas and pipe gallery, as required, to facilitate the maintenance and removal of equipment. Lifting equipment will consist of either a traveling bridge crane or a monorail. Lifting capacity will be equal to 1.5 times the maximum equipment weight in the building. Duty lifting equipment will be motorized trolley and electric wire rope hoists.

7.6.2 HEATING, VENTILATION, AND AIR CONDITIONING (HVAC)

HVAC systems are to be designed in accordance with the BC Building Code, WorkSafeBC, NECB, and ASHRAE standards, including energy efficiency requirements. The design of HVAC systems for each occupancy climate zone shall be based on its use and occupancy. There are two main area types: those assumed to be normally occupied, such as offices, change rooms, and public areas; and those for which the main use is for process and related equipment, and therefore are occasionally occupied. HVAC systems for occupied areas and areas for process and related equipment are to be separate from each other.

7.6.3 PLUMBING

Domestic plumbing systems are to be designed to meet the BC Plumbing Code. All hot- and cold-water piping is to be insulated. Potable water will be supplied by domestic plumbing system to fixtures in the occupied areas of the facility and to any equipment such as emergency showers, eyewashes, showers and drinking water fountains located in unoccupied areas.

A booster pump system, including a standby pump, will be used to provide the required flow and pressure conditions to the domestic water supply from the treated water reservoir. Piping for the domestic water system will be copper or stainless steel.

Hot water will be provided to the potable water system using commercial grade hot water tanks located in the mechanical room or other suitable location. Tanks are to be selected to provide, at minimum, hot water adequate for the demand of the emergency shower and eye wash plus demands for domestic uses. If a hot water supply is required for the non-potable system, that system will have a dedicated hot water tank(s).

An emergency shower and eyewash shall be installed in each of the chemical rooms. An emergency eyewash shall be installed in the laboratory. Emergency equipment are to come with flow limiting valves, thermostatic mixing valves, and flow switches to be used for alarming. Additional emergency equipment may be required based on the final design and layout of the system. The location, selection and installation of all emergency showers and related equipment is to be meet the requirements set out by WorkSafeBC and ANSI Z358.1.

7.6.4 DRAINAGE AND SANITARY

Drainage and sanitary piping systems are to be designed in accordance with the BC Plumbing Code. Trap primers are required for all traps.

7.7 ELECTRICAL AND INSTRUMENTATION

7.7.1 POWER SUPPLY

The primary Electric Service for the proposed site will be provided by BC Hydro from a new power pole which will be an extension of an existing pole, which supplies at 25 kV, 3 phase, 60 Hertz. A new 25kV-600V transformer will be installed adjacent to the proposed WTP building to provide the secondary 600V BC Hydro service. The estimated operating load for the entire system is 938 KVA. Specifics for the power distribution to the WTP will be determined by the utility during the pre-design phase of the project. A comprehensive power study for the electrical system may be required. This will include short circuit study, protection and coordination study, power flow, harmonic study, and arc flash hazard analysis.

The electrical power requirements at the new WTP will be based on the power demand of process pumps, process motors, building HVAC, lighting, general power, and process valves. Based on preliminary load calculations of the proposed conventional filtration system, the total connected load of the WTP will be approximately 647 kVA, as summarized in **Table 2-8**.

The new Residuals Handling building will be sub-fed from the WTP. The power demand at the building is estimated based on one 40 hp dewatering centrifuge, two 0.1 hp submersible sludge pumps, two 6 hp submersible spent backwash pumps, building HVAC, lighting, general power, and process valves. The preliminary estimate of the building's connected load is approximately 84 kVA, as summarized in **Table 2-9**.

The new Backwash Supply Pump Station will also be sub-fed from the WTP. The power demand at the building is estimated based on one 215 hp submersible or vertical turbine pumps, building HVAC, lighting, general power, and process valves. The preliminary estimate of the building's connected load is approximately 207 kVA, as summarized in **Table 2-10**.

The electrical design for all three buildings is based on the following:

- Lighting to be LED and compliant with ASHRAE 90.1
- Lighting within the disinfection building be designed for maximum 10 W/m^2.
- Exterior power connections and a manual transfer switch will be provided for a genset. The genset will not be provided as part of the project scope of work at this time but is conceptually discussed below.

Table 2-8: Connected Load of the Water Treatment Plant

WTP	DUTY	STANDBY	HP	KW	VOLTAGE	PH	HZ
Flash Mixing							
Rapid mixer	1	1	20	--	600	3	60
Flocculation							
Primary Flocculation Mixer	6	0	0.5	--	600	3	60
Secondary Flocculation Mixer	6	0	0.5	--	600	3	60
DAF							
Rotary screw air compressors	1	1	10	--	600	3	60
Recycle Pumps	3	3	40	--	600	3	60
Sludge Scraper	3	0	0.75	--	600		
Filter							
Vacuum Pumps	3	1	5.5	--	600	3	60
Air Scour Blower	1	1	60	--	600	3	60
Chemicals							
Coagulant	2	1	0.03	--	120		
Polymer	4	2	0.002	--	120		
Caustic Soda	1	1	0.00	--	120		
Domestic Water							
Booster Pumps	1	1	2	--	600		
Total Building HVAC				307	600	3	
TOTAL WTP LOAD					**647**	**kVA**	

Table 2-9: Connected Load of the Residual Handling Building

RESIDUALS HANDLING	DUTY	STANDBY	HP	KW	VOLTAGE	PH	HZ
Spent Backwash Tanks							
Spent Backwash Pumps	2	1	6	--	600		

RESIDUALS HANDLING	DUTY	STANDBY	HP	KW	VOLTAGE	PH	HZ
Backwash Clarifier							
Mixer	2	0	3	--	600	3	60
Sludge Holding Tanks							
Submersible Sludge Pumps	2	1	0.1	--	120		
Dewatering							
Centrifuge	1	1	40	--	600	3	60
Building HVAC			13	10	600		
TOTAL RESIDUAL HANDLING LOAD					**84**	**kVA**	

Table 2-10: Connected Load of the Backwash Supply Pump Station

BACKWASH SUPPLY PS	DUTY	STANDBY	HP	KW	VOLTAGE	PH	HZ
Wet Well							
Backwash Pumps	1	1	215	--	600	3	60
Building HVAC			4	3	600	1	
TOTAL BACKWASH SUPPLY PS LOAD					**207**	**kVA**	

7.7.2 BACK UP POWER SUPPLY

Currently, the costs of backup power have not been included in the cost estimations for the project, however, provisions for backup power have been included. If the District elects to provide an onsite generator, preliminary sizing of the backup power needed for this facility under two different operation conditions was reviewed.

The first operating condition reviewed for this facility was to run the low lift pumps, chlorine dosing station, and the WTP. However, do the required genset size to power the entire WTP, low lift pump station, and chlorine dosing station and the unlikelihood of a prolonged power outage at the facility, this genset selection has been made excluding the power demands of the backwash system components. As shown in **Table 2-10**, the backwash supply pumps account for a significant portion of the WTP total connected load. During a short-term power outage (<24 hours) the facility should be able to operate as normal without backwashing functionality. Budgetary pricing for a 1,250 KW genset completed with a 1,200A automatic transfer switch (ATS) is $490,000 including delivery, installation, testing, and commissioning. This budgetary estimate has been provided using the entire WTP building HVAC connected load of 307 KW, as presented in **Table 2-8**; however, this total connected load includes both heating and cooling components. Therefore, it is more likely that the actual HVAC demands will be much smaller. The actual demand for the WTP building HVAC has been estimated at 30 KW. Preliminary pricing for a 1,000 KW genset, completed with a 1,200A ATS and sufficient to supply the low lift pumpstation, chlorine dosing station, and the WTP (less backwash) using the estimated actual demand from the building HVAC system is $412,000 including delivery, installation, testing, and commissioning.

In the event of a prolonged power outage, the District indicated that they could provide chlorinated raw water into the distribution system. Preliminary sizing of a backup genset to power the low lift pump station and the chlorine dosing station results in a 275 KW genset. Budgetary pricing for a 275 KW genset, completed with a 400A ATS is $180,000 including delivery, installation, testing, and commissioning.

Ultimately, the decision to include backup power during the detailed design will come down to a comparative analysis between managing risks and the costs associated with risk management. It is recommended that a risk matrix be developed in the preliminary design phase to quantify the risks of not providing backup power at the site with the costs associated of providing different levels of back up power supply.

8 PHASING OPPORTUNITIES

While the proposed treatment plant presented in Section 7 is considered the best treatment selection for the ultimate design of this facility, there are opportunities to construct the WTP in phases to reduce initial capital costs. The following sub-sections outline the two phasing alternatives, while Section 9 provides preliminary capital cost estimations.

8.1 PHASED APPROACH ONE

The first opportunity for facility phasing is to defer a single treatment train including 1 flocculation basin, 1 DAF, and 1 rapid sand filter. To maintain the desired treated water production under Phased Approach One, this facility would be operating under a 3 duty + 0 standby configuration for DAF clarification and under a 4 duty + 0 standby configuration for the rapid sand filters. As a result, during routine maintenance of the process equipment there will be periods of time where one unit is offline, reducing the total capacity of the facility. Loading rates through the rapid sand filters became the limiting criteria for treated water production under phased approach one.

A total of 4 rapid sand filters (4 duty +0 standby) would be initially installed under the Phased Approach One alterative, compared to the proposed design of 5 rapid sand filters (4 duty + 1 standby). During normal operation, 4 duty reactors would be in service, producing the full 550 L/s design capacity of the facility. However, during routine backwash procedures, the total water production of the plant would be decreased (3 duty filters) to maintain the desired loading rates through the filters, as shown in **Table 8-1.**

Table 8-1 Comparative Rapid Sand Filtration Design Criteria Under Phased Approach One

DESCRIPTION	DESIGN CRITERIA	
	MDD- PROPOSED DESIGN	MDD – PHASED APPROACH 1
Feed Flow (L/s)	611	387
Treated Water Flow (L/s)	550	348
Number of filters operating	4 (+1 standby)	3 (+1 standby)
Cells per Filter	1	
Size of Cell (W x L), m (ft) x m (ft)	4.5 (14.8) x 8.8 (28.8) x 5.2 (17)	
Filtration Rate with Duty + Standby, m/h	11.1	10.6
Filtration Rate with Duty, m/h	14.0	14.0

As shown in **Table 8-1**, the total treated water production of 3 duty filters is 348 L/s, assuming 90% recovery. At this stage in the design process, each filter is anticipated to be backwashed once per day. Assuming a filter backwash takes 30 minutes, the total daily treated water production of this facility under Phased Approach One would decrease from 47.5 ML/day to 46 ML/day.

The resulting impacts to the DAF design criteria presented in **Table 7-3** are provided in **Table 8-2**, which compares the design criteria and total water production for the DAF clarification unit process under the proposed WTP configuration (3 duty + 1 standby) and the Phased Approach One configuration during filter backwash operation (3 duty+ 0 standby).

Table 8-2 Comparative DAF Clarification Design Criteria Under Phased Approach One

DESCRIPTION	DESIGN CRITERIA	
	MDD- PROPOSED DESIGN	MDD – PHASED APPROACH 1
Filter Flow Rate (L/s)	605	430
Filter Output at 90% Recovery (L/s)	550	387
Recycle ratio	12%	12%

No. of duty trains	3	3
No. of standby trains	1	0
Size of train (W x L x D), m (ft)	5.8(19) x 10 (32) x 3(9.8)	5.8(19) x 10 (32) x 3(9.8)
Loading rate, m/h (gpm/ft²)[1]	14.2 (5.8)	13.5 (5.5)
Detention Time, mins[1]	12.7	13.4

A Class 'D' cost estimate for Phase Approach One is provided in section 9.1.2.

8.2 PHASED APPROACH TWO

The second opportunity for facility phasing is to install the flocculation and DAF unit processes initially, but to defer filtration until a later date. Under this alternative, the remaining treatment processes of flocculation and DAF would not provide sufficient log-reduction credits to meet GCDWQ requirements. Clarification processes such as DAF do not provide any log-reduction credits for pathogens or viruses [3], therefore, under this alternative, UV disinfection would be required in addition to chlorine disinfection to achieve the necessary treatment. Installation of a UV disinfection system that satisfies the necessary validation protocol/certification standards (DVGW W294, NSF Standard 55, ÖNORM M 5873, or UVDGM) would provide 3-log reduction credits for pathogens, and 2 log-reduction credits for virus removal. Chlorine disinfection would be required for an additional 2-log reduction credits for virus inactivation and to supply disinfection residual to the distribution system.

Preliminary sizing of the UV disinfection system indicates that 2 duty reactors and 1 standby reactor will be required to meet the flow requirements of this facility. Under this alternative, the below grade pipe gallery, located on the west side of the water treatment plant, would need to be extended by approximately 150 m^2 to accommodate the reactors. Interim piping and isolation valves would also need to be installed to provide DAF effluent to the UV reactors and from the UV reactors to the treated water reservoir; yard piping from the UV reactors could be tied into the proposed treated water line discharging to the treated water reservoir in the vicinity of the proposed parking lot. While this alternative does have the additional capital costs associated with the UV disinfection system, expansion of below grade facilities, and installation of interim yard piping, it defers the costs associated with the rapid sand filter unit processes and all backwash components including the backwashing pump station. A Class 'D' cost estimate for this phasing alternative is provided in section 9.1.2.

[3] "Guidelines for Pathogen Log Reduction Credit Assignment", Ministry of Health, V1, January 2022.

9 PRELIMINARY COST ESTIMATES

This section presents the probable construction and operating costs for the Beaver Lake Water Treatment Plant project.

9.1 CLASS ‘D’ CAPITAL COST

The cost estimate prepared is a Class ‘D’ estimate with an accuracy of ±30%. This estimate is preliminary in nature given minimum to no site information and only indicates the approximate magnitude of cost of the project. Where possible, quantity takeoffs were completed for all elements shown in sufficient detail in the design drawings or described. Where possible, vendor estimates were obtained for elements. For all items known to exist but not defined in the project drawings, allowance was applied using experience and values from past projects. A 12% engineering services and 10% construction contingency are applied on the estimated capital costs. Project funding must be carefully reviewed prior to making specific financial decisions. **Table 9-1** provides a discipline breakdown of the Class D cost estimate. A full breakdown of the cost is available in Appendix A – Class ‘D’ Capital Cost.

Table 9-1: Class D Capital Cost of the Beaver Lake Water Treatment Plant

DISCIPLINE	EST. COST	%TOTAL
General	$3,955,00	8%
Civil	$1,785,000	4%
Structural	$14,305,000	29%
Architecture	$1,997,000	4%
Treatment	$11,859,000	24%
Process-Mechanical	$6,771,000	13%
Building-Mechanical	$805,000	2%
HVAC	$1,895,000	4%
Electrical and Instrumentation	$6,785,000	14%
SUB TOTAL	**$50,157,000**	**100%**
CLASS 'D' Contingency	$15,048,000	30%
EST. CAPITAL COST	**$65,205,000**	
Engineering Services	$7,825,000	12%
Construction Contingency	$6,521,000	10%
ESTIMATED PROJECT COST	**$81,912,000**	

9.1.6 CLASS 'D' CAPITAL COST- PHASED APPROACH 1

Table 9-2 provides a Class D cost estimate for Phased Approach One, in which a single treatment train (1 flocculation basin, 1 DAF, and 1 rapid sand filter) would be deferred from the initial facility construction.

Table 9-2 Class D Capital Cost of Phased Approach 1

DISCIPLINE	EST. COST	%TOTAL
General	$3,715,000	8%
Civil	$1,785,000	4%
Structural	$14,730,000	32%
Architecture	$1,997,000	4%
Treatment	$9,779,000	21%
Process-Mechanical	$5,202,000	11%
Building-Mechanical	$805,000	2%
HVAC	$1,895,000	4%
Electrical and Instrumentation	$6,785,000	15%
SUB TOTAL	**$46,693,000**	**100%**
CLASS 'D' Contingency	$14,008,000	30%
EST. CAPITAL COST	**$48,132,000**	
Engineering Services	$7,285,000	12%
Construction Contingency	$6,071,000	10%
ESTIMATED PROJECT COST	**$74,057,000**	

As shown, Phased Approach One results in approximately $8 million dollars in initial capital savings. However, this approach does reduce the overall treatment capacity of the WTP during routine maintenance activities and would provide extremely limited flexibility for system malfunctions or changes in water demands.

9.1.7 CLASS 'D' CAPITAL COST- PHASED APPROACH 2

Table 9-3 provides a Class D cost estimate for Phased Approach Two, in which the rapid sand filters would be deferred from the initial facility construction. Under this alternative, UV disinfection is added to the proposed WTP to achieve the necessary log-reduction credits for treatment efficacy.

Table 9-3 Class D Capital Cost of Phased Approach 2

DISCIPLINE	EST. COST	%TOTAL
General	$2,493,000	7%
Civil	$1,710,000	5%
Structural	$13,083,000	35%
Architecture	$1,952,000	5%
Treatment	$2,010,000	5%
Process-Mechanical	$6,156,000	17%
Building-Mechanical	$793,000	2%
HVAC	$1,834,000	5%
Electrical and Instrumentation	$7,085,000	19%
SUB TOTAL	**$37,116,000**	**100%**
CLASS 'D' Contingency	$11,135,000	30%
EST. CAPITAL COST	**$48,251,000**	
Engineering Services	$5,791,000	12%
Construction Contingency	$4,826,000	10%
ESTIMATED PROJECT COST	**$58,868,000**	

As shown, Phased Approach Two results in a decrease of initial facility capital costs equal to approximately $23 million. However, this alternative does add an additional $1.5 million in capital costs to the overall WTP design, which does not currently include UV disinfection.

9.2 OPERATING COST ESTIMATE

Operating cost as annual costs were developed for the Beaver Lake Water Treatment Plant. Present value is calculated over 25 years at 3% interest. Unit operating rates were developed for each of the operating costs as follows:

— Chemical costs are based on quotations from a chemical supplier.
— Electrical power rate used is $0.15 per kW-hour.
— Labour is based on $75 per hour salary and employment costs.
— Specific equipment replacement costs are based on manufacturer costs.

Table 9-4: Annual Operating Cost Estimates

ITEM DESCRIPTION	EST. ANNUAL COST
Electrical Power	
Raw water pumping	$126,000
Sedimentation (DAF/ in-DAFF)	$190,000
Filtration	$143,000
UV Disinfection	-
Building Lighting and HVAC [1]	$16,000
Parts	
General Equipment Parts Replacement [2]	$281,000
Chemicals	
Coagulant	$245,000
Filtration Polymers	$1,000
Residual Polymers	$3,000
Chlorine Gas	$5,000
Labour	
Operations [3]	$435,000
Maintenance Staff [4]	$106,000
Solids Disposal	$20,000
Miscellaneous [5]	$33,000
SUBTOTAL - Annual Costs	**$1,604,000**
25-year Present Worth	**$27,931,000**

[1]Assumed as all installed mechanical equipment running at 24/7.
[2]Assumed as 1% of Treatment, Mechanical/ Process-Mechanical, and Electrical capital cost.
[3]Assumed salary and employment costs for 6 full-time equivalents (FTE).
[4]Assumed 2 service calls per week at $1,000 per call.
[5]Miscellaneous includes variable costs for programming, outside laboratory testing, safety, training. Assumed as 2% of the annual costs.

10 CONCLUSIONS AND RECOMMENDATIONS

Based on the feasibility study contained herein, including the assessment on existing infrastructure, evaluation of the Beaver Lake water system, evaluation of historical water quality data, assessment of historic and future water demands, and a treatment process evaluation, the proposed treatment process for the Beaver Lake WTP consists of:

1. Flash Mixing and Coagulant Dosing
2. Flocculation
3. DAF Clarification
4. Rapid Sand Filtration; and
5. Chlorination

This proposed treatment configuration was selected based on process resiliency to changes in raw water quality, final treated water performance, ability to operate under adverse conditions (system failure, delivery disruption), robustness of treatment efficacy, ease of expansion, and ease of operation/maintenance. The proposed WTP was also designed to meet the four primary objectives set forth by the District including meeting regulatory requirements, providing a phased approach to meet long-term treatment needs, maximizing the functional benefit of the facility, and providing and cost effective and energy efficient design.

The proposed design flow for Stage 1 of this facility, balancing the desire to provide system redundancy and flexibility to meet current and future flow conditions with the desire to reduce capital costs associated with building a larger WTP initially, is 550 L/s. The proposed design flow rate for the ultimate construction of this facility is 760 L/s. Plant design flow rates were established based on the water demand analysis contained in Section 3 of this report, in which water demands of the combined Beaver Lake and Okanagan Lake system were assessed using historical and seasonal water uses.

In addition to the feasibility-level design proposed in this report, the following recommendations are presented for the next stage of design for the Beaver Lake WTP:

- Conduct piloting testing prior to preliminary design to:
  - Confirm rapid sand filter design criteria;
  - Confirm the proposed treatment process selection is the most effective for the water source;
  - Assess water stability to determine whether chemical addition is required to reduce the corrosivity of the water prior to entering the distribution system; and
  - Explore opportunities for less-conventional treatment configurations that may provide opportunities for costs reduction. An example of an alternative treatment process that could be explored during a piloting phase includes ozone, coagulation, clarification, and chlorination.
- Conduct jar testing during the pilot phase to determine coagulation requirements and coagulation chemistry including optimum pH, coagulant type, and dosage.
- Complete additional investigations into residual management alternatives including:
  - Refining the solids production estimates during preliminary design;
  - Further quantify the costs associated with upgrading the WWTP;
  - Further quantifying potential impacts and the WWTP from direct conveyance;
  - Complete additional investigations to ensure the WTP site offers favorable hydrogeologic conditions for onsite supernatant disposal; and
  - Complete a comparison of the life cycle costs for the District under each alternative.
- Perform additional geotechnical investigations at the location of any proposed structures to collected more detailed in-site density values.

- Explore potential to use the existing raw water reservoir as a conventional coagulation/flocculation clarifier to save on initial construction costs and provide additional flexibility for a phased approach consisting of coagulation/flocculation/sedimentation now, and filtration for the ultimate design.
- Refine chlorine contact calculations to ensure that the necessary treatment efficacy and chlorine contact time can be achieved in the existing treated water reservoir.

APPENDIX

A CLASS D COST ESTIMATE

Client: District of Lake Country
Project Name: Beaver Lake Water Supply and Treatment
Location: BC
Date: Jun-22
Estimate Class: Class D

								Labour		Markup		
DISCIPLINE	**DIVISION**	**Description**	**LOCATION**	**UNIT**	**QTY**	**UNIT PRICE**	**SUB-TOTAL**	%	Amount	%	Amount	**TOTAL**
	Division 01	**General Requirements**										
		.01 Insurance	ALL	%	1%	$32,233,798	$322,338					$323,000
		.02 Bonding	ALL	%	2%	$32,233,798	$644,676					$645,000
		.04 Mobilization/Demob	ALL	%	2%	$32,233,798	$644,676					$645,000
		.05 Commissioning	ALL	%	10%	$15,915,304	$1,591,530					$1,592,000
		1. WTP	WTP	%	10%	$14,291,624	$1,429,162					$1,430,000
		2. Residuals Handling	Residuals Handling	%	10%	$1,237,680	$123,768					$124,000
		3. Backwash Supply PS	Backwash Supply PS	%	10%	$386,000	$38,600					$39,000
		.06 Site Soft Costs (5,000/mth)		months	15	$10,000	$150,000					$150,000
		.07 Site Overhead (Project Staff)	ALL	months	15	$40,000	$600,000					$600,000
General		***Division 01 Subtotal***										***$3,955,000***
	Division 03	**Concrete**					$0					
		.01 Building Foundation	ALL		2210	$1,800	$3,978,000	incld.	$0	10%	$397,800	$4,376,000
		1. WTP	WTP	m^3	1900	$1,800	$3,420,000		$0	10%	$342,000	$3,762,000
		2. Residuals Handling	Residuals Handling	m^3	250	$1,800	$450,000		$0	10%	$45,000	$495,000
		3. Backwash Supply PS	Backwash Supply PS	m^3	60	$1,800	$108,000		$0	10%	$10,800	$119,000
		.02 Tilt-up Concrete (incld. Insulation) Building	ALL	m^2	2239	$800	$1,791,200	incld.	$0	15%	$268,680	$2,060,000
		1. WTP	WTP	m^2	1760	$800	$1,408,000		$0	15%	$211,200	$1,620,000
		2. Residuals Handling	Residuals Handling	m^2	289	$800	$231,200		$0	15%	$34,680	$266,000
		3. Backwash Supply PS	Backwash Supply PS	m^2	190	$800	$152,000		$0	15%	$22,800	$175,000
		.03 Sub-grade Concrete Tanks	ALL		733	$2,665	$1,954,000	incld.	$0	10%	$195,400	$2,150,000
		1. New Reservoir Cell	Reservoir	m^3	0	$2,500	$0		$0	10%	$0	$0
		2. Sludge Holding Tanks	Residuals Handling	m^3	311	$2,500	$777,000		$0	10%	$77,700	$855,000
		3. Backwash EQ	Residuals Handling	m^3	422	$2,500	$1,056,000		$0	10%	$105,600	$1,162,000
		4. Wet Well	Backwash Supply PS	m^3	48	$2,500	$121,000		$0	10%	$12,100	$134,000
		.04 Above-ground Tank Walls	ALL		529	$2,500	$1,322,850	incld.	$0	10%	$132,285	$1,456,000
		1. WTP	WTP	m^3	464	$2,500	$1,160,100		$0	10%	$116,010	$1,277,000
		2. Residuals Handling	Residuals Handling	m^3	65	$2,500	$162,750		$0	10%	$16,275	$180,000
		3. Backwash Supply PS	Backwash Supply PS	m^3	0	$2,500	$0		$0	10%	$0	$0
		.05 WTP 2nd Floor Concrete	WTP	m^3	1254	$2,500	$3,135,000	incld.	$0	10%	$313,500	$3,449,000
Structural		***Divison 03 Subtotal***					***$7,723,200***		***$0***		***$861,880***	***$13,491,000***
	Division 05	**Metals**					$0					
		.01 Process Platforms and ladders	ALL	m^2	216	$500	$108,000	10%	$10,800	10%	$10,800	$130,000
		1. WTP	WTP	m^2	170	$500	$85,000	10%	$8,500	10%	$8,500	$102,000
		2. Residuals Handling	Residuals Handling	m^2	45	$500	$22,500	10%	$2,250	10%	$2,250	$27,000
		3. Backwash Supply PS	Backwash Supply PS	m^2	1	$500	$500	10%	$50	10%	$50	$1,000
		.02 Metal Cladding	ALL	m^2	0	incld.	$0	0%	$0	0%	$0	$0
		1. WTP	WTP	m^2		incld.	$0	10%	$0	10%	$0	$0
		2. Residuals Handling	Residuals Handling	m^2		incld.	$0	10%	$0	10%	$0	$0
		3. Backwash Supply PS	Backwash Supply PS	m^2		incld.	$0	10%	$0	10%	$0	$0
		.03 Miscellaneous Metals	ALL		0	$108,000	$16,200	10%	$1,620	10%	$1,620	$20,000
		.04 Metal Roofing Structures	ALL	m^2	2224	$271	$603,323	incld.	$0	10%	$60,332	$664,000
		1. WTP	WTP	m^2	1954	$280	$547,142	incld.	$0	10%	$54,714	$602,000
		2. Residuals Handling	Residuals Handling	m^2	200	$208	$41,621	incld.	$0	10%	$4,162	$46,000
		3. Backwash Supply PS	Backwash Supply PS	m^2	70	$208	$14,560	incld.	$0	10%	$1,456	$17,000
Structural		***Division 06 Subtotal***					***$727,523***		***$12,420***		***$72,752***	***$814,000***
	Division 07	**Thermal and Moisture Protection**					$0					
		.01 Metal Roofing	ALL	m^2	2247	$300	$674,040	incld.	$0	15%	$101,106	$776,000
		1. WTP	WTP	m^2	2009	$300	$602,640		$0	15%	$90,396	$694,000
		2. Residuals Handling	Residuals Handling	m^2	218	$300	$65,340		$0	15%	$9,801	$76,000
		3. Backwash Supply PS	Backwash Supply PS	m^2	20	$300	$6,060		$0	15%	$909	$7,000
		.02 Sealants	ALL	LS	3	$11,667	$35,000	incld.	$0	10%	$3,500	$39,000
		1. WTP	WTP	LS	1	$25,000	$25,000		$0	10%	$2,500	$28,000
		2. Residuals Handling	Residuals Handling	LS	1	$5,000	$5,000		$0	10%	$500	$6,000
		3. Backwash Supply PS	Backwash Supply PS	LS	1	$5,000	$5,000		$0	10%	$500	$6,000
Architecture		***Division 07 Subtotal***					***$709,040***		***$0***		***$104,606***	***$815,000***
	Division 08	**Openings**					$0					
		.01 Doors - Single	ALL	EA	30	$2,500	$75,000	10%	$7,500	10%	$7,500	$90,000
		1. WTP	WTP	EA	30	$2,500	$75,000	10%	$7,500	10%	$7,500	$90,000
		2. Residuals Handling	Residuals Handling	EA	0	$2,500	$0	10%	$0	10%	$0	$0
		3. Backwash Supply PS	Backwash Supply PS	EA	0	$2,500	$0	10%	$0	10%	$0	$0
		.02 Doors - Double	ALL	EA	11	$4,000	$44,000	10%	$4,400	10%	$4,400	$53,000
		1. WTP	WTP	EA	9	$4,000	$36,000	10%	$3,600	10%	$3,600	$44,000
		2. Residuals Handling	Residuals Handling	EA	1	$4,000	$4,000	10%	$400	10%	$400	$5,000
		3. Backwash Supply PS	Backwash Supply PS	EA	1	$4,000	$4,000	10%	$400	10%	$400	$5,000
		.03 Overhead Coiling Door	ALL	EA	5	$20,000	$100,000	10%	$10,000	10%	$10,000	$120,000
		1. WTP	WTP	EA	3	$20,000	$60,000	10%	$6,000	10%	$6,000	$72,000
		2. Residuals Handling	Residuals Handling	EA	2	$20,000	$40,000	10%	$4,000	10%	$4,000	$48,000
		3. Backwash Supply PS	Backwash Supply PS	EA	0	$20,000	$0	10%	$0	10%	$0	$0
		.04 Windows	WTP	LS	1	$80,000	$80,000	10%	$8,000	10%	$8,000	$96,000
		.04 Access Hatch - Single	ALL	EA	10	$4,000	$40,000	10%	$4,000	10%	$4,000	$48,000
		1. WTP	WTP	EA	2	$4,000	$8,000	10%	$800	10%	$800	$10,000
		2. Residuals Handling	esiduals Handli	EA	6	$4,000	$24,000	10%	$2,400	10%	$2,400	$29,000
		3. Backwash Supply PS	ckwash Supply	EA	2	$4,000	$8,000	10%	$800	10%	$800	$10,000
		.05 Access Hatch - Double	ALL	EA	4	$6,000	$24,000	10%	$2,400	10%	$2,400	$29,000
Architecture		***Division 08 Subtotal***					***$363,000***		***$36,300***		***$36,300***	***$436,000***
	Division 09	**Finishes**					$0					
		.01 Interior Wall and Ceiling Assembly	ALL	m^2	1949	$248	$483,735	incld.	$0	10%	$48,374	$533,000
		1. WTP	WTP	m^2	1809	$250	$452,348		$0	10%	$45,235	$498,000
		2. Residuals Handling	Residuals Handling	m^2	140	$225	$31,388		$0	10%	$3,139	$35,000
		3. Backwash Supply PS	Backwash Supply PS	m^2	0	$225	$0		$0	10%	$0	$0
		.02 Interior Painting & Floor Coating	ALL	m^2	2862	$50	$143,095	incld.	$0	10%	$14,309	$158,000
		1. WTP	WTP	m^2	2202	$50	$110,120		$0	10%	$11,012	$122,000

Client:	District of Lake Country
Project Name:	Beaver Lake Water Supply and Treatment
Location:	BC
Date:	Jun-22
Estimate Class:	Class D

DISCIPLINE	DIVISION	Description	LOCATION	UNIT	QTY	UNIT PRICE	SUB-TOTAL	Labour %	Labour Amount	Markup %	Markup Amount	TOTAL
		2. Residuals Handling	Residuals Handling	m^2	185	$50	$9,225		$0	10%	$923	$11,000
		3. Backwash Supply PS	Backwash Supply PS	m^2	475	$50	$23,750		$0	10%	$2,375	$27,000
Architecture		*Division 09 Subtotal*					*$626,830*		*$0*		*$62,683*	*$691,000*
	Division 10	**Specialties**					$0					
		.01 Change Room & Washrooms	WTP	EA	6	$6,000	$36,000	incld.	$0	10%	$3,600	$40,000
		.02 Lab Equipment, Handheld Analyzers	WTP	LS	1	$15,000	$15,000	incld.	$0	0%	$0	$15,000
Architecture		*Division 10 Subtotal*					*$51,000*		*$0*		*$3,600*	*$55,000*
	Division 22	**Plumbing**					$0					
		.01 Building Plumbing		LS	1	$310,000	$310,000	10%	$31,000	10%	$31,000	$372,000
		1. WTP	WTP	LS	1	$280,000	$280,000	10%	$28,000	10%	$28,000	$336,000
		2. Residuals Handling	Residuals Handling	LS	1	$20,000	$20,000	10%	$2,000	10%	$2,000	$24,000
		3. Backwash Supply PS	Backwash Supply PS	LS	1	$10,000	$10,000	10%	$1,000	10%	$1,000	$12,000
		.02 Emergency Shower		LS	1	$100,000	$100,000	10%	$10,000	10%	$10,000	$120,000
Mechanical		*Division 22 Subtotal*					*$410,000*		*$41,000*		*$41,000*	*$492,000*
	Division 23	**Heating, Ventilation and Air-Conditioning**					$0					
		.01 Air Handling Unit, Fans, Ducting, Unit Heaters	ALL	m^2	2153	$800	$1,722,704	incld.	$0	10%	$172,270	$1,895,000
		1. WTP	WTP	m^2	1883	$800	$1,506,624		$0	10%	$150,662	$1,658,000
		2. Residuals Handling	Residuals Handling	m^2	200	$800	$160,080		$0	10%	$16,008	$177,000
		3. Backwash Supply PS	Backwash Supply PS	m^2	70	$800	$56,000		$0	10%	$5,600	$62,000
HVAC		*Division 23 Subtotal*					*$1,722,704*		*$0*		*$172,270*	*$1,895,000*
	Division 26	**Electrical**					$0					
		.01 Power Service/ Telephone/ Internet	WTP	LS	1	$350,000	$350,000	20%	$70,000	10%	$7,000	$427,000
		.02 MCC	WTP	LS	1	$3,000,000	$3,000,000	20%	$600,000	10%	$163,000	$3,763,000
		.03 SCADA and PLC Programming	ALL	LS	1	$300,000	$300,000	incld.	$0	0%	$0	$300,000
		.04 Instrumentation and Controls	ALL	LS	1	$830,000	$830,000	100%	$830,000	10%	$83,000	$1,743,000
		1. WTP	WTP	LS	1	$700,000	$700,000	100%	$700,000	10%	$70,000	$1,470,000
		2. Residuals Handling	Residuals Handling	LS	1	$100,000	$100,000	100%	$100,000	10%	$10,000	$210,000
		3. Backwash Supply PS	Backwash Supply PS	LS	1	$30,000	$30,000	100%	$30,000	10%	$3,000	$63,000
		.05 Lighting and Utilities	ALL	LS	1	$230,000	$230,000	10%	$23,000	10%	$23,000	$276,000
		1. WTP	WTP	LS	1	$150,000	$150,000	10%	$15,000	10%	$15,000	$180,000
		2. Residuals Handling	Residuals Handling	LS	1	$50,000	$50,000	10%	5000	10%	$5,000	$60,000
		3. Backwash Supply PS	Backwash Supply PS	LS	1	$30,000	$30,000	10%	3000	10%	$3,000	$36,000
Electrical		*Division 26 Subtotal*					*$4,940,000*		*$1,546,000*		*$299,000*	*$6,785,000*
	Division 31	**Earthworks**					$0					
		.01 Excavation - Offsite Disposal	General Site	m^3	4618	$20	$92,360	0%	$0	10%	$9,236	$102,000
		.02 Excavation - Onsite Storage	General Site	m^3	2309	$15	$34,635	0%	$0	10%	$3,464	$39,000
		.03 Backfilling - Reuse	General Site	m^3	2309	$25	$57,725	0%	$0	10%	$5,773	$64,000
		.04 Structural fill	General Site	m^3	15664	$50	$783,200	0%	$0	10%	$78,320	$862,000
		.05 Perimeter Drain	General Site	m	480	$80	$38,400	0%	$0	10%	$3,840	$43,000
Civil		*Division 31 Subtotal*					*$1,006,320*		*$0*		*$100,632*	*$1,110,000*
	Division 32	**Exterior Improvements**					$0					
		.01 Asphalt paving	General Site	m^2	3800	$55	$209,000	0%		10%		$209,000
		.02 Gravel surfacing	General Site	m^2	0	$21	$0	0%		10%		$0
Civil		*Division 32 Subtotal*					*$209,000*		*$0*		*$0*	*$209,000*
	Division 33	**Utilities**					$0					
		.01 <300mm SCH 80 PVC pipes	General Site	m	140	$250	$35,000	incld.	$0	10%	$3,500	$39,000
		.02 350 - 450mm SCH 80 PVC pipes	General Site	m	0	$450	$0	incld.	$0	10%	$0	$0
		.03 600mm SCH 80 PVC pipes	General Site	m	50	$600	$30,000	incld.	$0	10%	$3,000	$33,000
		.04 750 mm RW and TW Tie-ins	General Site	EA	2	$25,000	$50,000	incld.	$0	10%	$5,000	$55,000
		.05 750mm SCH 80 PVC	General Site	m	410	$750	$307,500	incld.	$0	10%	$30,750	$339,000
		.06 750mm SS Treated Water Piping	General Site	m	0	$1,200	$0	incld.	$0	10%	$0	$0
Civil		*Division 33 Subtotal*					*$422,500*		*$0*		*$42,250*	*$466,000*
	Division 40	**Process Pipes & Valves**					$0					
		.01 WTP	WTP	LS	1	$3,000,000	$3,000,000	40%	$1,200,000	10%	$300,000	$4,500,000
		.02 Residuals Handling System	esiduals Handli	LS	1	$1,000,000	$1,000,000	40%	$400,000	10%	$100,000	$1,500,000
		.03 Backwash Supply PS	Backwash Supply PS	LS	1	$150,000	$150,000	40%	$60,000	10%	$15,000	$225,000
Process-Mechanical		*Division 40 Subtotal*					*$4,150,000*		*$1,660,000*		*$415,000*	*$6,225,000*
	Division 41	**Conveyance and Lifting**					$0					
		.01 Davits and Lifting Devices		LS	1	$250,000	$250,000	15%	$37,500	10%	$25,000	$313,000
Mechanical		*Division 41 Subtotal*					*$250,000*		*$37,500*		*$25,000*	*$313,000*
	Division 43	**Process Pumps**					$0					
		.01 220HP Backwash Supply Pumps	Backwash Supply PS	EA	3	$100,000	$300,000	20%	$60,000	10%	$30,000	$390,000
		.02 Sludge Pumps	Residuals Handling	EA	3	$20,000	$60,000	20%	$12,000	10%	$6,000	$78,000
		.03 6HP Thickener Supply Pumps	Residuals Handling	EA	3	$20,000	$60,000	20%	$12,000	10%	$6,000	$78,000
rocess-Mechanical		*Division 43 Subtotal*					*$420,000*		*$84,000*		*$42,000*	*$546,000*
	Division 46	**Process Equipment**										
		.01 Conventional Filtration	WTP	LS	1	$8,000,000	$8,000,000	20%	$1,600,000	10%	$800,000	$10,400,000
		.02 Residuals Handling System	Residuals Handling	LS	1	$857,600	$857,600	20%	$171,520	10%	$85,760	$1,115,000
		0.3 Chemical System	WTP	LS	1	$312,500	$312,500	incld.	$0	10%	$31,250	$344,000
		1. Coagulant			LS	$97,500	$85,000	incld.	$0	10%	$8,500	$93,500
		2. Caustic Soda			LS	$67,500	$67,500	incld.	$0	10%	$6,750	$74,250
		3. Polymer			LS	$160,000	$160,000	incld.	$0	10%	$16,000	$176,000
Treatment		*Divison 46 Subtotal*					*$9,170,100*		*$1,771,520*		*$917,010*	*$11,859,000*
		SUB-TOTAL					***$32,233,798***		***$5,188,740***		***$3,095,540***	***$50,157,000***
		Class 'D' Contingency				30%					±	$15,048,000
		CLASS D Capital Cost										***$65,205,000***
		Engineering Services				12%						$7,825,000
		Construction Contingency				10%						$6,521,000
		ESTIMATED PROJECT COST										***$79,551,000***

APPENDIX

B ISSUED FOR FEASIBILITY STUDY

LAKE COUNTRY
Life. The Okanagan Way.

DISTRICT OF LAKE COUNTRY

BEAVER LAKE
WATER TREATMENT PLANT

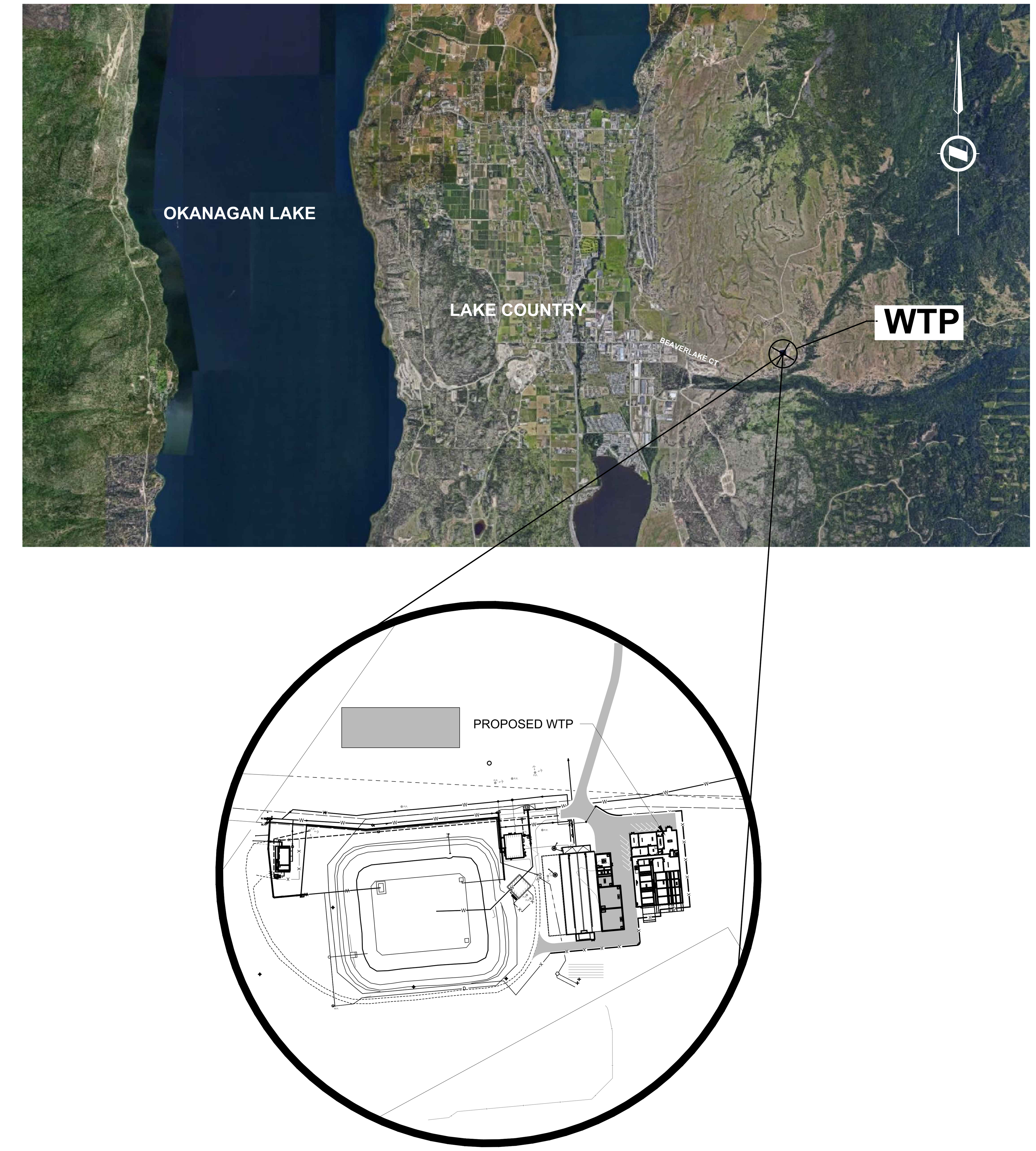
CONCEPTUAL DESIGN

Project No: 211-07826-00
Date: JUNE 2022

wsp

700 - 1631 DICKSON AVENUE
KELOWNA, BC
CANADA, V1Y 0B5
PHONE: 250-980-5500
WWW.WSP.COM

PROJECT LOCATION



INDEX TO DRAWINGS		
	SHEET TITLE	SHEET NO.
GENERAL	COVER PAGE, PROJECT LOCATION, DRAWING INDEX	G0-01
GENERAL	PROCESS FLOW DIAGRAM	G0-02
GENERAL	HYDRAULIC PROFILE	G0-03
GENERAL	BUILDING LAYOUT - MAIN LEVEL	G0-04
GENERAL	BUILDING LAYOUT - SECOND LEVEL	G0-05
GENERAL	BUILDING LAYOUT - RESIDUALS HANDLING	G0-06
GENERAL	BUILDING LAYOUT - SECTIONS	G0-07
CIVIL	WTP - OVERALL SITE PLAN	C0-00
CIVIL	WTP - YARD PIPING	C0-01

CONCEPTUAL DESIGN

Revision	Amendment	Approved	Revision Date
P1	CONCEPTUAL DESIGN	SH	MAR 2022
P1	CONCEPTUAL DESIGN	TM	JUN 2022

LAKE COUNTRY

wsp

Kelowna Office
+1 250 980 5500
Suite 700, 1631 Dickson Ave
Kelowna, BC V1Y 0B5
Canada

Designed	Approved	Approved Date
P. OKA	T.MUNDING	JUN 2022
Drawn	Scales	
J. JABLA	NTS	

Project
DISTRICT OF LAKE COUNTRY
BEAVER LAKE
WATER TREAMENT PLANT

Sheet
GENERAL
PROCESS FLOW DIAGRAM

Project No.	Sheet. No.	Revision
211-07826-00	G0-02	P2

Original Sheet Size ANSI D [22"x34"] Plot Date 2022-06-22 at 11:40:16 AM Path \\corp\ca\data$\CAKWL500\kw_proj\CLIENTS\362 Lake Country\proj\211-07826-00 Beaver Lake Road_Eldorado Treated Water Reservoir\500 Deliver\540 CAD & Dwgs\(G)General\+Autocad\PFD.dwg G0-02

HYDRAULIC PROFILE

Scale: VERT. 1:50 HORIZ. NTS.

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P1	CONCEPTUAL DESIGN	SH	MAR 2022
P2	CONCEPTUAL DESIGN	TM	JUN 2022

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Drawn	**Scales**	
J. JABLA	NTS	

Project
DISTRICT OF LAKE COUNTRY
BEAVER LAKE
WATER TREATMENT PLANT

Sheet
GENERAL
HYDRAULIC PROFILE

Project No.	Sheet No.	Revision
211-07826-00	G0-03	P2

PLAN - MAIN LEVEL @ EL 628.0m

SCALE: 1:100

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P1	CONCEPTUAL DESIGN	SH	MAR 2022
P2	CONCEPTUAL DESIGN	TM	JUN 2022

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P. OKA	T.MUNDING	JUN 2022

Drawn	Scales
J. JABLA	1:100

Project
DISTRICT OF LAKE COUNTRY
BEAVER LAKE
WATER TREATMENT PLANT

Sheet
GENERAL
BUILDING LAYOUT - MAIN LEVEL

Project No.	Sheet. No.	Revision
211-07826-00	G0-04	P2

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PLAN -SECOND LEVEL @ EL. 633.0m

SCALE: 1:100

CONCEPTUAL DESIGN

Revision	Amendment	Approved	Revision Date
P1	CONCEPTUAL DESIGN	SH	MAR 2022
P2	CONCEPTUAL DESIGN	TM	JUN 2022

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P. OKA	T.MUNDING	JUN 2022
Drawn	**Scales**	
J. JABLA	1:100	

Project
DISTRICT OF LAKE COUNTRY
BEAVER LAKE
WATER TREATMENT PLANT

Sheet
GENERAL
BUILDING LAYOUT - SECOND LEVEL

Project No.	Sheet. No.	Revision
211-07826-00	G0-05	P2

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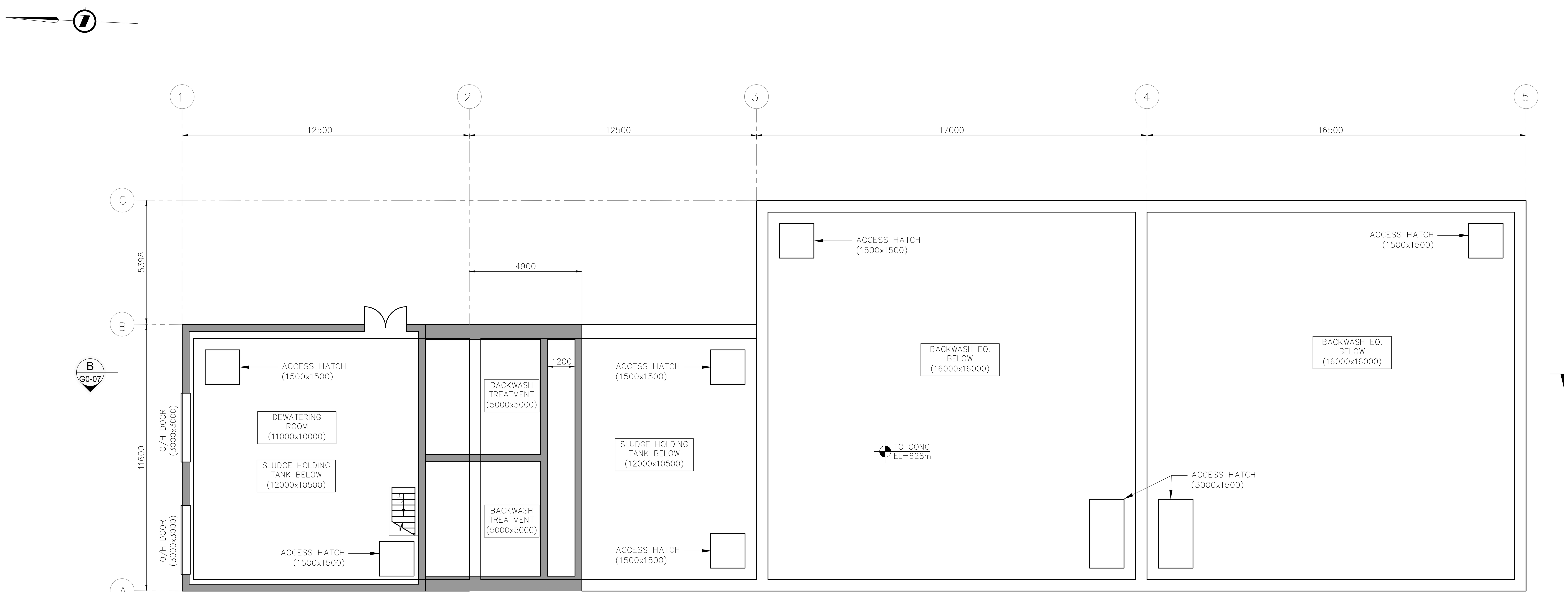
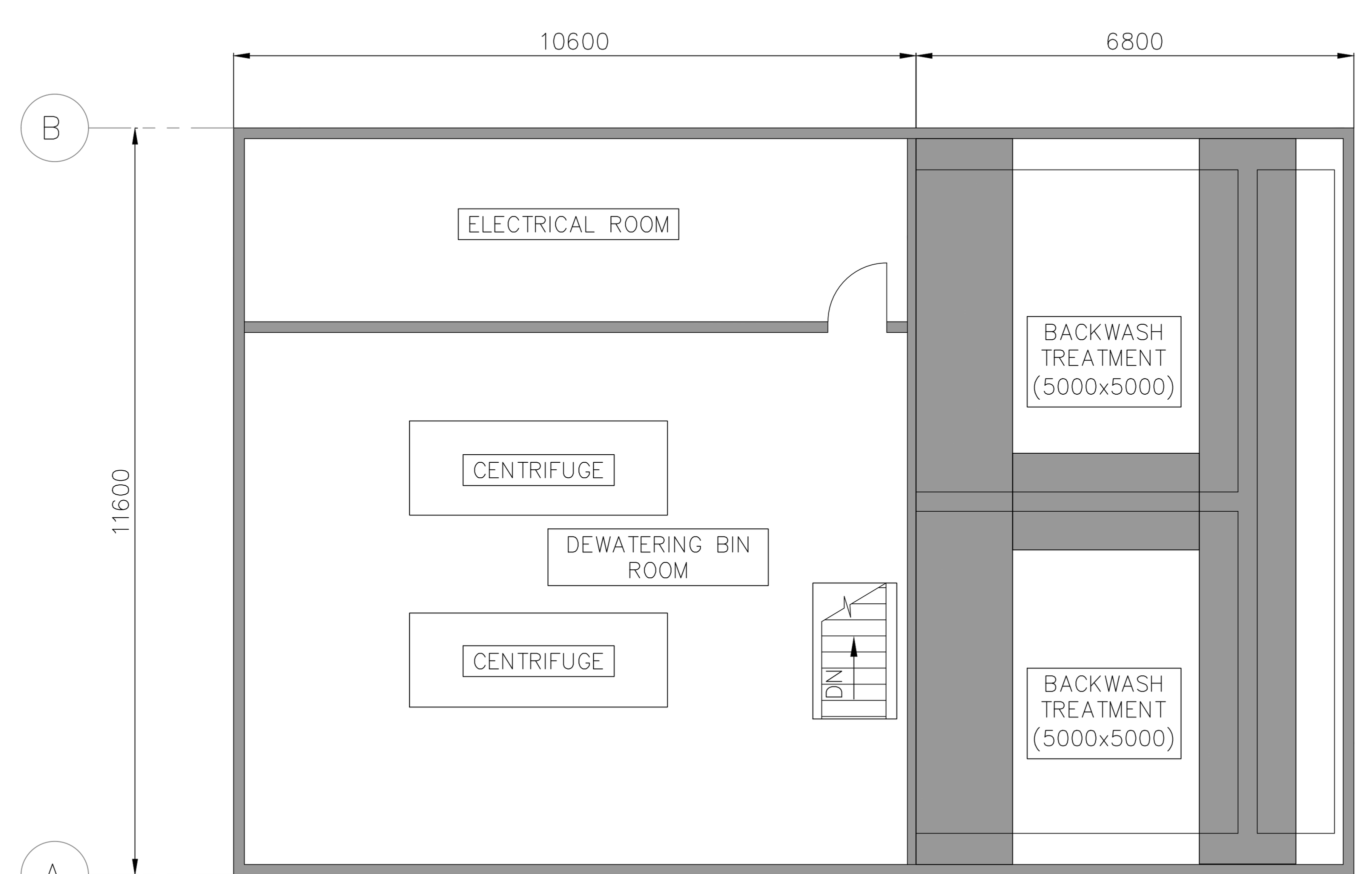


PLAN -MAIN LEVEL @ EL 628.0m

SCALE: 1:100



PLAN -SECOND LEVEL @ EL 633.0m

SCALE: 1:100

CONCEPTUAL DESIGN

Revision	Amendment	Approved	Revision Date
P1	CONCEPTUAL DESIGN	SH	MAR 2022
P2	CONCEPTUAL DESIGN	TM	JUN 2022

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Canada

Designed	Approved	Approved Date
P. OKA	T.MUNDING	JUN 2022

Drawn	Scales
J. JABLA	1:100

Project
DISTRICT OF LAKE COUNTRY
BEAVER LAKE
WATER TREATMENT PLANT

Sheet
GENERAL
BUILDING LAYOUT - RESIDUALS HANDLING

Project No.	Sheet. No.	Revision
211-07826-00	G0-06	P2

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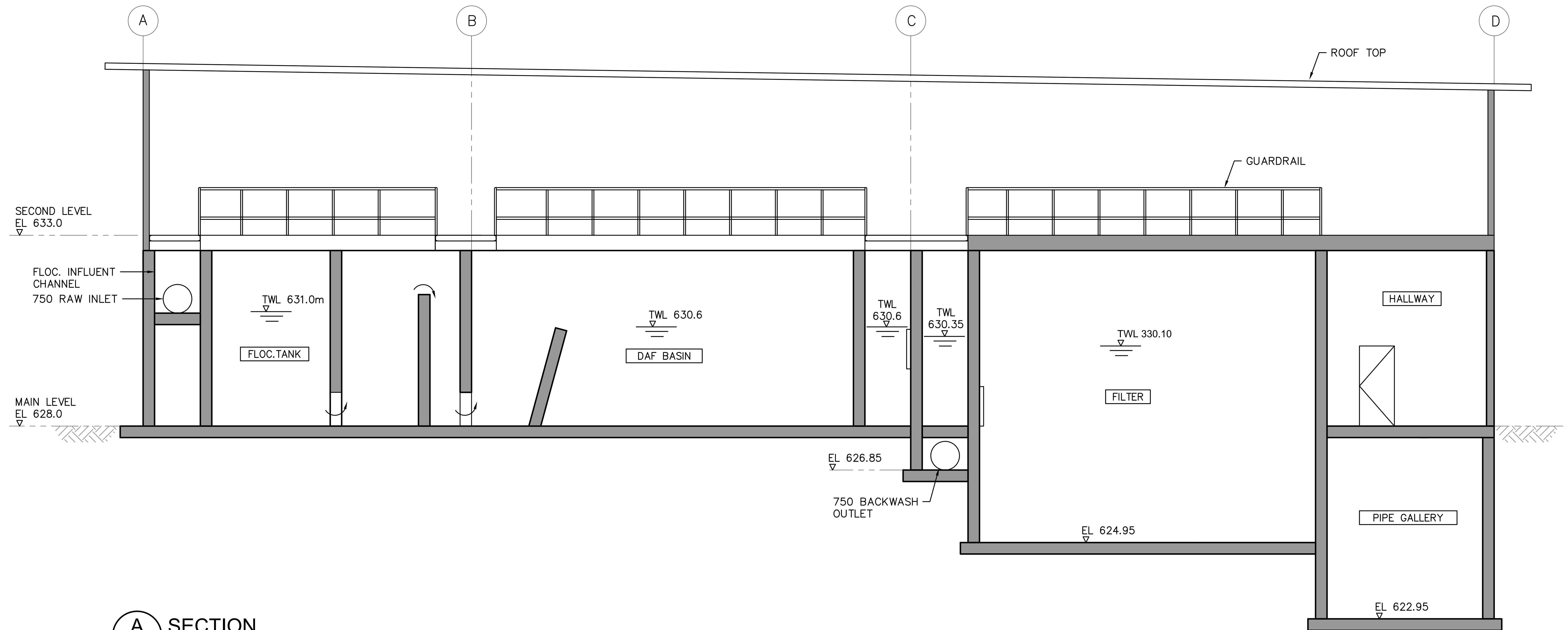

A SECTION
G0-04,05 SCALE: 1:75

B SECTION
G0-06 SCALE: 1:75

CONCEPTUAL DESIGN

Revision	Amendment	Approved	Revision Date
P1	CONCEPTUAL DESIGN	SH	MAR 2022
P2	CONCEPTUAL DESIGN	TM	JUN 2022

LAKE COUNTRY

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Kelowna, BC V1Y 0B5
Canada

Designed	Approved	Approved Date
P. OKA	T.MUNDING	JUN 2022

Drawn	Scales
J. JABLA	1:75

Project
DISTRICT OF LAKE COUNTRY
BEAVER LAKE
WATER TREATMENT PLANT

Sheet
GENERAL
BUILDING LAYOUT - SECTIONS

Project No.	Sheet. No.	Revision
211-07826-00	G0-07	P2

PLAN
SCALE: 1:500

CONCEPTUAL DESIGN

Revision	Amendment	Approved	Revision Date
P1	CONCEPTUAL DESIGN	SH	MAR 2022
P2	CONCEPTUAL DESIGN	TM	JUN 2022

0 10 20 30 40 50m
SCALE: 1:500

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Canada

Project
DISTRICT OF LAKE COUNTRY
BEAVER LAKE
WATER TREATMENT PLANT

Sheet
CIVIL
WTP - OVERALL SITE PLAN

Designed	Approved	Approved Date
P. OKA	T.MUNDING	JUN 2022

Drawn	Scales	Project No.	Sheet. No.	Revision
J. JABLA	1:500	211-07826-00	C0-00	P2

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PLAN

SCALE: 1:250

CONCEPTUAL DESIGN

Revision	Amendment	Approved	Revision Date
P1	CONCEPTUAL DESIGN	SH	MAR 2022
P2	CONCEPTUAL DESIGN	TM	JUN 2022

LEGEND:

(hatched)	TO BE REMOVED
TW	TREATED WATER
RW	RAW WATER
SFBW	SAND FILTER BACKWASH WATER
FW	FILTERED WATER
RCW	RECYCLED CLARIFIED WATER
SAN	SANITARY
PD	PROCESS DRAIN
BWS	BACKWASH SUPPLY
DAF-F	DAF FLOAT
OD	OVERFLOW DRAINS

0 5 10 15 20 25m

SCALE: 1:250

LAKE COUNTRY

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Project: DISTRICT OF LAKE COUNTRY
BEAVER LAKE
WATER TREATMENT PLANT

Sheet: CIVIL
WTP - YARD PIPING

Designed	Approved	Approved Date
P. OKA	T.MUNDING	JUN 2022

Drawn	Scales	Project No.	Sheet No.	Revision
J. JABLA	1:250	211-07826-00	C0-01	P2

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APPENDIX

C WATER LICENSING

SOURCE	LISENCE NO.	DEDICATED USES	QUANTITY	UNIT
Vernon Creek	C034636	Waterworks: Local Provider	414830.7	m3/year
Vernon Creek	C034636	Irrigation: Local Provider	1299162.8	m3/year
Vernon Creek	C056171	Domestic	0.91	m3/day
Vernon Creek	C056171	Irrigation: Local Provider	15702.2	m3/year
Vernon Creek	C059644	Irrigation: Local Provider	616740	m3/year
Vernon Creek	C059645	Waterworks: Local Provider	618268.2	m3/year
Vernon Creek	C122462	Irrigation: Local Provider	5184624.8	m3/year
Vernon Creek	C122462	Waterworks: Local Provider	82738.8	m3/year
Vernon Creek	C122463	Waterworks: Local Provider	82966.1	m3/year
Vernon Creek	F070848	Incidental - Domestic	1.1	m3/day
Vernon Creek	F070848	Irrigation: Local Provider	61674.0	m3/year
Vernon Creek	F070849	Incidental - Domestic	1.1	m3/day
Vernon Creek	F070849	Irrigation: Local Provider	17268.7	m3/year
Vernon Creek	F070850	Domestic	1.1	m3/day
Vernon Creek	F070850	Irrigation: Private	32070.5	m3/year
Vernon Creek	F070851	Incidental - Domestic	1.1	m3/day
Vernon Creek	F070851	Irrigation: Local Provider	16035.2	m3/year
Vernon Creek	F070852	Domestic	1.1	m3/day
Vernon Creek	F070852	Irrigation: Private	29603.5	m3/year
Vernon Creek	F070853	Irrigation: Private	15418.5	m3/year
Vernon Creek	F070853	Domestic	1.1	m3/day
Vernon Creek	F070854	Irrigation: Private	30837.0	m3/year

Vernon Creek	F070854	Domestic	1.1	m3/day
Vernon Creek	F070855	Irrigation: Private	29911.9	m3/year
Vernon Creek	F070855	Domestic	1.1	m3/day
Vernon Creek	F070856	Irrigation: Private	24052.9	m3/year
Vernon Creek	F070856	Domestic	1.1	m3/day
Vernon Creek	F070857	Irrigation: Local Provider	13259.9	m3/year
Vernon Creek	F070857	Incidental - Domestic	1.1	m3/day
Vernon Creek	F070858	Irrigation: Private	72158.6	m3/year
Vernon Creek	F070858	Domestic	1.1	m3/day
Swalwell Lake	F006991	Incidental - Domestic	9.09	m3/day
Swalwell Lake	F006991	Irrigation- Local Provider	678414	m3/year
Okanagan Lake	C033959	Waterworks: Local Provider	48950.0	m3/year
Okanagan Lake	C108271	Waterworks: Local Provider	2198602.8	m3/year
Okanagan Lake	C108281	Waterworks: Local Provider	8794411.1	m3/year
Okanagan Lake	C110266	Waterworks: Local Provider	2489.0	m3/year
Okanagan Lake	C110266	Lawn, Fairway, and Garden Watering	1850.2	m3/year
Okanagan Lake	C125141	Waterworks: Local Provider	69691.6	m3/year
Okanagan Lake	C125142	Waterworks: Local Provider	5807.6	m3/year
Okanagan Lake	C125143	Waterworks: Local Provider	829.7	m3/year
Okanagan Lake	C125144	Waterworks: Local Provider	5807.6	m3/year