

Final

Water Utility Master Plan



Submitted To:

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District of West Kelowna

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Revision Log

Revision #	Revised By	Date	Issue / Revision Description
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Abbreviations

AES	Atmospheric Environment Service	M	metres (length)
AC	Asbestos Cement	m ³ /s	cubic metre per second, (flow rate)
ADD	Average Daily Demand	Mg/L	milligrams/litre (parts per million)
ALR	Agricultural Land Commission	MAC	Maximum Acceptable Concentration
AO	Aesthetic Objective	MF	multi-family
AWWA	American Waterworks Association	ML	megalitre (one million litres = 1000 m ³)
BCWWA	BC Water and Waste Association	MLD	Megalitres per day
BD	Base Demand	MDD	Maximum daily demand
BTEX	Benzene, toluene, ethyl benzene and xylenes	Mlgpd	Million Imperial gallons per day
CCP	Concrete Cylinder Pipe	MOE	Ministry of Environment
CFU	Coliform Unit	MTBE	Methyl Tertiary Butyl Ether
CI	Cast Iron	NTU	Nephelometric Turbidity Unit
CPI	Consumer Price Index	OCP	Official Community Plan
CSA	Canadian Standards Association	OD	Outside diameter
CT	concentration x time of contact with disinfectant	O & M	Operations and Maintenance
CDP	Concept Development Plan	PHD	Peak hour demand
DAF	Dissolved Air Flotation	PLC	Programmable Logic Controller
DBP	Disinfection byproduct	POU	Point of Use
DCC	Development Cost Charge	PRV	Pressure reducing valve
DI	Ductile Iron	PS	Pump Station
DR	Dimension Ratio	psi	pounds per square inch (pressure)
DSM	Demand Side Management	PST	Provincial Sales Tax
DWPA	Drinking Water Protection Act	PVC	Polyvinyl Chloride
DWK	DWK of West Kelowna	PSAB	Public Sector Accounting Board
FF	Fireflow	PZ	Pressure Zone (normal HGL in metres)
FUS	Fire Underwriters Survey	RO	Reverse Osmosis
GCDWQ	Guideline for Canadian Drinking Water Quality	SCADA	Supervisory Control and Data Acquisition
GIS	Geographical Information System	SF	Single family development
GST	Goods and Services Tax	SDWR	Safe Drinking Water Regulation
HAAs	Haloacetic Acids	SWTR	Surface Water Treatment Rule
HDPE	High density polyethylene (pipe)	TCA	Tangible Capital Assets
HGL	Hydraulic grade line (slope of water in m/m)	TCU	True Color Units
ICI	Industrial, Commercial, Institutional	TDH	Total Dynamic Head
ID	Internal Diameter	THMs	Trihalomethanes
Igpm	Imperial Gallons per minute	TOC	Total Organic Carbon
IMAC	Interim Maximum Acceptable Concentration	TWL	Top water level (metres)
IHA	Interior Health Authority	UFW	Unaccounted for Water
km ²	square kilometre	µg/L	micrograms / litre (parts per billion)
L/ca/d	Litres per capita per day	uS /cm	microsiemens
L/s	litres per second (flow rate)	USEPA	US Environmental Protection Agency
Le	Leakage	UV	Ultraviolet
LWBC	Land and Water BC	WSC	Water Survey of Canada
		WTP	Water Treatment Plant

Executive Summary

Background

The District of West Kelowna (DWK) was incorporated in December of 2007. As part of the creation of the DWK, the five primary water purveyors within the new municipality boundary were amalgamated into a single water utility. Each of the legacy water systems evolved according to its own customer requirements resulting in a range of levels of service currently being delivered to the customers. Some key comments and characteristics of each legacy water system are:

1. **Lakeview Irrigation District:** This water system was originally constructed to provide irrigation water for agricultural customers and relies on Lambly Creek for the supply of raw water. The raw water supply is robust and reasonably easy to operate given the water storage reservoirs at the Big Horn and the Rose Valley dams. The raw water is chlorinated and then primarily supplied by gravity to the roughly 3,800 domestic customers and 226 Ha. of irrigation land.
2. **Pritchard:** This is a small water system constructed to provide potable water to a development consisting of 150 single family domestic services. The water system relies on raw water diverted from Okanagan Lake with the only treatment consisting of chlorination for disinfection.
3. **Sunnyside:** This is a developer constructed water system that supplies chlorinated Okanagan Lake water to 1,100 single family domestic services and 36.4 ha.
4. **Westbank Irrigation District:** This system was also originally constructed to supply irrigation water to agricultural customers. The water system supplies raw water diverted from Powers Creek that is then treated with the Powers Creek water treatment plant to be fully compliant with the Interior Health potable drinking water guidelines. This water system supplies treated water to both approximately 5,000 domestic customers and 385 Ha. of irrigation land.
5. **West Kelowna Estates:** This is a water system that developed with time in conjunction with the primarily single family development in the West Kelowna Estates area. The distribution system supplies roughly 1,200 domestic customers with chlorinated water diverted from Okanagan Lake.

One of the difficult engineering and administrative challenges within the DWK system is that it must meet the needs of two very different customer classifications. Domestic customers require high quality water, while agricultural water requires no water quality treatment. Agricultural water demand is seasonal but accounts for a significant portion of overall water demand and it drives the peak demand, which sets the capacity requirement for the design of the overall system. These unusual systems require unique solutions to meet the needs of all users in a manner that is fair and equitable where it comes to water rates. Developing a plan for the optimized supply of water within the DWK given the existing assets is key to ensure the financial sustainability of the water utility. Also, for the supply of water to the domestic customers, the DWK has been informed by Interior Health that a plan needs to be developed and executed that meets their "Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies in British Columbia". This means a higher level of treatment for all the legacy water systems except for the Westbank Irrigation District.

The development of a Master Plan needs to consider the future, but the extent into the future will vary depending on the item being planned. For this project the assumed study requirements are:

1. All the distribution system and any physical infrastructure being planned either for the raw water supply or treatment are planned for the next 20 years to meet the projected growth values in the Official Community Plan.
2. The supply of raw water, raw and treated water transmission mains and the space requirements at the water treatment plant sites were planned for the 50 year horizon based on supporting a 2% growth rate in the

community. Having sufficient raw water and a plan to treat the water is a cornerstone for any municipal water system. Given the importance of these items the planning considerations cover a longer duration. Ensuring the continued supply of water to all the existing customers, planning for future growth and improving the level of treatment to ensure the supply of potable water is a major challenge for the DWK. The key goal of this study is to determine the most feasible approach to supply treated water that is compliant with the Interior Health guidelines while continuing to maintain the supply of irrigation water to the agricultural users. The specified level of service needs to be achieved while effectively using the available money.

The Consumption of Water and Future Water Demands

Establishing the existing flow requirements and then estimating the future flows that will be used for the basis of the analysis is a critical step when assessing the existing function and the future needs of a water system. To complete this task the various historical flow records available from the legacy water system were compiled and analyzed. The other important piece of data used in the analysis was the recently available water meter data. In addition to studying the data some judgment needs to be applied to ensure reasonable decisions are made related to the identification of existing system deficiencies, rectifying current infrastructure needs and planning for the future.

The two legacy Irrigation Districts contain agricultural property with a defined allocation of water that the DWK water utility is obligated to supply, should the agricultural customers want the water. Based on our review of the flow data, it appears that the actual volume of water used for agriculture is significantly less than the allocation. The hydraulic model was analyzed based on the agricultural allocation but the evaluation of the raw water supply requirements and treatment facilities are based on the actual agricultural water used. This means the actual agricultural irrigation demand should be monitored closely and if there are any changes in the trend of agricultural water demand adjustment may be required.

Across the Okanagan most municipal water systems experienced the peak daily demand in 2004. Since then the peak daily water demand has consistently decreased and depending on the level of growth the annual water demand has remained somewhat consistent or increased. The exact cause of the reduction in the peak water demand is debated, but it is assumed within this document that the source is increased consumer awareness about the importance of water conservation and cooler weather patterns during the month of July. This means that the available flow data for the past couple of years provided by the DWK was adjusted to reflect a water demand pattern similar to 2004, but based on the current DWK population. For the future demands the recommended bylaw values were used. **Table E.1** below provides a summary of the existing and future distribution system unit demands used for the basis of the hydraulic model analysis. **Table E.2** provides the total and future annual and maximum daily flows projected for the use of estimating the raw water supply and treatment requirements.

Table E.1 – Existing and Future Water Demands for Key Demand Conditions

Condition	Existing (Utilized for Analysis)	Future Demands
Average Day Demand (L/cap/day)	670	900
Maximum Day Demand (L/cap/day)	2,240	2,400
Peak Hour Demand (L/cap/day)	3,300	4,000

Table E.2 – Existing and Future Total System Water Demands

Condition	Existing (Utilized for Analysis)	Future Demands - 2032	Future Demands - 2062
Average Annual Demand (ML/year)	14,250	18,980	30,660
Total Maximum Day Demand (ML/d)	131	166	251

Raw Water Supply

The DWK has the benefit of a number of good quality water sources that collectively have more than adequate available water to meet future needs. A review of the available water sources confirmed that Powers Creek, Lambly Creek and Okanagan Lake are the best long term sources of raw water for the DWK. There has been several millions of dollars invested in both the Powers Creek and the Lambly Creek watersheds; focused on collecting and releasing raw water as required during the course of the year to meet the water demand of the distribution system. The majority of the legacy investments are in suitable condition and can be relied on in the foreseeable future. In addition to maximizing the use of acceptable existing infrastructure these sources provided sufficient volume of licensed water to meet the long term needs of DWK. The recommended long term raw water supply strategy is summarized below:

1. **Powers Creek:** Extensive effort has been spent to maximize the collection of raw water within the Powers Creek watershed. This results in the effective and reliable collection of raw water within the watershed, but the operation is somewhat labour intensive. While there is some available additional capacity of the watershed to generate more water during an average year, this is not the case during a 50-year drought. During the design drought under the future water demands the existing storage reservoirs will be empty due to a lack of water. This situation is predicted to occur beyond the 20-year planning horizon, meaning there is certainly not an immediate concern, but this situation does question the logic of building more storage in the Powers Creek watershed.

Given the limited run-off availability within the watershed the general recommendation is to maximize the capacity of the existing upland infrastructure and complete some nominal capital improvements to modernize existing infrastructure resulting in a reduction of manual operator input. Future major raw water investments are recommended for the Lambly Creek watershed and Okanagan Lake as the risk of sufficient supply during a drought is far lower with these sources.

2. **Lambly Creek:** The watershed supplying raw water to the primary storage reservoirs at the Big Horn dam and the Rose Valley Reservoir has measurably more capacity than the Powers Creek watershed. Also, given the natural configuration of the watershed combined with the size of the Big Horn dam and Rose Valley Reservoir, the operation of the upland infrastructure is reasonably simple. Due to the available capacity in the watershed and an easier operation, it is recommended that an additional storage asset be built to improve the annual total volume of raw water available from the Lambly Creek source.

The exact date will vary depending on the actual annual demand of the DWK, but in the vicinity of 2032 more storage will be required within the Lambly Creek watershed. To address this need a new dam is recommended upstream of the existing Lambly Creek diversion structure. This new dam is estimated to cost \$ 13.6 M and provides 4,500 ML of total storage.

3. **Okanagan Lake:** It is recommended to retain the current water diversion licenses currently held on Okanagan Lake for long term use in the future. Once the capacity of the upland watershed is in jeopardy of being exceeded, a raw water pump station and transmission main is recommended to pump raw Okanagan Lake water to the Rose Valley Reservoir water treatment plant site. The raw water from Okanagan Lake will serve as a supplemental flow to augment the water available from Lambly Creek. The Okanagan Lake pump station and transmission main will provide an operational benefit during drought conditions or some other emergency within the watershed.

The raw water pump station and transmission main will be sized to convey 48 ML/d and is estimated to cost \$ 16.9 M. This project is not expected to be required until after the current 20 year planning horizon. This project can be completed prior to the new dam on Lambly Creek to further defer this project or the opposite approach can be implemented.

Water Treatment Requirements

Presently, Powers Creek water is treated to meet the requirements of the Interior Health. This means all the legacy Westbank Irrigation District customers receive Interior Health compliant treated water. Currently, all the other customers within the service area receive chlorinated surface water that does not meet Interior Health's "4-3-2-1-0 Dual Treatment guidelines". Further water treatment will be necessary for all the sources other than Powers Creek to meet the standards expected by Interior Health and to be comparable with the required level of service provided elsewhere in Canada given the raw water characteristics of the source water.

Water treatment facilities are expensive to maintain and operate. For a community with the size of the DWK, it is a common practice to only have one water treatment plant to realize the maintenance and operational efficiencies associated with one treatment facility. The best local examples are the City of Penticton and the District of Summerland that both rely on a single water treatment facility. With the goal of minimizing the number of treatment plants several options were considered with the preferred lowest life cycle cost solution being the following:

1. Retain the existing 55 ML/d Powers Creek water treatment plant. As development and demand increases within the plant service area this facility can be expanded, as pre-planned, to a total treated water capacity of 81 ML/d. Currently based on the domestic demand and the agricultural allocation within the existing water treatment plant service area, the peak daily demand is roughly 55 ML/d; however, the maximum daily demand currently processed by the Powers Creek water treatment plant is in the order of 40 ML/d. This means the current facility has sufficient capacity and the actual water demand patterns within the service area should be closely monitored. Assuming there is not a significant change in the usage of water for agriculture and subject to the exact growth rate, the expansion of the existing Powers Creek water treatment plant is expected to be required in the next 10 – 15 years.
2. Build a new in-filter dissolved air flotation plant at the site of the existing Rose Valley Reservoir dam. This new facility should be 90 ML/d or sized to meet the estimated 20 year demand of the service area. In addition to supplying treated water to the legacy Lakeview Irrigation District, this new water treatment plant will serve Pritchard, Sunnyside and the West Kelowna Estates services areas. For the Pritchard and Sunnyside areas this will be accomplished by interconnecting the existing distribution systems with some watermain improvements. To supply water to West Kelowna Estates a new transmission main to convey water by gravity from the Rose Valley reservoir site to the existing Blackwood Reservoir is required. Once this work is complete the existing Pritchard, Sunnyside, and West Kelowna Estates pump stations can be isolated from the potable water network, and treated water from the Rose Valley water treatment plant can be delivered to all customers not currently receiving a treated domestic supply.
3. In the future once the capacity of the expanded Powers Creek and the Rose Valley water treatment plants is reached further treated water will be provided by expanding the capacity of the Rose Valley facility. The ultimate treated water capacity of the Rose Valley Reservoir water treatment plant is 170 ML/d. To supply the treated water within the distribution network, transmission mains are planned to convey water to the Sunnyside area and the legacy Westbank Irrigation District. The currently estimated transmission mains need to be reviewed in the future as the exact size and location of the new transmission mains will depend on the location of future development.

This means the long term water treatment plan for the DWK is two water treatment plants – retain the Powers Creek facility and construct a new plant at the Rose Valley Reservoir site. This situation is a bit unique for a community the size of the DWK, but given the geographic location of the available raw water sources and the historical investments, two water treatment facilities are economically defensible.

Distribution System Assessment

The existing distribution systems were analyzed for compliance with the DWK bylaws during the conveyance of peak hour demand and the maximum daily demand plus fire flow. Additional analysis was completed to determine opportunities to realize potential interconnections of the legacy distribution systems to improve efficiency of water distribution by reducing the number of pump stations, pressure reducing facilities, and other facilities.

To support the engineering analysis a computer hydraulic model was developed for the entire DWK water system. The software used for the computer model is Innowyze InfoWater, which is a GIS based modeling program. This means that as the DWK continued to advance the management of the water system information in a GIS, the hydraulic model and the associated results could be integrated with the overall information management system being pursued by the DWK. Once all the legacy hydraulic models and record drawing information was converted into the Innowyze InfoWater format, the model was calibrated using field measurements collected by the DWK operational staff.

The key conclusions as a result of the analysis of the existing and future water distribution systems are:

1. The existing system performs reasonably well during the conveyance of the two different design scenarios of peak hour demand and maximum daily demand plus fire flow. The deficiencies within the existing distribution system are limited to some fire flow conveyance deficiencies.
2. Once all the legacy water systems are combined there are 47 different pressure zones. Given the topography of the DWK numerous pressure zones will always be required, but the recommendation is to consolidate and simplify the number of pressure zones where practical. There are numerous projects proposed throughout the distribution network focused on consolidating the number of pressure zones resulting in the simplified operation of the distribution system.
3. The immediate recommendation is to reconfigure some of the pressure zones in the West Kelowna Estates and Sunnyside areas to allow for the gravity supply of water from the future Rose Valley water treatment plant. Given the condition of the West Kelowna Estates raw water pump station, the piping improvements to supply Rose Valley water to this service area should be completed immediately.

The Sunnyside Okanagan Lake pump station is reliable and diverts higher quality water to the distribution network than the water currently available from the Rose Valley reservoir. This means the extension of the transmission mains to support the isolation of the Sunnyside pump station can wait until the Rose Valley water treatment plant is commissioned.

4. There is a reasonably significant storage deficiency throughout the network. Historically, the legacy irrigation Districts relied on the ability to convey peak water demands through the distribution network with a somewhat unlimited water supply from raw water reservoirs. With the addition of the Powers Creek water treatment plant and the planned addition of the Rose Valley water treatment plant the ability to convey peak water demands throughout the network will be encumbered. Also, it is generally recommended that storage reservoirs be located to provide storage for the immediately adjacent and one lower pressure zone. Supplying multiple cascading pressure zones with pressure reducing valves is not a good practice. With time it is recommended that storage reservoirs be added throughout the network to provide the recommended fire flow storage. This work should be completed in conjunction with the consolidation of the pressure zones.
5. Growth is expected within the DWK. The infill growth is not expected to have a significant impact on the distribution system, but depending on the type and scale of the development distribution system upgrades may be required. Also, there is significant growth expected at some point in the future in the Smith Creek, Goat's Peak, and Raymer areas. For the major development nodes identified new transmission mains will be required to supply treated water from the Powers Creek and Rose Valley water treatment plants. The transmission mains are identified within the long term plan, but the exact size and the timing for the new pipes will be a function of the actual development plans.

Effective Management of a Water System

In addition to the fixed infrastructure required to meet the supply, treatment and distribution requirements there are several other operational and management items that need to be addressed to effectively run a municipal water system. As part of the incorporation of the new DWK, the five smaller legacy water systems have been amalgamated into a larger utility operation. Since economies of scale can work to the benefit of larger organizations, this Water Master Plan conducted an evaluation of a range of effective water utility management strategies that can be applied to the benefit of the larger DWK water organization. We focused our evaluation on the efficiency of water use within the network, the age of the existing assets and the need for renewal and the general operational bylaws and procedures. Based on the review and assessment of these items the key recommendations to improve the long term function of the utility are:

1. **Water Conservation:** The DWK has recently completed the installation of water meters throughout the entire service area. Water meters provide the ability for the utility to base water rates as a function of water consumption, which tends to result in some reduction in water consumption. Presently there are three different water rates in effect throughout the service area (based on the legacy water systems). To truly accrue the benefit of water meters and potential to enhance water conservation, DWK should adopt a common water rate schedule that provides a strong financial incentive for customers considering water conservation at peak water demand times. A common approach should be implemented to water demand side management throughout all of DWK.
2. **Infrastructure Renewal:** Nothing lasts forever and water system infrastructure is no exception. All the currently installed water system assets owned by the DWK will continue to deteriorate to the point where it needs to be replaced. Planning for the eventual replacement of the existing infrastructure is an often forgotten, but important component of the financial management of a water system. Analysis was completed on the infrastructure currently owned by the DWK and the key results of this work was:
 - a. Generally, the water system could be categorized as being near the middle of the life span. This means there are no immediately identified items that are in urgent need of renewal. To retain this positive position, on-going preventative maintenance is critical such as the cathodic protection on the existing welded steel transmission mains.
 - b. The analysis completed for the renewal requirements examined the next 25-years and then the foreseeable future. For the next 25-years the annual average estimated capital renewal expenditure is \$ 1.8 M. This value is intended for planning purposes and should be implemented on an as needed basis. It is expected that all capital money available will be spent on addressing the water treatment and distribution system piping deficiencies, not the renewal of existing infrastructure in the next 5 years.
3. **Operational Assessment:** Generally, the day-to-day operation of the utility can be categorized as functioning comparably with other similar sized municipalities. This means that there are no immediate recommendations for changes to the operational structure of the water utility; however, it is suggested that a documented maintenance plan be developed that links the planned and emergency maintenance associated with an individual asset.
4. **Water System Revenue:** The planning and collection of sufficient money to ensure financial sustainability is a very important component of any well run water utility. The key elements that should be completed to support this effort are a Water Utility Cost of Service Study and an updated Development Cost Charge (DCC) Bylaw. With more accurate water consumption data available from the universal metering program and the plan to provide comparable treated water quality to all the customers within the service area an accurate estimate of the cost to run the utility can be determined. This information can be used to develop a consolidated plan for the application of water rates across the DWK. For the DCC Bylaw, there are currently several different rates depending on the location of the development within the DWK. This approach should be reviewed and studied completely to develop a consolidated approach that is consistent across the entire service area.

Capital Plan & Implementation

A detailed summary of the recommended capital projects is included within **Appendix I**, resulting in a total capital program of roughly \$ 150 Million. Also, the annual average estimated renewal cost for the next 25 years is \$ 1.8 M. The high level summary of the capital plan is as follows:

1. The primary project that is recommended is the new Rose Valley water treatment plant. This will be a 90 ML/d facility with a total estimated cost of \$ 40.6 M. As part of the construction of a centralized water treatment plant, the transmission mains to service West Kelowna Estates and part of the pipeline with Sunnyside needs to be constructed. The water transmission improvements within the distribution system totals an additional \$ 3.1 M. This work should be completed as soon as it is financially possible for the District.
2. The other capital improvements recommended in the immediate future consist of a total project value of roughly \$2.9 M and are summarized below:
 - a. Complete a detailed water balance within the distribution network to identify the location of the majority of the unaccounted for water. Once this is completed and the source of the water loss is known, efforts should be made to reduce the water loss to less than 10% of the total annual volume of water used. A budget allocation of \$ 550 k to address this issue is included within the capital plan.
 - b. The capital plan includes \$ 30 k to complete a DCC bylaw update to ensure that a sufficient and fair amount of money is being collected from the developers.
 - c. Collecting sufficient money to support the utility and having a fair and equitable rate structure based on the level of service provided is an immediate item that needs to be addressed. The capital plan includes \$ 60 k for the completion of a Water Rate Cost of Service Study.
 - d. Ongoing annual hydrant additions to address the unsuitable hydrant coverage that exists within the distribution system.
 - e. Other miscellaneous distribution system projects to address miscellaneous deficiencies within the network.
3. Once the treatment uses are addressed the next recommendations are related to fire storage, simplifying the number of pressure zones, and addressing existing deficiencies within the distribution network. This group of projects are estimated to cost \$ 29.5 M.

Also identified is another \$ ~70 M of capital improvements to address long term raw water supply requirements and additional treatment needs. The timing off all these projects will be directly linked to the actual growth rate within the DWK and the ability to continue the evolving downward trend of the per capita water demand.

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1. Introduction

1.1 Preamble

Originally, water was supplied to the District of West Kelowna (DWK) residents primarily from the Lakeview Irrigation District and the Westbank Irrigation District in 1951 and 1922. The official transfer of these irrigation districts to the DWK occurred on December 31, 2010. In addition to acquiring the irrigation districts, the DWK also assumed the ownership of the West Kelowna Estates, Sunnyside and Pritchard water systems. **Table 1.1** provides a summary of the 5 main water systems within the DWK and some of their key characteristics.

Table 1.1 - Summary of the Existing Water Systems

Current Water Supply System	Water Source	Customers	Water Supply Availability	Current Treatment
Lakeview	Lambly Creek	Roughly 3,800 customers with 226 Ha of irrigation land	Primarily gravity supply from 598.0 m	Chlorination only of a surface water source that is subject to seasonal turbidity and algae events
Pritchard	Okanagan Lake	150 domestic customers	Pumped supply from roughly 340.0 m	Chlorination only of a lake intake
Sunnyside	Okanagan Lake	1,100 domestic customers	Pumped supply from roughly 340.0 m	Chlorination only of a lake intake
Westbank	Powers Creek	Roughly 5,000 customers with 385 Ha of irrigation land	Primarily gravity supply from 583.0 m	Multi-barrier treatment plant that fully meets Interior Health requirements
West Kelowna	Okanagan Lake	1,200 domestic customers	Pumped supply from roughly 340.0 m	Chlorination only of a lake intake

As seen in **Table 1.2**, the DWK water customer base consists primarily of single family residential service connections, representing approximately 95% of all connections. While agricultural services comprise only 1.4% of all connections, this customer class represents approximately 23% of the total DWK water consumption.

This type of consumption scenario is typical of Okanagan Valley municipalities where agricultural users, who represent a small portion of the user population, are consuming a measurable amount of the total water volume produced. The agricultural users consume this volume during the growing months (April – October), which is also when the domestic users are typically consuming the highest volumes of water. This results in a high maximum day demand, which is a key parameter when sizing water system infrastructure such as transmission mains and treatment and storage facilities.

Table 1.2 - 2011 Meter Count and Consumption

Service Type	# of Meters	% of Total	Consumption (ML)	% of Total
Residential	9,836	95.0%	4,591.29	63.0%
Multi-Family	64	0.6%	354.60	4.9%
Commercial	236	2.3%	434.18	6.0%
Institutional	72	0.7%	227.20	3.1%
Agricultural	146	1.4%	1,681.36	23.1%
TOTAL	10,354		7,288.63	

Amalgamating the 5 historically independent water systems into one utility in a cost and operational efficient manner is key to the successful management of the DWK water utility. Also, ensuring the continued supply of water to all the existing customers, planning for future growth and improving the level of treatment to ensure the supply of potable water is a major challenge for the DWK. The key goal of this study is to determine the most feasible approach to supply treated water that is compliant with the Interior Health guidelines while continuing to maintain the supply of irrigation water to the agricultural users. The specified level of service needs to be achieved while effectively using the available money.

1.2 Background Documents

Many previous reports and assessments have been completed in the past for the various different water utilities within the DWK. The majority of the background documents associated with the existing water utilities were collected and reviewed during this study. The majority of data was collected at the outset of the project, while specific data requests during model calibration, planning of ultimate system configuration, and assessing treatment options were ongoing for the duration of the project.

The list of background documents collected and considered during the completion of this document is included within **Appendix A**.

1.3 Water Master Plan Objectives and Goals

Making the transition from 5 independent water utilities to a unified DWK water utility to realize the operation efficiencies of a combined system is a major change. The goal of this report is to compile all the background data associated with the legacy water systems, determine the existing and future deficiencies and then develop the lowest life cycle cost approach to realize the successful implementation of the recommended solutions. With this overall goal in mind, some of the more detailed objectives of the master plan are:

- Based on the historical flow records determine the water consumption requirements for the existing distribution systems and estimate the future water requirements of the DWK. The other objective related to the review of the water demand data is determining the variation between the domestic and agricultural irrigation flow. This is key for determining if the development of dedicated raw water distribution systems for agricultural irrigation is a defensible approach.
- Determine the capacity of the existing raw water sources and develop a plan to achieve the additional raw water required.
- Determine the lowest cost solution to supply Interior Health compliant treated water to all the domestic customers within the DWK.
- Develop a comprehensive hydraulic model for the DWK's water distribution system by consolidating the existing EPANET models from each of the former water systems. The hydraulic model will be developed in a GIS platform and used in conjunction with the overall data management system allowing for easy updating of the hydraulic model to ensure it remains current. The goal at the end of this assignment is to ensure the hydraulic model is fully functional so DWK staff can maintain the file and complete future analysis related to development applications or other capital project plans.
- Determine the existing deficiencies within the distribution network and the future infrastructure necessary to meet the expected growth within the DWK. For the identified deficiencies capital projects will be provided to rectify the issues.
- Review existing water system infrastructure that is owned by the DWK and determine the value and approximate condition of the assets. This information will be used to determine the approximate level of annual investment necessary for renewal of the existing infrastructure.

- Develop cost estimates for the infrastructure necessary to ensure the supply of Interior Health compliant potable water to the domestic customers. Based on the total value of the capital program water rate and development cost charge studies will need to be completed in the future.

All long term water supply solutions will meet the B.C. Drinking Water Objectives as part of complying with the Drinking Water Treatment Objectives.

1.4 Report Organization

The Water Master Plan is a high level assessment of the raw water supply, the treatment of the raw water and the distribution of the treated water to the customers. The other item included within a Water Master Plan is a review of the existing management and financial health of the utility complete with recommendations for improvements. Combining several interrelated, but distinctly separate items into one report is achieved in this document by dedicating a section of the report to each item. Each section of the report provides an assessment of the current situation followed by a recommended approach.

This report is sub-divided into the following sections beyond the Executive Summary and Introduction:

- **Section 2 – Existing and Future Water Demands** provides a summary of the historical water system demand information and the water meter data. All the available data was analyzed to determine the existing and future water needs of the DWK;
- **Section 3 – Watershed** summarizes the existing function of the Powers Creek and Lambly Creek raw water supply systems and provides an assessment of the sustainable yield available from each watershed. Also, provided in this section is a summary of the raw water licenses for the upland sources and Okanagan Lake;
- **Section 4 – Raw Water Quality and Treatment** reviews the raw water characteristics of the long term raw water sources and determines the treatment necessary to ensure that Interior Health guidelines are met. Included in this section of the report is an assessment of the available solutions to provide treated water universally throughout the DWK and the rationale used to select the preferred approach;
- **Section 5 – Water Distribution and Hydraulic Analysis** summarizes the efforts completed to develop, calibrate and analyze a complete hydraulic model that covers the entire DWK. Also, provided in this section is a summary of the existing and predicted future deficiencies within the distribution system. For the identified deficiencies, recommended hydraulic improvements are provided;
- **Section 6 – Water Conservation** is an important part of any Water Master Plan for an Okanagan based utility given the high per capita water consumption of the local customers relative to the remainder of Canada and the world. Reducing the amount of unaccounted for water and the per capita demand is the best approach to minimize the magnitude of capital projects and extend the useful function of existing infrastructure. This section of the report reviews the current programs being completed by the DWK and provides recommendations for additional items the DWK should pursue to further try and reduce the amount of water consumed;
- **Section 7 – Asset Inventory Review** provides a summary of the existing water system assets owned by the DWK and an assessment of the condition of the existing infrastructure. This work was completed to provide the DWK guidance regarding the timing and magnitude of the reinvestment necessary to renew the existing water system assets;
- **Section 8 – Operation and Maintenance Assessment** provides a high level review of the current DWK operational practices and offers some optional recommendations to further optimize the operational efficiency of the DWK;

- **Section 9 – Financial Assessment and Rate Structures** includes a review of the existing rates and bylaws and provides input regarding options to consolidate the legacy approaches used for rate collection and bylaws. Also, provided is a summary of the additional work that is necessary to ensure the financial health of the utility.
- **Section 10 – Conclusion and Capital Plan** provides a summary of the key action items and the magnitude of the estimated capital investment to fund the projects necessary to ensure the adequate supply of potable water to all the DWK customers.

1.5 Approach to the Completion of the Master Plan

The first step during the completion of the master plan was compiling the background data followed by the completion of the initial engineering analysis. Once this was completed the initial findings were reviewed with the District staff to confirm the technical accuracy of the engineering analysis. The supply of potable water is an important issue that requires significant capital investment to implement. Additionally, the integration of the legacy water systems within the current boundaries of the District of West Kelowna involves several different interest groups.

To obtain input from the different stakeholders within the District a Technical Steering Committee was developed. During the course of almost a year the committee reviewed and provided input to the Water Master Plan. The input from the Technical Steering Committee primarily focused on the development and review of the long term options to supply potable water to all the domestic customers within the water service area. The other principle focus of the committee was the development of long term solutions to amalgamate the legacy water systems allowing for a reduction in the annual operating cost.

The members of the Technical Steering Committee are acknowledged in **Section 1.6** below.

1.6 Acknowledgements

AECOM would like to recognize the following District of West Kelowna staff that provided significant time and effort in support of the development of this document.

- Gary O'Rourke, P.Eng., Director of Engineering and Operations (Former)
- Rob Hillis, P. Eng., Engineering Supervisor
- Al Paterson, Operations Manager
- Technical Steering Committee
 - Committee Chair – Michael Trickey;
 - Committee Member – Brian Jamieson;
 - Committee Member – Claude Drought;
 - Committee Member – John Byland;
 - Committee Member – Keith Bepple;
 - Committee Member – Ken Cooper;
 - Committee Member – Raymond Reilly.

2. Development of the Design Flow

2.1 Population Projections

The final draft of the DWK's Official Community Plan (OCP) was adopted in July 2011. This document provides fundamental objectives, policies and actions for sustainable growth within the DWK. The OCP provides population growth projections for the next 20 years at a rate of 2.0%. The Central Okanagan Economic Development Commission estimated the 2008 population at 27,261. **Table 2.1** provides the design horizon populations at different years.

Table 2.1 - Population Projections

Year	Population
2008 (OCP)	27,261
2012	30,892
2032	45,900
2062	83,150

The population projections will be used to estimate the expected increase in water demand at the key study milestones.

As per DWK staff, we understand that 25% of that growth or 0.5% of the total annual growth will be infill within existing serviced area. The remaining 75% of that growth or 1.5% of the total annual growth will be fringe development outside of the existing service area and will require network expansion.

2.2 Design Periods

Infrastructure and financial planning of any water system requires a structured review of the system at discrete milestones. For the development of this Water Master Plan the following dates were selected for the review of the water system:

- 2012 (Existing Conditions): The existing water system was analyzed during the current demands with the existing infrastructure to determine the deficiencies based on current design standards. This analysis establishes the benchmark for status of the existing system and defines the level of investment that needs to be paid by the existing customers.
- 2032 (20 Year Development Horizon): This milestone was selected as it generally coincides with the recently issued Official Community Plan. The 20 year horizon is also ideal for planning infrastructure requirements such as distribution mains, pump stations, pressure reducing stations and other water system assets with mechanical and electrical equipment that typically have a 20 year life span.
- 2062 (50 Year Development Horizon): This milestone is for the long term needs of the water system and addresses items such as:
 - Water licenses;
 - Property and land acquisition;
 - Key infrastructure such as transmission mains, raw water storage facilities (i.e. dams) and pre-planning for water treatment site, major pump stations and other key water supply facilities;

2.3 Water Demands

The following section presents the methodology for determining the water demand criteria. The logic used for establishing the estimated existing and projected future flows requires careful review and analysis. These flow values developed will be used to determine the suitability of the existing water system infrastructure and any future system needs.

2.3.1 Source Volumes

One of the first tasks undertaken during completion of the Water Master Plan was analysis of the water consumption data for each of the 5 former service areas. Data analyzed consisted of source flow information, water meter consumption data, and winter low-flow data from the Westbank service area. This data was used to estimate the design demands, unit flows by land use, and leakage for use in the report and model.

The DWK implemented water metering in 2010 resulting in water meter data being available from the 3rd quarter of 2010, 2011 and 2012. This information was analyzed and the results compiled.

Table 2.2 below presents the water meter consumption data by service area and land-use type for the three time periods. The original data (in grey) is from the 3rd quarter of 2010 to the 2nd quarter of 2011. This was the only data available at the time when the hydraulic model development was completed. **Table 2.2** shows that the 2011 total consumption is 8.1% higher than the original data and the 2012 consumption is 2.8% higher. When only residential consumption is compared, values are: 8.8% higher (2011) and 1.6% higher (2012).

Table 2.2 – Water Meter Consumption Data – by Service Area and Land-Use Type

	3Q 2010 - 2Q 2011 <i>(used for hydraulic model development)</i>			2011			2012		
	WID	LID	DWK	WID	LID	DWK	WID	LID	DWK
Residential - SF	1,521,050	1,808,710	893,690	1,620,900	1,950,370	1,020,030	1,550,420	1,834,030	822,960
Residential - MF	109,100	188,400	24,690	150,700	145,260	58,640	175,950	177,480	55,820
Commercial	182,810	337,590	59,100	148,870	215,910	69,400	147,000	183,140	76,490
Institutional	103,880	227,510	230	142,860	83,240	1,100	136,320	88,460	5,970
Agricultural	732,840	440,540	119,190	993,830	542,240	145,290	991,710	557,520	117,160
SUB-TOTAL (m ³)	2,649,690	3,002,750	1,096,890	3,057,160	2,937,010	1,294,460	3,001,400	2,840,630	1,078,400
TOTAL (m ³)	6,749,330			7,296,700			6,941,283		
TOTAL ML	6,750			7,300			6,940		
% Difference	-			+8.1%			+2.8%		
Residential ONLY (ML)	4,550			4,950			4,620		
% Difference	-			+8.8%			+1.6%		

The total annual flows seen in **Table 2.2** were converted into ADD, MDD and PHD based on the MDD/ADD and PHD/MDD ratios generated using source flow data. The following **Table 2.3** shows that the ADD, MDD, and PHD demands that were used for the model demands compared to the actual metered flows. The based flows used for the hydraulic model development compare reasonably closely to the actual measured flows.

Table 2.3 – Resulting Demand Conditions (ML/d)

	Used for Hydraulic Model Development	2011	2012
ADD	36.09	34.21	33.14
MDD	103.03	97.67	94.63
PHD	151.45	143.58	139.10

2.3.2 Flow Adjustments Based on Regional Data

At the time the demand criteria was being established, data available from the DWK for the various water sources only covered the period from 2009 to 2012.

The available flow data from the DWK is somewhat limited and based on our knowledge of other Okanagan water utilities may not convey an accurate view of the actual existing maximum day water demand condition. Historical water demand from other Okanagan based water utilities show that 1998 and 2004 were high water consumption years. Comparing this water demand data to historical weather records highlights the impact that weather has on the peak water demand in the Okanagan. The Okanagan water demand data between 2009 and 2011 shows a marked reduction in the peak demands from previous years, which is attributed to the cooler and wetter than average summers.

The analysis of the existing water system needs to be completed based on a realistic existing water demand given the current service population. This means using the actual water demand that only includes the past couple years of records would not provide an accurate representation of the existing situation given that it is known that the peak water demands were reduced.

To account for the impact of weather on the DWK's water demands, daily flow data from the North Okanagan Regional District, the City of Kelowna, and the Lakeview Irrigation District was reviewed. Based on the average ratio of the population corrected peak flows from 1998 and 2004 for the North Okanagan & City of Kelowna, the historical peak flow compared to the flow measured during the past couple of years is 1.274. In comparison, the LID max day demand data from 1988 to 2009 was used to verify the weather dependent variations seen in the regional data. As shown in **Table 2.4** below, the historical population corrected maximum daily demand in LID demand occurred in 1998. This means the historical peak flow experienced in the LID distribution system is 1.262 higher than the flow measured in the past couple of years. This generally corresponds with the regional data factor of 1.274.

Table 2.4 - Adjusted Demands for DWK of West Kelowna Water System

Year	LID MDD (ML)	2009 Population Corrected Flow	Factor
1988	2,977.60	4,513.04	1.002
1989	3,058.31	4,544.49	1.009
1990	2,936.92	4,278.54	0.950
1991	3,212.94	4,588.87	1.019
1992	3,550.81	4,972.00	1.104
1993	2,893.71	3,972.44	0.882
1994	4,222.88	5,683.43	1.262
1995	3,962.36	5,228.25	1.161
1996	3,625.68	4,690.20	1.042
1997	3,399.89	4,311.89	0.958
1998	4,569.23	5,681.27	1.262
1999	3,935.60	4,797.47	1.065
2000	3,047.18	3,641.66	0.809
2001	4,206.16	4,928.18	1.095
2002	4,616.10	5,302.45	1.178
2003	4,848.40	5,460.09	1.213
2004	4,413.40	4,872.75	1.082
2005	4,398.12	4,760.67	1.057
2006	4,428.79	4,699.87	1.044
2007	4,466.30	4,646.74	1.032
2008	4,478.76	4,568.33	1.015
2009	4,502.63	4,502.63	1.000

Historically, higher peak water demands have been measured both in the DWK and across the Okanagan. This would indicate that the summer weather pattern has a significant impact on the peak water demand experienced in a water system. It also highlights the variability and the many factors that influence water demand that are beyond the control of the DWK. This means judgement needs to be applied to the actual measured historical flow and a realistic existing water demand established.

It is acknowledged that the implementation of water conservation and the addition of universal water meters throughout the DWK will heighten the awareness about the importance of water conservation. However, for sizing infrastructure and establishing the current maximum daily demand the measured 2009 flow of 80.9 ML/d was adjusted to 103.0 ML/d based on historical actual measure peak daily flows.

Provided in **Table 2.5** are the factored ADD, MDD and PHD used for water system infrastructure planning.

Table 2.5 - Adjusted Demands for DWK of West Kelowna Water System

		2012
Average Day Demand	(ML/day)	36.09
Maximum Day Demand	(ML/day)	103.0
Peak Hour Demand	(ML/day)	151.5
Annual Average Demand	(ML/year)	13,172

2.3.3 Unit Flows

In addition to establishing the total water demand for the DWK water service area, the water demand by land-use is also an important component of infrastructure management. Using the metering data, the ratio of flows by land-use was determined. **Table 2.6** below shows the breakdown of flows by land-use for the time period of the 3rd Quarter 2010 to 2nd Quarter of 2011.

Table 2.6 - Metered Flows by Land-Use

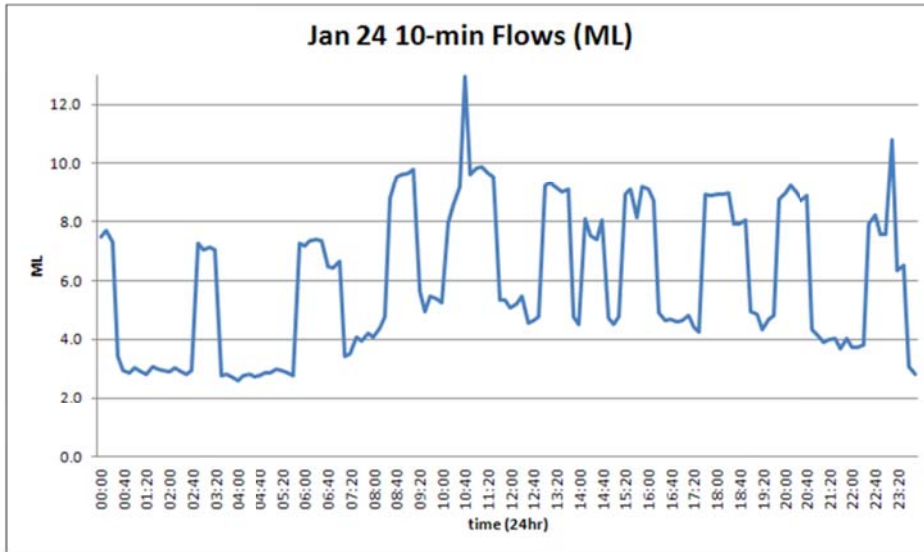
Land-Use Type	Yearly Flow (m ³)	% of Total Flow
Residential - SF	4,223.45	62.6%
Residential - MF	322.20	4.8%
Institutional	331.62	4.9%
Industrial	59.10	0.9%
Commercial	520.41	7.7%
Agricultural	1,292.56	19.2%
Total	6,749.33	100%

2.3.4 Unaccounted for Water

Water loss in most water distribution systems represents around 20-30% of production.¹ Water loss can be attributed to several causes, including leakage, metering errors, public usage (fire-fighting and pipe flushing), and theft. Leakage is typically the major cause of water loss and needs to be estimated and accounted for in the hydraulic model.

To estimate the leakage in the DWK's water distribution system, 10-minute increment flows from the Westbank service area, during a low-flow day (January 24, 2010) was graphed to show night-time flows. As seen in **Figure 2.1**, flows between 1AM and 4AM are approximately 2.9 ML/d.

Figure 2.1 - Night-time Flows During Low Flow Day



The night-time flows seen above can be assumed to be leakage in the system as there is generally no other water consumption at this time. The leakage was converted to a unit rate in L/d/km of pipe by dividing 2.9 ML/d by the total pipe length in the Westbank service area of 105,193 lm. This results in a unit leakage of 27,568 L/d/km. For the entire DWK service area, based on 277,070 lm of pipe, the total leakage can be estimated at 7,638,369 L/d, or 7.638 ML/d. Calculations between the source flow meters and the water meters generate a similar leakage rate.

To determine the actual water consumption by land-use, the total leakage was then deducted from the total adjusted source flows in **Table 2.6**, leaving a total remaining flow to be re-distributed between the different land-use types.

2.3.5 Unit Flow Rates

The metering data was used to determine the number of units of each land-use type within the current service area. The metering data is organized by a meter code for each service; each of the meter codes corresponds to one of the land-use types (Residential – SF, Residential – MF, Commercial, etc.). This data is shown in **Table 2.7** below.

Table 2.7 - Units by Land-Use from Metering Data

Land-Use Type	Units	
	No. of Folios (Accounts)	Acres
Residential - SF	9,662	NA
Residential - MF	1,794	NA
Institutional	NA	267
Industrial	NA	488
Commercial	NA	239
Agricultural	NA	1,026

The adjusted ADD and MDD by land-use, accounting for leakage, were then divided by the units in **Table 2.7** to determine a unit flow rate for each land-use type. The resulting unit flows and leakage for the ADD scenario can be seen in **Table 2.8**, below.

Table 2.8 - Average Day Demands – 2012 Existing System

	% flows	ADD (ML/d)	Units	L/day ADD
Unaccounted for	21.17%	7.64	-	-
Residential - MF	49.33%	17.80	9,662	1,842.45
Residential - MF	3.76%	1.36	1,794	757.00
Institutional	3.87%	1.40	267	5,235.16
Industrial	0.69%	0.25	488	510.44
Commercial	6.08%	2.19	239	9,177.85
Agricultural	15.10%	5.45	1,026	5,310.05
Total	100%	36.09		

2.3.6 Agricultural Flows

The agricultural parcels in the DWK each have a certain allocated irrigation amount that can be used. The allocation amount information was given to AECOM in the form of tables for the Westbank and Lakeview service area. In the Westbank service area, there were 131 parcels with an allocation for each based on the dole valve size of the service. For the Lakeview service area, there were 43 parcels with an allocation based on 70 lpm per hectare. From these allowances and based on continuous watering over the 150-day irrigation season (April 15 to Sept. 15), a total “allocated” agricultural flow for the MDD scenario was estimated at 47.12 ML/d. This amount was then used for the agricultural demand under the MDD scenario, while the other land-use type unit flows were not adjusted.

Comparing the total allotted demand to the actual agricultural demand presented in **Table 2.8**, it is clear that the current agricultural demands are significantly lower than the agricultural allocations; however, the hydraulic model was analysed based on the agricultural allocations and commitments as opposed to current demands.

2.3.7 Resulting ADD and MDD Scenario Unit Flows – Current and Future

The resulting ADD and MDD flows for the existing system are seen in **Table 2.9** and **Table 2.10**. Note that the agricultural amounts do not match those in **Table 2.8**, as the agricultural demand used for analysis of the distribution system is based on the allocated agricultural demand since this is the flow that the DWK is committed to provide. **Table 2.10** provides the future MDD based on land-use for the 2032 and 2062 planning horizons.

Table 2.9 - Average Day Demands – 2012 Existing System

	% flows	ADD (ML/d)	Units	Unit Demand L/day ADD	
Unaccounted For	19.46%	7.64	-	-	
Residential - SF	45.35%	17.80	9,662	1,842.45	per parcel
Residential - MF	3.46%	1.36	1,794	757.00	per unit
Institutional	3.56%	1.40	267	5,235.16	acres
Industrial	0.63%	0.25	488	510.44	acres
Commercial	5.59%	2.19	239	9,177.85	acres
Agriculture	21.95%	8.62	1,026	8,398.68	acres
Total	100%	39.26			

Table 2.10 - Maximum Day Demands – 2012 Existing System

	% flows	MDD (ML/d)	Units	Unit Demand L/day MDD	
Unaccounted For	5.79%	7.64	-	-	
Residential – SF	45.26%	59.69	9662	6,177.85	per parcel
Residential – MF	3.45%	4.55	1794	2,538.26	per unit
Institutional	3.55%	4.69	267	17,553.82	acres
Industrial	0.63%	0.84	488	1,711.53	acres
Commercial	5.58%	7.35	239	30,773.91	acres
Agriculture	35.73%	47.12	1026	45,929.82	acres
Total	100%	131.88			

Table 2.11 – Future Maximum Day Demands (2032 & 2062)

	2032 MDD (ML/d)	2062 MDD (ML/d)
Unaccounted For	7.64	7.64
Residential - SF	88.70	160.66
Residential - MF	6.77	12.26
Institutional	6.96	12.62
Industrial	1.24	2.25
Commercial	10.93	19.80
Agriculture	47.12	47.12
Total	169.36	262.34

2.3.8 Demand Master Spreadsheet

The resulting unit ADD & MDD demands were used to populate a master demand spreadsheet which was used to assign demands to the hydraulic model. Using the GIS data received from the DWK, all parcels within the DWK service area were extracted along with their land-use type. Based on the land-use type, unit demands for each scenario was assigned to each parcel in the spreadsheet, and then input to the model.

2.3.9 Domestic Demand Criteria

Design demands are set out in the Regional District of Central Okanagan's Subdivision and Development Servicing Bylaw No. 704 and Lakeview Irrigation District Bylaw No. 273. It is expected that bylaw design demands will be reduced in the future due to cost, reduced availability, increased conservation efforts and increased value of water.

Table 2.12 presents the current design criteria for the RDCO and LID, the actual DWK demand, the design criteria utilized in the hydraulic model and the design criteria we recommend the DWK adopt in their bylaw.

Table 2.12 - Estimated Water Demands for Key Demand Conditions

Condition	RDCO Bylaw	LID Bylaw	Actual	Utilized	DWK Recommendation
Average Day Demand (L/cap/day)	1,000	900	522*	670	900
Maximum Day Demand (L/cap/day)	3,000	2,400	-	2,240	2,400
Peak Hour Demand (L/cap/day)	5,000	4,000	-	3,300	4,000

*Actual ADD data was taken from the quarterly metering data for the period as discussed in previous sections; thus, MDD and PHD data could not be obtained.

For comparison purposes, the 2012 Kelowna Integrated Water Supply Plan Water Demand Management, dated September 2012 indicates that the total MDD for the City of Kelowna water utility is 151 ML/d for a service population of 61,000 people. This equates to a per capita demand for the overall system of roughly 2435 L/cap/day, which is somewhat comparable to the DWK recommendation for the MDD.

At the time that this document was prepared the only complete planning data available for the DWK is the population projections. This means that a blended per capita water demands as presented in **Table 2.12** are reasonable values to establish an estimate of the future water demands. Once more detailed land-use based long term planning data is available land-use specific per unit water demands can be used to estimate the future water demands of the water system.

2.3.10 Fire Flows

The RDCO and LID Bylaws states that "...fire flows must not be less than 60 L/s." Typically, fire flows under maximum day conditions differ by land-use. **Table 2.13** presents the flow parameters used by other local governments in the interior.

Table 2.13 - Fire Flow Demands under Maximum Day Conditions

Fire Flow	Kelowna		Vernon		Penticton		DWK Recommendation	
	L/s	Duration (Hrs)	L/s	Duration (Hrs)	L/s	Duration (Hrs)	L/s	Duration (Hrs)
Single and Dual Residential	60	1.5	60	1.5	60	2.0	60	2.0
Multi Residential	90	2.0	90	2.0	90	2.0	90	2.0
Institutional	150	2.0	150	2.0	150	3.0	150	2.0
Industrial/Downtown	225	3.0	200	2.5	225	3.0	225	3.0
Light Commercial & High Residential	150	2.0	150	2.0	150	2.5	150	2.0

The City of Kelowna and Vernon both use the fire flow duration tables as established by the Fire Underwriters Survey, Water Supply for Public Fire Protection 1999. The recommended fire flows and duration for the DWK are also included in **Table 2.13**. Fire flow and corresponding duration are normally assigned to each designated land-use. Agricultural land-use is suggested to be assigned parameters similar to single/dual residential fire flow and duration. This assumption will provide some degree of flexibility for any future prospect of development and change of land-use.

2.3.11 Pressure and Storage Design Parameters

The industry recognised pressure and storage parameters can be seen in **Table 2.14**, below.

Table 2.14 - Pressure and Storage Requirements

	Criteria
Pressures	-
Static (maximum)	900 KPa (130 psi)
Dynamic at PHD (minimum)	275 KPa (40 psi)
Residual during MDD + FF (minimum)	140 KPa (20 psi)
Reservoir Storage (A + B + C)	A= Balancing Storage of 25% of MDD B=Fire Flow (ie. Flow x Duration) C=Emergency Storage (25% of A + B)
Pump Station Criteria	Pump MDD with largest pump out of service in the facility. Pump PHD and/or MDD + FF with stand-by power.

All services connections will require PRVs to limit pressures below 100 psi. In addition, to limit pressure surges, a pipe flow maximum velocity of 4.0 m/s for MDD +FF and 2.0 m/s for PHD is suggested.

3. Watershed

The DWK currently holds water licenses in the following watersheds: Powers Creek, Lambly Creek, McDougall Creek and Okanagan Lake. The two main water sources for the DWK are the upland sources of Powers Creek and Lambly Creek. The upland sources have been developed over many years and rely on the storage of snowmelt and rainwater during the spring freshet to ensure the daily water demands of the distribution system is met throughout the course of the year. To effectively store and release water within each watershed the DWK staff need to actively manage the various different facilities within each watershed. McDougall Creek offers the DWK a nominal supply of water and is not a significant consideration for the long term development of the water system.

Conversely, Okanagan Lake is a significant reservoir and the management of the flow out of the lake is completed by the Province. This means the diversion of water from Okanagan Lake consists of an intake pipe and pump station. These facilities do not require DWK staff to actively manage and maintain storage reservoirs such as the effort required for the upland water sources.

This section of the report examines the 4 raw water sources and provides a recommended approach for the long term supply of raw water for the DWK.

3.1 Powers Creek Watershed

The Powers Creek watershed is the source for the Westbank Service Area. The watershed encompasses an area of 139 km² and ranges in elevation from 1,860 m at the summit of Whiterocks Mountain to 342 m at the drainage point into Okanagan Lake. Powers Creek flows through the Westbank service area and discharges into Okanagan Lake at Gellatly Bay. The upper watershed consists of six storage lakes: Tadpole, Dobbin, Horseshoe, Paynter, Jackpine and Lambly Lake. Flow upstream of the Powers Creek Diversion Pipeline is routed through Lambly Lake, which is used to store and regulate flows throughout the winter. The **Table 3.1** below summarizes the active storage capacity available in each of the upland reservoirs and the associated storage license. As shown, there is less license than storage on Tadpole Lake meaning application should be made to increase the license.

Table 3.1 - Powers Creek Watershed – Upland Reservoir Capacity and Licenses

Lake	Storage (ML)	Licensed Storage (ML)
Tadpole	3,602	2,467
Dobbin	692	524
Horseshoe	995	1,110
Paynter	432	432
Jackpine	1,224	951
Lambly	3,491	9,658
Total	10,436	15,142

3.2 Lambly Creek Watershed

The Lambly (Bear) Creek watershed is the source for the Lakeview Service Area. The watershed encompasses an area of 244 km² and ranges in elevation from over 1,900 m at the summit of Terrace Mountain to 342 m at the drainage point into Okanagan Lake. Lambly Creek flows southeast, discharging to Okanagan Lake at Bear Creek Provincial Park. The upper watershed consists of Esperon Lake, Christie Lake and Duo Via Lake which feed Big Horn Reservoir. Storage in Big Horn Reservoir is released into Lambly Creek, which is

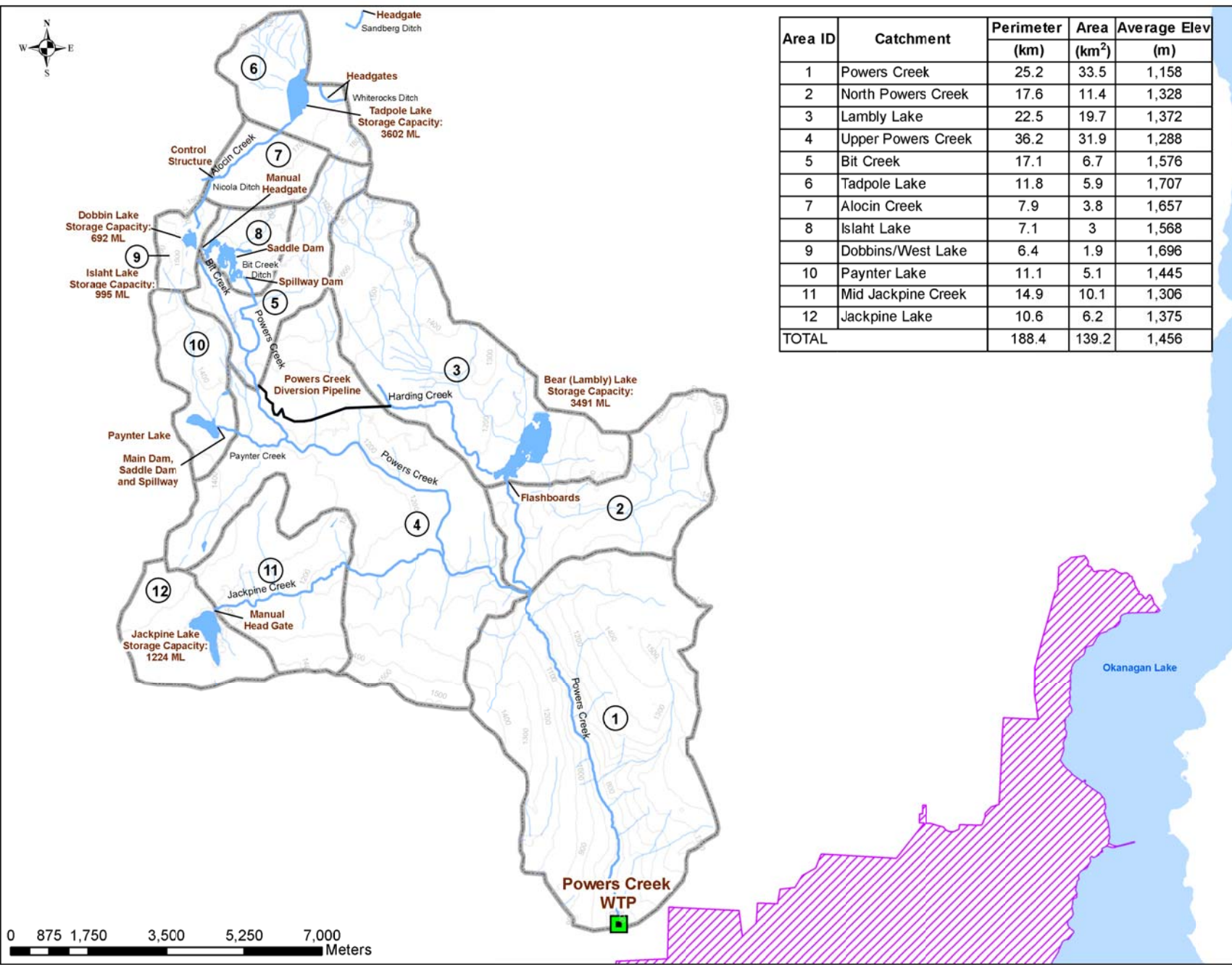
intercepted by the Rose Valley Diversion Pipeline. This pipe diverts flow into the Rose Valley Reservoir. The Rose Valley Reservoir is a relatively large storage reservoir that supplies water into the distribution network. At the south end of the reservoir the water enters the distribution network where it is chlorinated prior to reaching the first customer.

Table 3.2 below summarizes the active storage capacity available in each of the upland reservoirs and the associated licenses. The storage capacity and the licensed capacity are essentially the same meaning no action is necessary at this time.

Table 3.2 - Lambly Creek Watershed – Upland Reservoir Capacity

Lake	Storage (ML)	Licensed Storage (ML)
Esperon	200	247
Big Horn	2,300	2,300
Rose Valley	3,600	3,600
Total	6,100	6,147

Detailed descriptions of each watershed can be found in the Upland Water System Operation memo located in **Appendix C**. Plans showing the main elements of the Powers Creek and Lambly Creek watershed are included provided in **Figure 3.1** and **3.2** below.



Area ID	Catchment	Perimeter	Area	Average Elev
		(km)	(km ²)	(m)
1	Powers Creek	25.2	33.5	1,158
2	North Powers Creek	17.6	11.4	1,328
3	Lambly Lake	22.5	19.7	1,372
4	Upper Powers Creek	36.2	31.9	1,288
5	Bit Creek	17.1	6.7	1,576
6	Tadpole Lake	11.8	5.9	1,707
7	Alocin Creek	7.9	3.8	1,657
8	Islaht Lake	7.1	3	1,568
9	Dobbins/West Lake	6.4	1.9	1,696
10	Paynter Lake	11.1	5.1	1,445
11	Mid Jackpine Creek	14.9	10.1	1,306
12	Jackpine Lake	10.6	6.2	1,375
TOTAL		188.4	139.2	1,456



**District of West Kelowna
Water Utility Master Plan**

Powers Creek Watershed

Legend

- Existing Water Treatment Plant
- Powers Creek Diversion
- Streams
- Contour
- Lakes
- District of West Kelowna
- Watershed Boundary

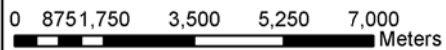
Figure No:
Figure 3.1

Project No: 60216671 Date: October, 2012





Area ID	Catchment	Perimeter	Area	Average Elev
		(km)	(km ²)	(m)
1	Residual (Below)	18.4	12.9	950
2	Residual (Above)	58	69.4	1,050
3	Bald Range	32.2	40.7	1,150
4	Northfork	28.7	37.3	1,450
5	Terrace	45.8	80.4	1,350
TOTAL		183.1	240.7	1,190



**District of West Kelowna
Water Utility Master Plan**

Lambly Creek Watershed

Legend

- Future Water Treatment Plant
- Rose Valley Diversion Pipeline
- District of West Kelowna
- Watershed Boundary
- Lakes
- Streams
- Contours

Figure No:

Figure 3.2

Project No:

60216671

Date:

October, 2012



**Rose Valley
Chlorination Station**

3.3 McDougall Creek Watershed

The McDougall Creek watershed is one of the sources for the Prichard Service Area. The watershed encompasses an area of 45 km² and ranges in elevation from 342 m at the drainage point into Okanagan Lake to 1,562 m at Mount Swite.

3.4 Okanagan Lake

Okanagan Lake is the sole water source for the West Kelowna Estates and Sunnyside Service Areas. It also is the primary source for the Pritchard Service Area. The supply of water is licensed and reliably available to the DWK.

3.5 Current Licensed Capacity

Table 3.3 shows the current water licence volumes for each of the DWK sources, extracted from the Ministry of Environment Web License database. The two types of water licences are Waterworks Local Authority (WWLA) which is domestic supply and Irrigation Local Authority (ILA) which is for agricultural and irrigation supply only and is limited to seasonal use (April 15 to October 15). A complete list of water licences is included in **Appendix C**.

Table 3.3 - DWK Current Licence Volume and Storage by Source

Source	Flows		Storage	
	WWLA (ML/yr)	ILA (ML/yr)	Total Actual Storage (ML)	Total Licensed Storage (ML)
Powers Creek Watershed	10,703	13,340	10,436	15,142
Lambly Creek Watershed	6,736	4,441	6,100	6,147
McDougall Creek Watershed	0	14	-	-
Okanagan Lake	2,923	484	-	-
Totals	20,362	18,279	16,536	21,289

The DWK currently holds 20,362 ML of WWLA licences; 18,279 ML of ILA licences.

As noted in **Section 2** the existing total annual demand is estimated to be 14,250 ML/year and projected demand in 2032 is 18,980 ML/year. This means that the DWK currently holds sufficient license to meet the estimated demands, but not from one single raw water source. The exact need for additional water license will vary depending on the long term configuration of the raw water supply, but generally the DWK should plan on needing to obtain additional water license beyond the 20 year planning horizon. However, the DWK should be aware that obtaining additional water license can be a time consuming process that should be initiated at a minimum of 5 years prior to needing the additional water. The total water demand of the DWK and the rate of growth should be tracked and the process of obtaining additional water licence commenced at the appropriate time.

3.6 Existing Upland Water Source Capacity Assessment

This section provides a review of the DWK existing upland water sources with respect to water quantity. Okanagan Lake is not included within this assessment as this source is closely monitored and studied by the Province. Further analysis of Okanagan Lake is assumed to not be a part of this study.

Numerous reports completed in the past have assessed the volume of water that can be generated from the Powers Creek, Lambly Creek and the McDougall Creek watersheds. **Table 3.4** below summarizes the estimated mean annual runoff generated from each watershed. Also, provided within the table below is a summary of the existing DWK held licenses, a summary of the other water obligations, and the resulting available flow.

Table 3.4 - Summary of Estimated Flows

Watershed	Estimated Annual Average Flow (ML/year)	DWK Licensed Amount (ML/year)	Other Obligations (ML/year) <i>(fish habitat, other licenses)</i>	Available Flow – Average Year (ML/year)
Powers Creek	29,013	24,043	3,650	1,320
Lambly Creek	55,818	11,177	2,450	42,191
McDougall Creek	3,753	28	3,507	218

The above table shows that McDougall and Powers Creek are essentially fully-licensed. The Powers Creek licensed amount is very similar to the total estimated volume of water that the watershed can generate during an average year. It is noted that the DWK holds the license indicated in **Table 3.4** for Powers Creek; however, relying on diverting this volume of water every year is assumed to be impractical. Further explanation about the recommended sustainable function of the Powers Creek watershed is provided below.

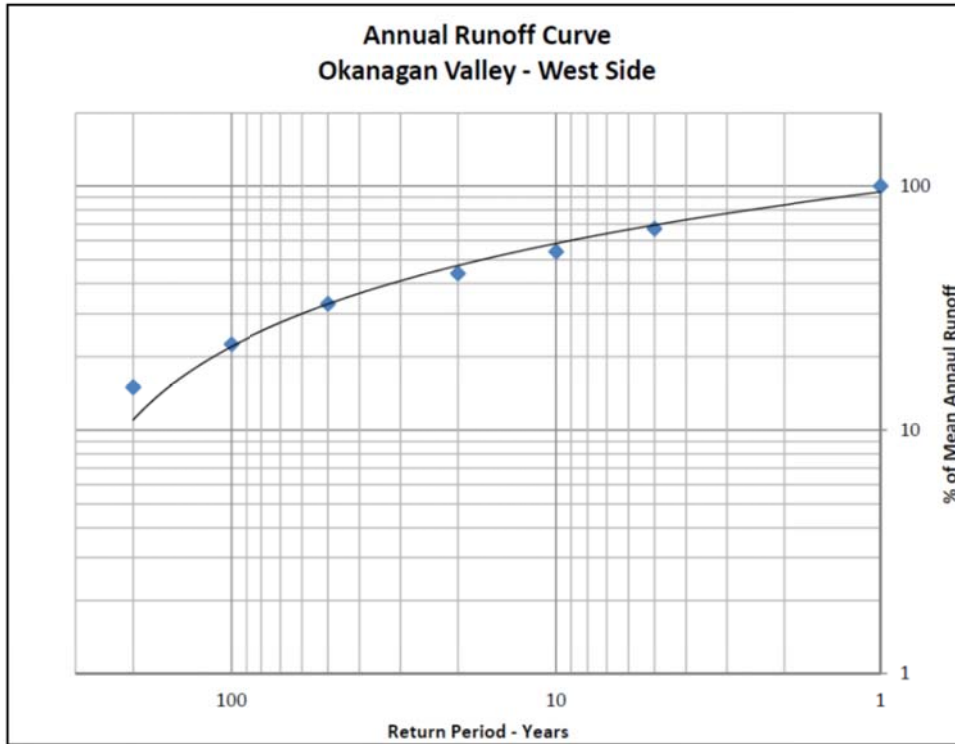
It is also noted that there is a significant volume of water available from the Lambly Creek watershed. When the DWK requires more water licence from an upland water source, it is recommended that efforts be focused on Lambly Creek as the reliability of the flow is expected to be higher during drought conditions.

The DWK's McDougall Creek license is very small in proportion to the other upland water licenses. Given the small volume of water available to the DWK from McDougall Creek, it is recommended that this source should not be depended on for any substantial contribution to DWK demands. The following water source capacity assessments will be completed excluding the McDougall Creek watershed.

3.6.1 Drought Conditions

To estimate the probability of runoff for various drought scenarios, a Regional Frequency Runoff Curve (Letvak, 1980 and BC Ministry of Environment, Water Management Branch), shown in **Figure 3.3** below, can be used to scale the mean annual flows from each watershed. This curve was previously developed for land on the west side of Okanagan Lake and is consistent with previous methods used for estimating drought scenarios within the DWK.

Figure 3.3 - Regional Frequency Runoff Curve



Based on the Frequency Curve, runoff volumes during various return period droughts are provided in **Table 3.5**. The key observation is that roughly twice the volume of water is available from the Lambly Creek watershed than the Powers Creek watershed during any drought scenario. Given the larger size of the watershed, Lambly Creek is estimated to generate more water during a drought meaning there will be more water available from this source for supplying the water system customers.

Table 3.5 - Runoff Volumes by Watershed

Return Period	% of Mean	Estimated Runoff (ML/year)	
		Powers Creek Watershed	Lambly Creek Watershed
Average Year	100	29,000	55,820
5 Year	67	19,460	37,400
10 Year	54	15,680	30,140
20 Year	44	12,780	24,560
50 Year	33	9,580	18,420
100 Year	22.5	6,530	12,560
200 Year	15	4,360	8,370

3.6.2 Sustainable Watershed Yield

To establish the long term plan for the upland water sources the sustainable volume of water available annually needs to be determined. This volume of water will be used as the basis for developing infrastructure planning and will be a key factor related to the reliability of the water system. The typical municipal customer expects to have a sufficient volume of water available throughout the year, meaning careful consideration is necessary when calculating the capacity of an upland watershed.

The volume of water available from an upland watershed varies every year based on snowpack, rain temperature and many other climatic impacts that the DWK cannot control. To reduce some of this variability and raw water supply risk the supply scenario used to determine the sustainable water yield from the upland watersheds is an average year followed by the 50 year drought condition. This condition was selected as statistically this provides an acceptable balance of reliability while not being overly conservative. Another key consideration when determining the sustainable yield from a watershed are the losses. Based on anecdotal input from the DWK, it is assumed that there will be 30% losses in the upland watershed due to evaporation and infiltration during the conveyance through nature channels and creeks.

Figures 3.4 – 3.7 present the total runoff for the Powers and the Lambly Creek watersheds in average year and 50 year drought plotted against the demands at each planning horizon. The demand curves shown on the graphs include the distribution system customer water requirements, backwash volumes for filtration, fish habitat and other licenses. All water demands in this section assume that Lakeview service area will be combined with Sunnyside, Pritchard and WKE.

The figures show the run-off generated by the watershed with the blue line. The other lines on the figures represent the total water demand, including the assumed losses. The space below the blue line and above the demand curves is the volume of water available to fill the raw water storage reservoirs within the watershed. Whereas when the demand curve is above the blue line, the raw water needs to be released from the upland storage reservoirs to meet the needs of the system. Review of the graphs clearly shows that both the Powers and Lambly Creek watersheds can generate sufficient water to meet the ultimate water demands during an average run-off year; but during a drought there are challenges.

During a 50-year drought the Powers Creek watershed generates less water than required meaning, in the future, an alternate water source will be required. During a 50-year drought the Lambly Creek watershed is predicted to have the ability to generate sufficient water proportional to the demand, assuming there is additional storage constructed in the future.

Figure 3.4 - Powers Creek Watershed Runoff Average Year vs. Demand

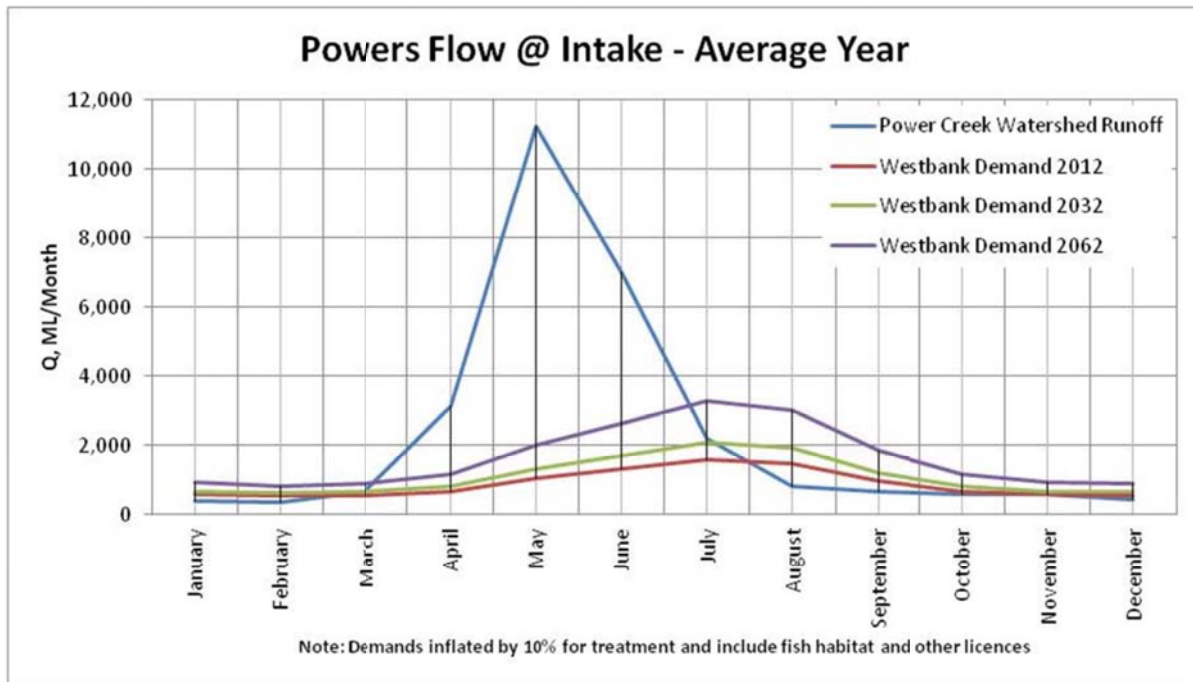


Figure 3.5 - Powers Creek Watershed Runoff 50 Year Low Return vs. Demand

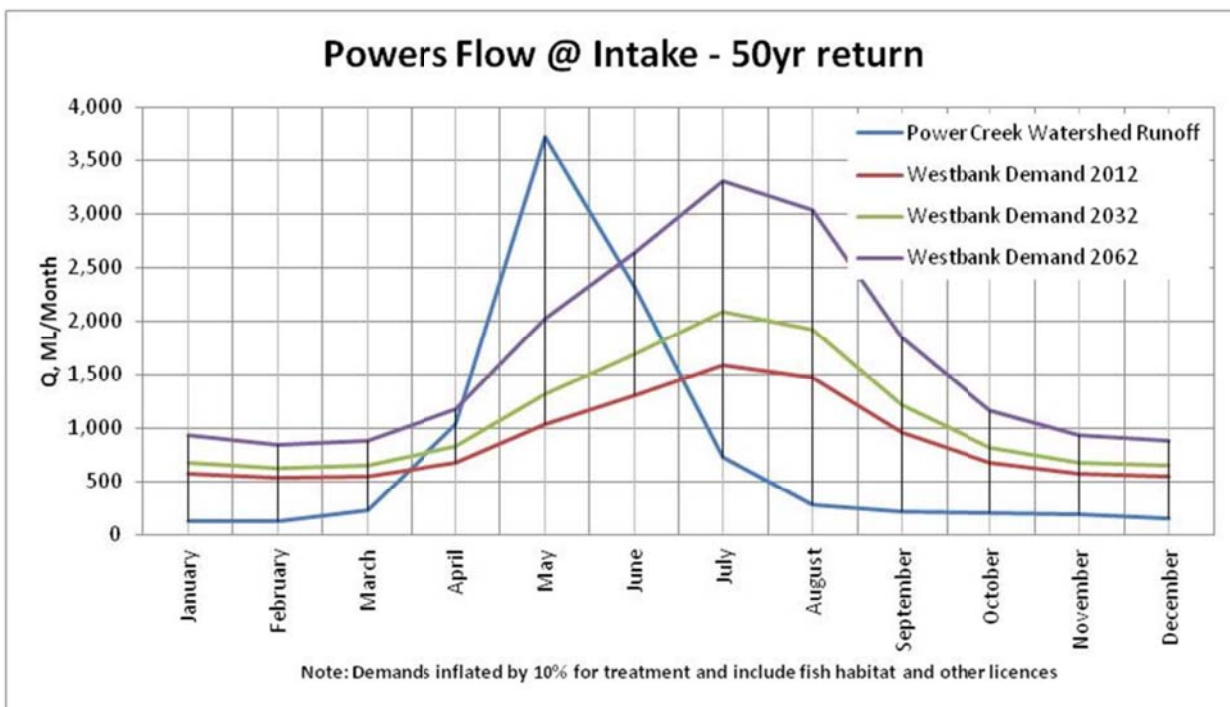


Figure 3.6 - Lambly Creek Watershed Runoff 50 Year Low Return vs. Demand

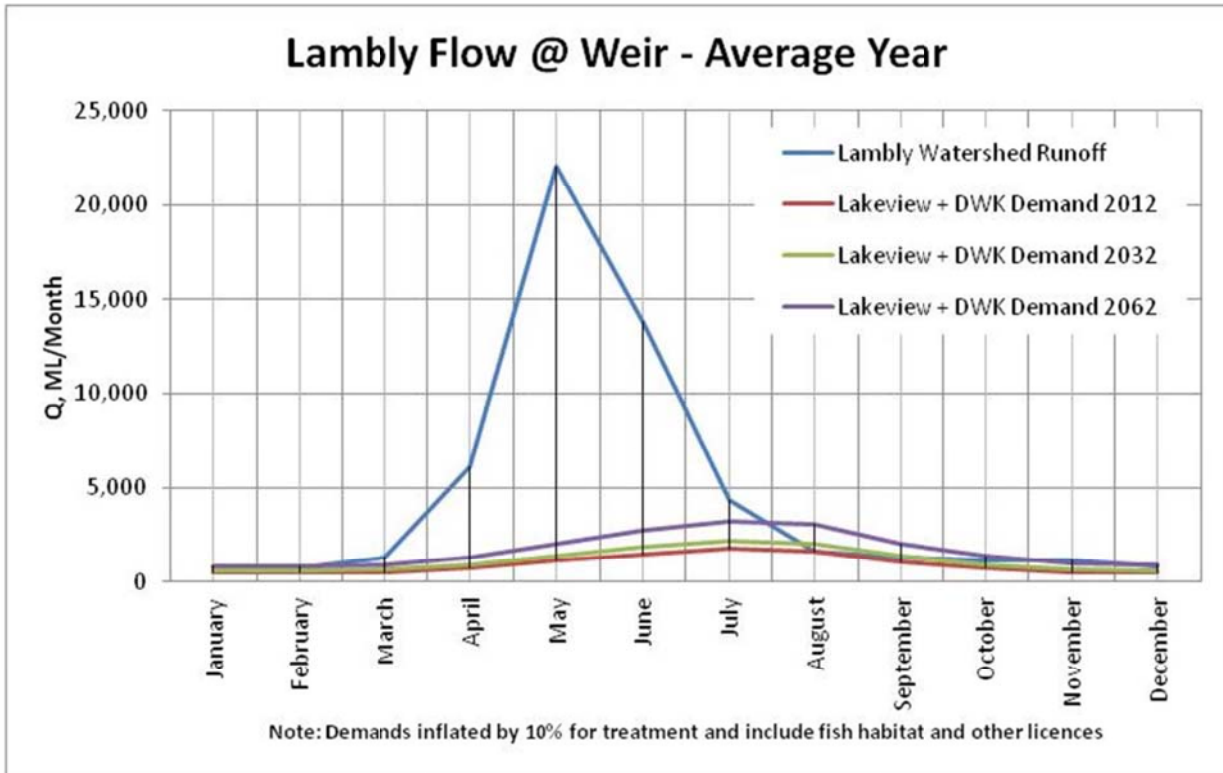


Figure 3.7 - Lambly Creek Watershed Runoff Average Year vs. Demand

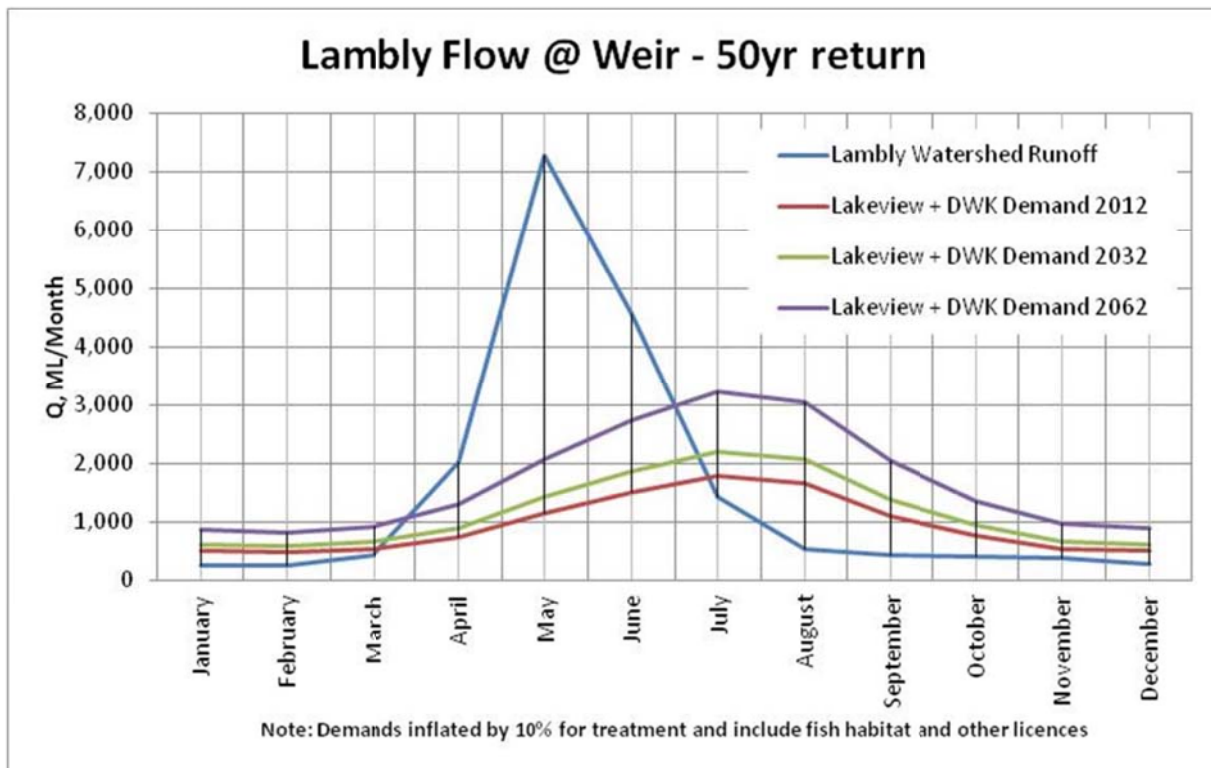


Table 3.6 and Table 3.7 summarize the sustainable yield information from each watershed during the design condition (average run-off year followed by a 50-year drought) and the associated storage requirements. Some additional notes to support the table are:

- Raw Water Available:** This defines the run-off volume available to fill the storage reservoirs each year. If there is sufficient run-off to fill the existing storage facilities this is the maximum number shown in the table since any additional run-off will spill over the dam and flow down the creek into Okanagan Lake. During an average year, both watersheds are able to fill the existing storage reservoirs; however, for the Powers Creek watershed there is insufficient water available in the future to meet the estimated demands of the distribution system.
- Storage Required:** This is the volume of water that needs to be supplied from the storage facilities in order to meet the total demands of the distribution system. It is assumed that the infrastructure exists to control the release of the water from the existing dams to supplement the base creek flow during the summer and winter allowing sufficient water to be conveyed to the point of diversion. As expected, the table shows that the reliance on storage increases as the demands of the distribution system increase.
- Stored Raw Water:** This column is unique to the drought design condition and summarizes the total raw water available. This value is the total of the theoretical storage available from an average year plus the volume of water that can be collected and stored during the 50-year drought. The key item to note is that ultimately the Powers Creek watershed is unable to fill the existing storage reservoirs during a drought design condition meaning the demand of the system would not be met.
- Theoretical Stored Volume Available:** This defines the volume of water either available or required to meet the total demands of the system given the current levels of the storage constructed within the upland watersheds. Given the projected water demands of the DWK water system using the current unit demands and growth assumptions additional storage for both the Powers and Lambly Creek watershed is required in the next 20 years.
- New Storage Required:** This column provides a summary of the total storage necessary to ensure the demands of the distribution system are met. The storage volume accounts for the assumed raw water losses associated evaporation, infiltration and other raw water flow losses. This means that if additional storage were provided in the upland watershed to meet the ultimate demands of the DWK water system an additional 23,000 ML of raw water storage needs to be constructed. This is roughly 140% more storage than what is currently constructed within the upland watersheds. Alternatively if the additional raw water flow is provided from a piped source such as Okanagan Lake to be pumped/piped directly to the treatment facility the additional raw water flow necessary is 16,000 ML.

Table 3.6 - Powers Creek Watershed Storage Potential and Requirements

	Average Year			50 yr Drought				New Storage Required
	Raw Water Available (ML)	Storage Required (ML)	Theoretical Stored Volume Available (ML)	Raw Water Available (ML)	Stored Raw Water (ML)	Storage Required (ML)	Theoretical Stored Volume Available or Required (ML)	
2012	10,440	2,120	8,310	4,040	10,440	7,510	2,920	0
2032	10,440	3,870	6,570	3,230	9,800	10,100	(310)*	310
2062	10,440	10,070	370	1,700	2,070	17,190	(15,120)*	15,120**

*Negative yield – water demands exceed water available

**Storage requirements exceed the watershed runoff.

Table 3.7 - Lambly Creek Watershed Storage Potential and Requirements

	Average Year			50 yr Drought				New Storage Required
	Raw Water Available (ML)	Storage Required (ML)	Theoretical Stored Volume Available (ML)	Raw Water Available (ML)	Stored Raw Water (ML)	Storage Required (ML)	Theoretical Stored Volume Available or Required (ML)	
2012	6,100	80	6,020	10,440	6,100	5,060	1,040	0
2032	6,100	780	5,320	9,670	6,100	7,630	(1,530)*	1,530
2062	6,100	3,740	2,360	7,770	6,100	13,990	(7,890)*	7,890

*Negative yield – water demands exceed waier available

3.7 Watershed Conclusions and Recommendations

Based on the information presented above the some key recommendations are:

- During an average year both watersheds have sufficient storage to meet the ultimate predicted demands of the distribution network with no upland watershed upgrades.
- The key findings associated with the Powers Creek watershed are:
 - Based on the projected increase in water demand and assuming the supply of the agricultural allocation by 2032 the Power Creek Watershed will need additional storage.
 - The Powers Creek watershed is somewhat limited during the design drought condition while delivering the ultimate estimated water demands associated with the current service area. This results in the long term water demands of the distribution network exceeding the annual production capacity of the watershed. During this future condition additional raw water will be required from an alternate source.
 - Constructing more storage in the Powers Creek watershed should be closely examined and compared to other raw water investments where the reliability of the raw water supply will be higher.
- The Lambly Creek watershed the findings are:
 - In 2032 the upland raw water system will require an additional 1,550 ML of storage.
 - As growth within the distribution system is predicted to continue, by 2062 an additional 7,900 ML of storage will be required.
 - It is estimated that the Lambly Creek watershed can meet the 2062 demands during 50-year drought including the current service areas of Pritchard, Sunnyside, West Kelowna Estates and part of the legacy Westbank Irrigation District.

4. Raw Water Quality and Treatment

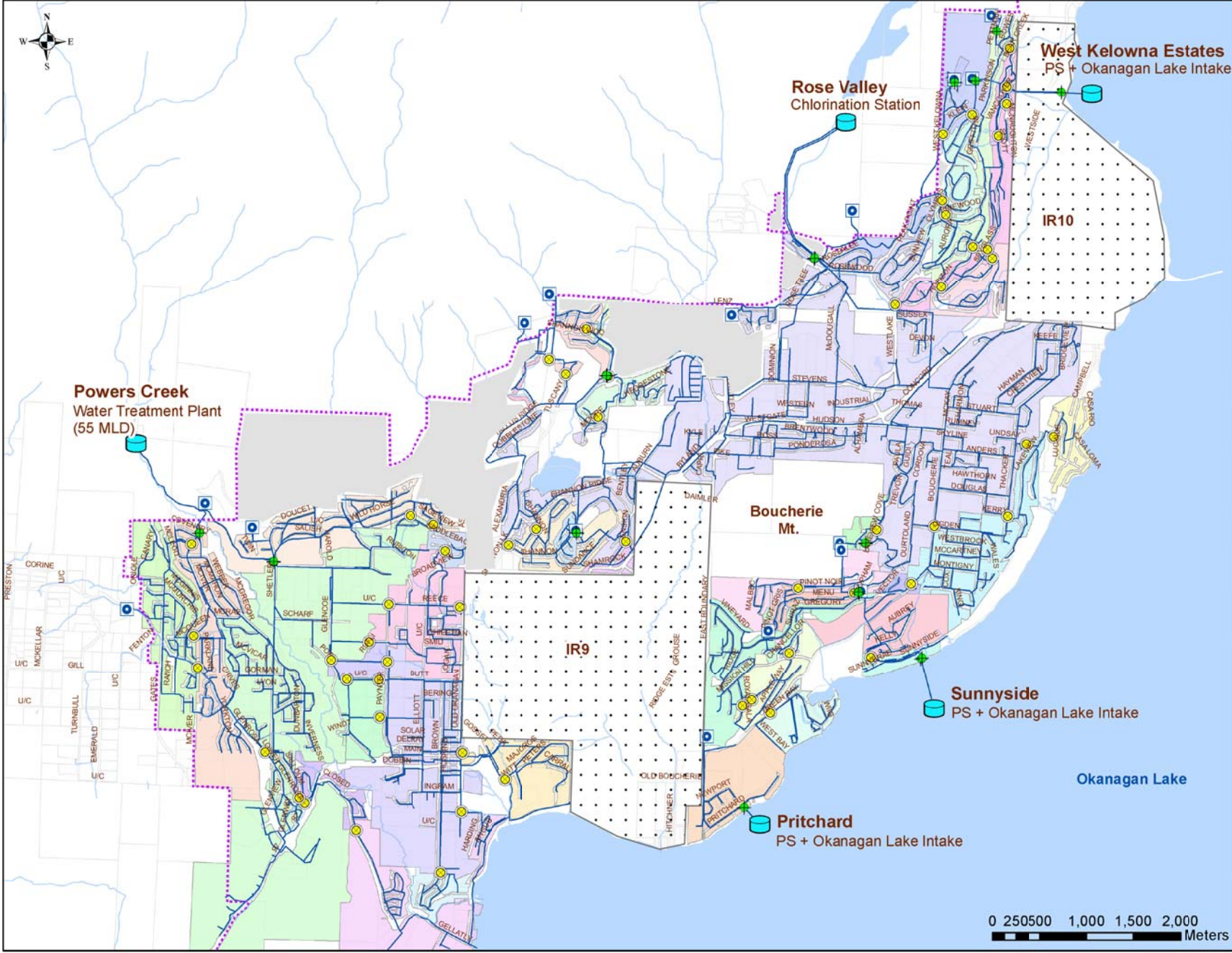
4.1 Existing Water Systems

Water is currently supplied by five separate distribution and supply systems within the DWK. The existing water systems evolved over a number of years resulting in various different levels of service currently being provided to the customers. One of the key goals of this study is to determine the most feasible approach to supply treated water that is compliant with the Interior Health guidelines while continuing to maintain the supply of irrigation water to the agricultural users without adversely impacting their user costs.

Provided in **Table 4.1** is a summary of the key statistics associated with each water utility. **Figure 4.1** shows schematically how water is currently conveyed to the existing customers, both domestic and irrigation within the DWK.

Table 4.1 - Summary of the Existing Water Systems

Current Water Supply System	Water Source	Current Treatment
Westbank	Powers Creek	Multi-barrier treatment plant that fully meets Interior Health requirements
Lakeview	Lambly Creek	Chlorination only of a surface water source that is subject to seasonal turbidity and algae events
Pritchard	Okanagan Lake	Chlorination only at lake intake
Sunnyside	Okanagan Lake	Chlorination only at lake intake
West Kelowna	Okanagan Lake	Chlorination only at lake intake



**District of West Kelowna
Water Utility Master Plan**

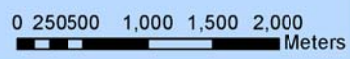
**Water Distribution
Existing System**

Legend

- Pump Station
- Intake
- Storage Tank
- Pressure Reducing Valve
- Service Boundary
- Existing Watermain
- Streams
- Un-irrigated Park Space

Figure No:
Figure 4.1

Project No: 60216671	Date: September, 2012
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4.2 Water Quality Goals

The topics discussed in this section of the report include water quality regulations and considerations for water treatment. At the end of this section of the report long term water treatment goals will be established. Treatment strategies will be developed for each of the potential raw water sources based on achieving the long term treated water goals documented within this section of the report.

4.2.1 Water Quality Regulations and Treated Water Goals

Within the province of BC, water quality requirements are stipulated under the Drinking Water Protection Act. The key water quality parameters addressed within this act are provided in **Table 4.2**.

Table 4.2 - BC Drinking Water Protection Act Water Quality Requirements

Parameter	Units	Long Term Goal
Fecal coliform bacteria	organisms/ 100 mL	No detectable fecal coliform bacteria
<i>Escherichia coli</i>	organisms/ 100 mL	No detectable <i>Escherichia coli</i>
Total coliform bacteria - (a) 1 sample in a 30 day period	organisms/ 100 mL	No detectable total coliform bacteria
Total coliform bacteria - (a) more than 1 sample in a 30 day period	organisms/ 100 mL	<ul style="list-style-type: none"> At least 90% of samples have no detectable total coliform bacteria No sample has more than 10 total coliform bacteria

The current drinking water regulations only address the immediate health risk associated with the potential for pathogens to be present within the water supply. Other immediate health risks and long term health concerns associated with items such as disinfection by-products are not addressed. Furthermore, there are no regulations related to ensuring water potability by setting maximum levels for parameters such as turbidity, true colour, dissolved compounds, taste and odour.

In addition to the drinking water regulations in BC, there is the “Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies in British Columbia”. This document provides guidance for water purveyors trying to establish long term goals and generally includes the following water quality objectives:

- 4-log (99.99%) inactivation for enteric viruses;
- 3-log (99.9%) inactivation or removal for Giardia;
- 3-log (99.9%) inactivation or removal for Cryptosporidium;
- Dual stage treatment;
- Less than 1.0 NTU turbidity in the treated water at all times; and
- Zero total and fecal coliforms.

When planning new water treatment facilities, it is also important to consider the water quality regulations which may come into effect during the life of the water treatment plant. The long term viability of the water treatment plant will depend on its ability to meet, where practical, foreseeable increases in treated water requirements. Consequently, the following additional treated water quality goals are recommended:

- Consistent compliance with the Guidelines for Canadian Drinking Water Quality (GCDWQ);
- Less than 0.3 NTU turbidity for at least 95% of the time for chemical assisted conventional media filtration;
- Less than 80 ug/L trihalomethanes (THM's), as measured on a locational running annual average. This means that the running average THM concentration will never exceed 80 ug/L at any single sampling point in the distribution system;
- Less than 60 ug/L haloacetic acids (HAA's), as measured on a locational running annual average. This means that the running average HAA concentration will never exceed 60 ug/L at any single sampling point in the distribution system.

Table 4.3 lists treated water quality targets that are the assumed minimum standard for any new water treatment facility considered as part of this study.

Table 4.3 - Treated Water Quality Goals

Parameter	Units	Long Term Goal
Total alkalinity	mg/L as CaCO ₃	> 25
Aluminium, total	mg/L	< 0.1
Coliform bacteria	organisms/ 100 mL	< 1
<i>Cryptosporidium parvum</i>	log reduction	> 3-log (99.9 %) removal or inactivation
<i>Giardia Lambli</i> a	log reduction	> 3-log (99.9 %) removal or inactivation
Enteric viruses	log reduction	> 4-log (99.99 %) removal or inactivation
Iron	mg/L	< 0.3
Sulphates	mg/L	< 200
pH		Stable, non-aggressive
Nitrates	mg/L	< 45.0
Manganese	mg/L	< 0.05
Temperature	°C	< 15
Trihalomethanes	µg/L	< 80, on a Locational Running Annual Average
Haloacetic Acids	µg/L	< 60, on a Locational Running Annual Average
Bromodichloromethane	µg/L	< 16, on a Locational Running Annual Average
Total Organic Carbon	mg/L	Optimize reduction to meet THM and HAA goals
True Colour	TCU	< 15
Turbidity	NTU	Granular Media Filtration < 0.3 NTU 95% of the time, never to exceed 1 NTU Membrane Filtration < 0.1 NTU
Chemical and Physical Parameters	N/A	Meet or exceed the Canadian Guidelines for Drinking Water Quality

4.3 Source Water Characteristic Review

As noted above DWK relies on raw water from Powers Creek, Lambly Creek and Okanagan Lake to meet the potable water demands of the community. These existing sources have successfully supplied the community for many years and they have sufficient capacity to continue to be the principle water sources for the planning horizon of this study. This means there is no reason to consider alternate water sources and abandon the existing investments in the current raw water infrastructure.

This section of the report will focus on the raw water characteristics of Powers Creek, Lambly Creek and Okanagan Lake from a treatment perspective resulting in the identification of a sustainable water treatment process necessary for each source. Based on the treatment requirements capital and operation costs will be generated for the production of optional long term water supply solutions.

4.3.1 Powers Creek Source Water Quality

Powers Creek was the subject of extensive raw water quality review and pilot testing in 2003/2004 during the development of the Powers Creek water treatment plant. This treatment facility has been successfully treating the water diverted from Powers Creek since 2007 so this section of the report provides a brief overview of the treatment challenges that were successfully addressed with the existing in-filter dissolved air flotation water treatment plant.

Powers Creek is an upland water supply that frequently demonstrates contamination with pathogenic bacteria (such as coliforms) and protozoa (such as Giardia). Bacterial contamination is generally more pronounced in the summer months, when warmer temperatures accelerate growth. Risk from Giardia and Cryptosporidium contamination is expected to be highest during the rainy season, when runoff carries topsoil containing faecal matter into the Creek. Raw water turbidity is also at its highest in the rainy season and spring freshet for this same reason. Raw water turbidity has averages up to 3 NTU in the month of April, with a peak in excess of 20 NTU.

Raw water true colour reaches a peak in April, with peak true colour of the order of 80 – 90 TCU, significantly over the Canadian Federal aesthetic guideline for true colour of 15 TCU. True colour is a significant concern with respect to the palatability of the water, since water in the Creek has a tea-like appearance during the freshet months. Perhaps more importantly however, true colour is an indicator that naturally occurring organic compounds are present in the water and react with chlorine disinfectant to produce by-products such as the family of trihalomethanes, linked to possible long term health effects in humans. Trihalomethanes have been documented to reach as high as 160 ug/L in parts of the Westbank system in the spring, significantly in excess of the Canadian Federal Maximum Acceptable Concentration of 100 ug/L. Since the commissioning of the treatment plant, the true colour of the treated water is less than 15 TCU and the disinfection by-products are generally compliant with the Canadian guidelines.

4.3.2 Lambly Creek Source Water Quality

Water is diverted from the Lambly Creek to the Rose Valley Reservoir. The raw water enters the north end of the Rose Valley Reservoir and is diverted through a distribution pipe located adjacent to the dam at the South end.

The watershed that supplies Lambly Creek is essentially the same as Powers Creek meaning it is reasonable to expect similar raw water quality at the point of diversion at the Rose Valley Reservoir, as experienced at the Powers Creek water treatment plant. Based on a brief review of the raw water collected in the watershed the raw water quality is somewhat similar; however, the impact of the Rose Valley Reservoir has a measurable

impact on the raw water prior to being diverted to the distribution network. The impacts of the reservoir and the key considerations related to treatment of the water are discussed below.

Table 4.4 presents a summary of the Rose Valley Reservoir raw water quality data collected at the point of diversion during the past few years.

Table 4.4 - Lambly Creek (at Rose Valley) Raw Water Quality

Parameter	Units	Minimum	Maximum	Average	95th Percentile	# of Samples
Alkalinity	mg/L as CaCO ₃	75.3	75.3	75.3	75.3	1
Algae	Counts/100 mL	2	1545	192	566	77
Colour	TCU	16	38	28	36	53
Conductivity	Mmho/cm	143	186	160	181	28
Hardness	mg/L as CaCO ₃	71.8	71.8	71.8	71.8	1
Iron	mg/L	<RDL	0.2	<RDL		8
Manganese	mg/L	0.0629	0.0629	0.0629	0.0629	1
Phosphorous	mg/L	0.005	0.23	0.04	0.077	54
Sulphate	mg/L	4.9	4.9	4.9	4.9	1
E.Coli		<RDL	<RDL	<RDL		2
Total Coliform		<RDL	3.6	<RDL		2
Temperature	Celsius					
TOC	mg/L	6.5	17.9	10.7	17.2	14
Turbidity	NTU	0.5	16	2.9	11.5	16
pH		7.1	8.5	7.77	8.1	56
%UV Transmittance		58.7	63.4	60.6	63.0	8

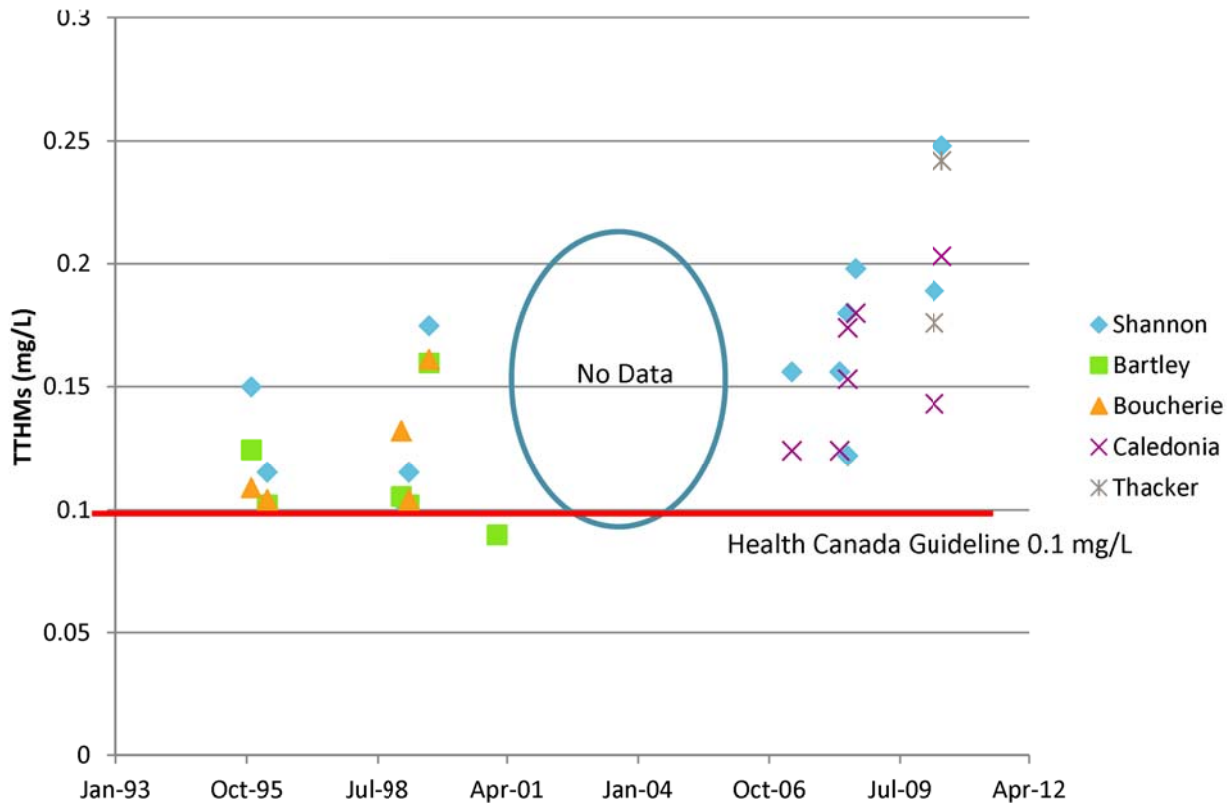
The following are water quality parameters that are important for existing and future treatment of the Rose Valley sources:

- **Turbidity:** While this in itself poses no known direct health concern, there is the potential for the physical masking of pathogens by turbidity particles, thereby reducing the effectiveness of disinfection. For the Rose Valley Reservoir the turbidity is typically in the order of 2.0 NTU with excursions that occasionally reach 10 NTU, which are related to storms or seasonal turn-over events. This means that the turbidity is typically low but not low enough to support filtration deferral as a long term strategy.
- **Protozoa (Giardia & Cryptosporidium):** Both of these chlorine-tolerant organisms have shown themselves to be present in watersheds throughout the province of British Columbia. This means that all surface water sources should be treated to provide 3-log inactivation/removal of Giardia & Cryptosporidium. Testing in the past supports that these parasites are present in Lambly Creek and the Rose Valley Reservoir, but at low concentrations meaning that a 3-log inactivation/removal target is acceptable.
- **Algae:** In most cases, algae do not pose a direct health threat; however, there is increasing concern regarding toxins formed as metabolites by certain types of algae, notably the family of blue-green algae. Algae can also create taste and odour problems and can clog filters in water treatment plants; presenting significant operation challenges. Historically, algae blooms occur during the summer within the Rose Valley Reservoir. In the past algae blooms were managed by adding a copper based compound. This practice is no longer considered acceptable meaning that any new treatment process needs to be designed to remove more algae with a clarifier prior to filtration. Given the algae

concentrations measured in the past, filtration without clarification would not function sustainably during an algae bloom.

- **Iron:** This item does not pose a health concern, but can be an aesthetic concern. Iron can stain laundry and water fixtures, impacting the acceptance of the water by customers.
- **Manganese:** This mineral occurs commonly in natural environments and is typically found in surface and groundwater sources. Manganese, in moderation, is essential to humans, meaning the primary water quality concern is related to staining on plumbing fixtures and unpalatable water taste.
- **Hardness and Alkalinity:** These parameters are indicators of the water chemistry relative to the potential for corrosion posed by the water. Corrosive water can reduce the life of the water distribution network, especially for large systems with high water residence time. It is recommended that corrosive water be stabilized to minimize corrosion in the transmission and distribution infrastructure.
- **Nitrates:** Nitrates are naturally occurring ions within the environment and are widely used as inorganic fertilizers. There are links between nitrates and elevated occurrences of gastric cancer, making prolonged exposure to elevated levels of nitrates undesirable. This contaminate has not historically been a concern, but this parameter should continue to be monitored given the activity within the watershed. An additional consideration is the potential health risk to newborn infants less than 3 months of age. Overexposure to nitrates can result in Methaemoglobinaemia or “blue baby syndrome”.
- **True Colour and Natural Organic Matter:** This is first and foremost an aesthetic concern, as it impacts the visual appeal of the water. However, if the colour has been imparted by the presence of naturally occurring organic acids, including the families of humic and fulvic acids, there is an increased potential for the formation of chlorinated disinfection by-products (DBP’s), such as trihalomethanes or haloacetic acids. The organic acids are not known to pose direct health effects in drinking water. The levels of organic matter within the Rose Valley Reservoir could be categorized as moderate to high, resulting in the need for treatment to reduce this contaminate from the process flow.
- **Disinfection By-Products (DBP’s):** DBP’s are the by-products of the reaction of chlorine with organic substances, and in many cases have been linked to health effects such as cancer in humans. It is common for surface water to contain natural humic and fulvic acids released into the water through the decay of natural organic materials such as leaves, and other plant matter in the watershed. Provided below in **Figure 4.2** is a summary of the THM data collected from the distribution network historically supplied water from the Rose Valley Reservoir. As shown with the figure the THM data is measurably above the current Health Canada guideline of 0.1 mg/L. To address this issue the natural organic matter present in the raw water needs to be reduced through the new treatment process.

Figure 4.2 - THM Data – Legacy Lakeview Irrigation District



4.3.3 Okanagan Lake Source Water Quality

Okanagan Lake is the largest surface water source in the Okanagan Valley. Currently, DWK diverts water from Okanagan Lake at the Prichard, Sunnyside, and West Kelowna pump stations. All these facilities currently only disinfect the raw water using chlorine.

The raw water quality data available from the existing DWK facilities that divert water from Okanagan Lake is somewhat limited, however, several other water purveyors of similar size divert water from Okanagan Lake and have completed extensive source sampling. Specifically, since the 1996 *Cryptosporidium* outbreak in the City of Kelowna, water utility purveyors in the Okanagan have sought to improve their knowledge of the lake limnology to better understand its hydraulic behaviour and the associated influence on water entering raw water intakes. The following studies have been completed and were reviewed in conjunction with the consideration of diverting water from Okanagan Lake:

- City of Kelowna, Drinking Water Source Protection Report, EBA, May 2011
- Westbank First Nations, IR10 Water System Okanagan Lake Water Quality Monitoring, Urban Systems, January 2001
- DWK of Lake Country, Source to Tap Assessment of Okanagan Lake Intake, Larratt Aquatic, July 2010
- City of Kelowna, Influence of Limnology on Domestic Water Intakes, Hayward and Company, 2001

These studies primarily focus on the Okanagan Lake water quality as it relates the depth and location of raw water intakes used to supply potable water to the local communities.

Figure 4.3 obtained from the *Source to Tap Assessment of Okanagan Lake Intake* by Larratt Aquatic, lists the depth of the major raw water intakes on the Okanagan Lake and the anticipated water quality influences at various water depths.

Figure 4.3 - Major Okanagan Lake Intakes; Depths and Influences

South sub-basin	Central sub-basin	North sub-basin	Depth (m)	Thermal Zones	Risk of pathogen	Cyano-bacteria
O Peachland	O Shanbooldard		1	warm surface water	high risk	high risk of surface cyanobacteria
			2		risk is higher for surface water contamination	lower risk of surface cyanotoxins
			3			
			4			
			5			
			6			
			7			
			8			
			9			
			10			
O Westbench	O Eldorado O Sunnyside O Swick O R # 9	O Adventure Bay O West Kelowna Est. O McKinley	11	summer thermocline zone		
			12			
			13			
			14			
			15			
			16			
			17			
			18			
			19			
			20		15°C guideline exceeded above this depth	
O Penticton	O Casa Loma	O Outback O Poplar Point O LC Okanagan O R# 10	21	seiches diminish 5-12 °C temp range	low risk of pathogens	lower risk of cyanotoxins
			22			
			23			
			24			
			25			
			26			
			27			
			28			
			29			
			30			
			31			
			32			
			33			
			34			
			35			
			36			
			37			
38	low seiche risk temp range <5°C	very low risk of pathogens	best range for intakes to avoid cyanobacteria			
39						
40						
41						
42						
43						
44						
45						
46						
47				maximum depth for divers		
48				minimal seiche penetrations		lower risk of cyanotoxins
49						
50						
51						
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75						
76						
77						
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79						
80	suspended detritus	high risk of benthic cyanob				
>>>						

The City of Kelowna's Poplar Point, Eldorado and Cedar Creek facilities are generally located directly across the lake from the DWK. The City of Kelowna has been successfully disinfecting Okanagan Lake water with UV radiation since 2006. Based on the Lake Limnology presented in the HAYCO 2001 and EBA 2011 studies, with deep raw water intakes the DWK could be expected to experience similar influences on the water quality conditions as the City of Kelowna's Poplar Point facility. The City has extensive historical water quality data from this facility demonstrating the treatability of the Okanagan Lake at this depth and location.

The quality of water entering a raw water intake from a surface water source is largely a function of its depth and location in relation to potential sources of contamination. A submerged lake intake can be subject to contamination from a multitude of sources, some of which include: tributary streams, seasonal lake turn-over events, surface contamination (i.e. spills), wastewater treatment outfalls, and the lake hydraulics (such as seiches). The risk associated with these sources of contamination needs to be assessed so that the long term water supply scheme achieves the water treatment needs.

4.4 Water Treated Requirements

The raw water characteristics of each of the main optional raw water sources are described above. This section describes the water treatment infrastructure necessary to reliably treat these raw water sources to meet the Interior Health standards.

The recommended treatment process trains presented below are based on previous experience and review of the key treatability challenges associated with each raw water source. The recommended treatment process train is an approach that will be able to produce potable water that meets the Interior Health standards and is used for the basis of establishing a capital and operating budget. This section of the master plan is not a detailed water treatment process review, but rather a defensible approach to establish a budget and a plan that will be the basis of future engineering assignments focused on the optimized design of the treatment plants.

4.4.1 Powers Creek Water Treatment Plant

The existing Powers Creek water treatment plant functions well and reliably produces treated water that meets the needs of Interior Health. For the basis of this study it is assumed that the existing Powers Creek treatment facility is suitable to meet the long term treated water quality goals. This means the expansion of the existing Powers Creek facility is assumed to be 3 more basins using the same treatment approach.

4.4.2 Lambly Creek Source

The raw water quality of the Lambly Creek source is very similar to Powers Creek. During the development of the Powers Creek water treatment plant optional treatment approaches were considered and pilot testing completed. The conclusion of this previous work was the selection of a clarification and granular media filter water treatment plant. Given the similarities of the raw water and the success of the Powers Creek water treatment plant it is assumed that the same process train will be used for the Lambly Creek water source.

The new water treatment plant will be sized to meet the maximum daily demand, which will vary depending on the preferred long term water supply option selected. To address the raw water quality issues identified above while sustainably ensuring the treated water quality goals are achieved a water treatment plant with the following key infrastructure is recommended:

- Tie-ins into the existing raw water main, to draw raw water from the main into the new treatment plant, and to return treated water back into the main for distribution. The goal will be to divert water from the existing main through the water treatment plant without additional pumping;

- The new water treatment plant proper, including the following processes:
 - Coagulation, using poly-aluminium chloride, to destabilize colloidal material, and entrap natural colour in the water within a chemical floc;
 - Jet flash mixing facilities, to rapidly mix the coagulant into the raw water;
 - Mechanical Flocculation, to gently stir the newly coagulated water, and encourage the small floc particles formed during coagulation to adhere together and grow larger flocs;
 - Dissolved air flotation (DAF), using micro-bubbles to float the flocs to the surface of the tank, forming a sludge layer which can be scraped from the surface, and separated from the water;
 - Granular media filtration, constructed within the same concrete tank as the DAF process (in combination this process is known as DAF/F);
 - Primary disinfection using chlorine;
 - Facilities for backwashing and air scouring of the filters, to remove foulants;
 - A treated water pump station, to pump treated water to the new treated water pump station;
 - Facilities to capture sludge formed by the DAF process, and pump the sludge at a steady rate to the sludge treatment facilities;
 - A sludge treatment facility based on the use of centrifugation for mechanical dewatering of the sludge, allowing for most of the water contained in the raw sludge to be removed, rendering the sludge amenable for hauling and disposal off-site;
 - Facilities for treating the waste generated by the backwashing of the filters;
 - Chemical feed facilities for poly-aluminium chloride, caustic soda (sodium hydroxide), and polymers for the sludge treatment process;
 - Centrate disposal facilities;
- A treated water reservoir; and
- An administration building and operation & maintenance facilities. The administrative and operations & maintenance building will be constructed as part of a consolidated facility with the water treatment plant proper.

During the course of a development of a water treatment solution for the Rose Valley Reservoir pilot testing and further analysis should be completed to confirm the above assumptions. However, for the point of options review and long term planning, the above treatment solution is a suitable starting point that can be optimized in the future.

4.4.3 Okanagan Lake Source

Based on a review of the raw water quality and similar to the City of Kelowna it is expected that with a deep lake intake high quality raw water that would be suitable for 2-stage disinfection could be successfully obtained. Based on the experience of other municipal water purveyors that use Okanagan Lake as a raw water source the following improvements will be required by the DWK:

- Extend the existing raw water intake(s) so they divert water from a depth of approximately 35 m below the water surface of Okanagan Lake.
- Provide ultraviolet disinfection for a 3-log inactivation credit for *Cryptosporidium* and *Giardia*;
- Provide chlorination for 4-log inactivation of viruses;

- Apply for filtration deferral with Interior Health; and
- Financially plan for filtration as it is reasonable to expect that filtration will be mandated within the planning horizon of this study.

For the basis of comparing options it is assumed that a filtration plant will be required for Okanagan Lake water by 2032. This assumption is somewhat subjective, but based on the City of Kelowna being able to successfully obtain approval for filtration deferral it is reasonable to expect that the DWK could also obtain the same approval from Interior Health. However, it is our opinion that the filtration deferral for the foreseeable future is not a reasonable assumption. Okanagan Lake is a highly used surface water body with the human activity increasing every year. This means it is assumed that a filtration plant will be required in the next 20 years.

4.5 Treated Water Solution

4.5.1 Treated Water Supply Options

Seven options for the long term supply of water were developed for all the current and expected customers within the water service area. The long term water supply options were developed collaboratively between AECOM, DWK staff, and members of the Technical Steering Committee. Once the practical options were developed, capital and operating costs were developed. The options complete with the capital cost and the estimated operating cost associated with the new capital is presented in **Table 4.5**.

Table 4.5 - Capital & Operating Cost Summary

Option	Estimated Total Capital Cost	Net Annual O&M Change, 2032 (\$ millions)
Option 1 – Maintain Current System, Treatment at all Sources	\$ 163.8 M	\$ 1.68 M
Option 2 – Centralized Treatment at Powers Creek and Rose Valley Using all Three Raw Water Sources	\$ 101.7 M	\$ 1.54 M
Option 3 – Centralized Treatment and Raw Water Supply From Powers Creek and Rose Valley	\$ 124.5 M	\$ 1.54 M
Option 4 – Centralized Treatment and Raw Water Supply From Powers Creek and Rose Valley, Complete System Separation	\$ 110.6 M	\$ 1.68 M
Option 5 – Centralized Treatment and Raw Water Supply From Powers Creek and Rose Valley, System Separation in Sunnyside	\$ 103.7 M	\$ 1.56 M
Option 6 – Centralized Treatment and Raw Water Supply From Powers Creek, Expand Powers Creek and Delay Rose Valley, Complete System Separation	\$ 121.1 M	\$ 1.46 M
Option 7 – Centralized Treatment at Powers Creek and Rose Valley, Filtration Deferral by Using Okanagan Lake for Raw Water	\$ 111.1 M	\$ 1.78 M

Some general comment about the optional long term water supply options are:

- The highest capital cost option and essentially the highest operating cost solution is to add treatment facilities at the existing 5 main raw water sources for the DWK. This seems to be intuitively correct as having 5 treatment facilities for a community of roughly 30,000 people is not typical. Maintaining all 5 existing raw water sources results in the DWK incurring unnecessary additional cost, meaning consolidation of the raw water sources offers a financial benefit.
- All options that rely on Okanagan Lake result in increased operating cost over options that use the existing upland creeks for the supply of raw water. Significant investments have been made in the

Powers Creek and Lambly Creek watersheds for the supply of raw water by gravity to the DWK water service area. These raw water sources are subject to drought concerns, but generally are reliable sources of raw water that should be part of the long term water supply solution prior to making significant new investments in the development of more water from Okanagan Lake.

- It is expected that filtration of all the three main water sources available to the DWK will eventually be required. The analysis completed indicates that expanding raw water supply from Okanagan Lake and pursuing filtration deferral does not offer the DWK a financial benefit given the significant capital investments required to expand the Okanagan Lake water supply to meet the needs of the DWK.
- Adding filtration at the Rose Valley Reservoir site results in maximizing the use of the existing DWK infrastructure and supply of gravity water to the distribution network.
- Separation of the distribution network for the supply of treated water to the domestic customers and raw water for the agricultural customers was reviewed in close detail. Given the amount and location of agricultural water demand complete separation of the distribution network does not offer the DWK a financial benefit. This means the lower capital cost options do not include system separation. However, the highest potential areas for the completion of cost effective system separation is on the bench north of Highway 97 and west of IR 9 in the legacy Westbank Irrigation District area. This area could be provided raw water from the Powers Creek through a dedicated gravity pipe network. The other high potential area is the legacy Sunnyside service area. This area could be provided agricultural water by converting the existing Sunnyside Okanagan Lake pump station into a raw water supply for the agricultural customers in the area between Boucherie Mt. and Okanagan Lake. System separation is not currently part of the recommended plan, but this item should continue to be monitored and if system separation offers a financial benefit in the future this work can be implemented.

Detailed financial review of the options was completed and provided to the Technical Steering Committee for review. Once this work was reviewed and accepted that Technical Steering Committee ranked the non-cost considerations of the options to establish the benefit to cost of each option. This review resulted in Option 2 being selected as the preferred long term water supply solution for the DWK. For more information about the options considered and the option evaluation process refer to **Appendix E**.

4.5.2 Development of the Preferred Long Term Water Supply Solution

The preferred option relies on treatment plants only located at the existing Powers Creek site and a new plant at the Rose Valley Reservoir dam site. This reduces the number of treatment plants required long term meaning the operating cost associated with maintaining numerous facilities is reduced. To meet the long term raw water supply requirements the goal with this option is to maximize the existing upland watershed infrastructure. Once the capacity of the upland watershed is met supplemental water will be provided from Okanagan Lake to the Rose Valley Reservoir site water treatment plant. By providing the option for the supply of Okanagan Lake water to the Rose Valley Reservoir site the reliability and drought tolerance of this option is significantly improved. The geographic location of the new infrastructure is presented in **Figure 4.4**. In summary the key infrastructure being added with this option is:

- Immediate Infrastructure Upgrades (Now – 2032):
 - Maintain the existing Powers Creek water treatment plant. Depending on the actual demands some expansion may be required prior to the 20 year design horizon;
 - Construct a new water conventional water treatment plant and treated water clearwell at the Rose Valley Reservoir site;

- Install a transmission main to convey treated water from the new Rose Valley water treatment plant site to West Kelowna Estates. This allows the existing West Kelowna Estates pump station to be abandoned.
- Future Upgrades (2032 to 2062):
 - Further expand the Rose Valley water treatment plant;
 - Provide a pipeline sized to convey 6,650 ML to Rose Valley WTP to supplement the raw water storage shortage in the upland watershed during a drought. In addition to the transmission main a pump station is necessary to convey Okanagan Lake water to the Rose Valley water treatment plant;
 - Install an interconnecting gravity transmission main to feed the legacy Westbank Irrigation District system from Rose Valley. This transmission main is a 600mm pipe 9.2km long and is designed to reduce the maximum daily flow required at the Powers Creek facility by 40 ML/d;
 - Provide a gravity transmission main to improve the transmission capacity of the network from the Rose Valley reservoir to the Sunnyside area.

The implementation of Option 2 is developed further through the remainder of this document with the primary goal of establishing timelines and budgets for the implementation of water system improvements. It is expected that the details associated with the implementation of Option 2 will continue to be refined as the DWK continues to collect more water demand data and develop more detailed land-use plans. This additional background information will allow for further refinement of the long term Water Master Plan in the future.



District of West Kelowna Water Utility Master Plan

Option 2

Preferred Long Term Water Supply Solution

Legend

- Future Water Treatment Plant
- Existing Water Treatment Plant
- Raw Water Supply Intake
- Inactive Intake (Emergency)
- Raw Water Supply PS
- Proposed Transmission Mains
- Proposed Raw Water Supply Main
- Service Boundary
- Existing Watermain
- Streams
- Un-irrigated Park Space

Figure No:

Figure 4.4

Project No:

60216671

Date:

September, 2012



Powers Creek WTP

2012 - 2032: 81 MLD
2032 - 2062: 81 MLD

Future Rose Valley WTP

2012 - 2032: 90 MLD
2032 - 2062: 170 MLD

Proposed Transmission Mains
are connected to the Existing Watermain
(Not to the Proposed Raw Water Main)

IR10

Boucherie
Mt.

Okanagan Lake

Sunnyside
Raw Water Intake

Note:
Proposed pipe alignments and pump station
are conceptual and need to be verified.

0 245490 980 1,470 1,960
Meters

5. Water Distribution and Hydraulic Analysis

5.1 Network Model Development

To support this project, DWK acquired hydraulic modelling software that can import the existing models and simulate multiple-node fire flow analysis while being user-friendly, cost effective, GIS compatibility and compatible with other municipalities for informal support and networking. Based on a review of the typically used hydraulic software programs, it was recommended that the DWK selected **Innovyze's InfoWater** software for this project. A detailed review and recommendation letter was provided to the DWK to support this decision. The letter issued to the DWK is available within **Appendix B**.

Water demand scenarios were generated for both existing and future (2032) time horizons. Future demands are based on the recommended bylaw per capita demands and a population growth of 2% per year.

All model components (pipes, nodes, valves (PRV), pumps, tanks, reservoirs), including their modeling attributes were imported from the former hydraulic models to the new and combined model. In general the system is connected properly. Hydrant flow testing was used to confirm the static pressure at discreet locations in the distribution network and the pressure loss experienced during different flow conditions. This information was used to calibrate the model resulting in the production of reliable output data.

A detailed description of the development of the computer hydraulic model, the demand allocation, calibration and analysis is included within **Appendix F** for more information. The analysis covers both the existing and future conditions.

Within the following parts of this section of the report is a detailed summary of the existing hydraulic deficiencies within the distribution system and the future deficiencies based on the predicted water demands by 2032. Also, provided is a conceptual level plan for the consolidation of the pressure zones within the service area and a brief review of the areas where additional hydrants are required.

5.2 Existing Distribution System Deficiencies

The recommended prioritization of the upgrades is shown in **Figures 5.1** and **5.2** for existing and 2032 demand conditions respectively. It is important to note that the proposed upgrades listed in 2032 scenario are solely triggered by the three expansion growth locations. As discussed in earlier sections, the infill growth that was equally distributed throughout the system has a significant impact on the system's capacity. Therefore, the project prioritization for 2032 scenario should be further refined as more information on the development of the area becomes available.

A brief description of each proposed upgrade for the existing system is as follows:

1. Project 1 - Sunnyside Transmission Main

This project will allow the existing Sunnyside Lake Intake to be decommissioned and the Sunnyside service area to be fed from Rose Valley Reservoir. A new PRV and 450mm – 665m new watermains will be required.

2. Project 2 – Mission Tank Supply Watermain Upgrade

Once the Pritchard service area is supplied by Rose Valley Reservoir through Sunnyside, increased flow rates would be required to be supplied to Mission Tank at Sunnyside. Under this condition the existing 300mm dia. mains between Mission PS and Mission Tank will significantly experience high headloss and velocity. New 400mm – 1,330m of watermains will be required.

3. **Project 3 – West Kelowna (WKE) Transmission Main**
This project will allow the existing WKE Intake to be decommissioned and the WKE service areas to be fed by the Rose Valley Reservoir. Two PRVs and a total of 3,295m of new watermains with diameter ranging from 200mm to 500mm will be required.
4. **Project 4 – Weber Road Watermain Upgrade**
The existing 150mm dia. Mains on Weber/McCalister/Mclver Rd do not provide adequate flow under MDD+Fire scenario. New 200mm – 1,075m watermains will be required.
5. **Project 5 – Glenrosa Industrial Area Watermain Upgrade**
The existing 150mm and 200mm dia. mains at this location do not provide adequate flow under MDD+ Fire scenario. New 300mm – 910m watermains will be required.
6. **Project 6 – Old Okanagan/Butt Road Watermain Upgrade**
The existing 100mm and 150mm dia. mains at this location do not provide adequate flow under MDD+Fire scenario. A total of 2,160m of new watermains with diameter ranging from 150mm to 200mm will be required.
7. **Project 7 – Witt and Peters Road Watermain Upgrade**
The existing 100mm dia. mains at this location do not provide adequate flow under MDD+Fire scenario. New 150mm – 1,050m watermains will be required.
8. **Project 8 – Angus Drive/Harding Road Watermain Upgrade**
The existing 150mm and 200mm dia. mains at this location do not provide adequate flow under MDD+Fire scenario. A total of 1,000m of new watermains with diameter ranging from 200mm to 250mm will be required.
9. **Project 9 – Mclver and Gorman Road Watermain Upgrade**
The existing 150mm and 200mm dia. mains at this location do not provide adequate flow under MDD+Fire scenario. New 250mm – 645m watermains will be required.
10. **Project 10 – Talus Ridge Watermain Upgrade**
The existing 200mm dia. mains at this location do not provide adequate flow under PHD scenario. New 250mm – 835m watermains will be required.
11. **Project 11 – Auburn Road Watermain Upgrade**
The existing 150mm dia. mains at this location do not provide adequate flow under PHD scenario. New 200mm – 555m watermains will be required.
12. **Project 12 – Boucherie Road Watermain Upgrade**
The existing 100mm dia. mains at this location do not provide adequate flow under PHD scenario. New 200mm – 320m watermains will be required.
13. **Project 13 – Ridge Boulevard and Mission Hill Road Watermain Upgrade**
The existing 250mm dia. mains at this location do not provide adequate flow under PHD scenario. New 350mm – 380m watermains will be required.
14. **Project 14 – Sunnyside Distribution Upgrade**
Once the Sunnyside service area is supplied by Rose Valley Reservoir, the existing 150mm – 250mm dia. mains at this location will be part of the main supply route. Thus with anticipated increased flow rates, these mains will significantly experience high headloss and velocity. A total of 1,070 m of watermains with diameter ranging from 450mm to 500mm will be required.

Provided on **Figures 5.2** are **5.4** are future projects that are currently the result of the specific allocation of the future flow. The actual projects are expected to vary as the actual development scenarios continue to evolve and will be the subject of future review.

Figure 5.3 shows the assumed location of the growth within the service area. The growth within the DWK is based on a population increase of 2% per year until 2062. There are specific growth nodes identified in the Smith Creek, Goats Peak, and Raymer areas with the remainder of the growth being uniformly allocated across the DWK.

5.3 Pressure Zone Management

Currently there are roughly 47 pressure zones in the system supplied by combinations of pumps and control valves. It is valuable to investigate the possibility of reducing the number of pressure zones in the system to minimize overall management, operational, and future capital investment costs.

This study examines the system network connectivity as well as the HGL requirement for each zone to determine which pressure zones can be combined. Additionally, we have also looked at ways to establish a centralized supply from Lakeview system (Rose Valley Reservoir) to West Kelowna Estate (WKE), Sunnyside and Pritchard, and ultimately inactivating the supply from the three intakes from Lake Okanagan. We have also identified any upgrades required to support the proposed supply mechanism and pressure zone configuration.

A key modification to the distribution of water within the network is the supply of West Kelowna Estates from the Rose Valley Reservoir. The focus of this change is to simplify the supply of water through the use of fewer raw water sources and simplified pressure zones. The main upgrades required for this strategy are:

1. New transmission main from Lakeview (LID-PZ3) to Blackwood Tank. Additionally this connection requires a new pressure reduce valve under the existing condition and it requires a booster pump under 2032 demand conditions due to significant demand increase in Raymer area. The existing booster pump at this location may be utilized with sufficient capacity and accommodation of the head and piping reconfiguration around the pump house.
2. New pressure reduce valve on the pipe connection located on the easement between Scott Crescent and Griffith Place.
3. Connection between LID-PZ10 and WKE-PZ5.
4. Connection between LID-PZ9 and WKE-PZ8.
5. Decommissioning of Blackwood pump (that feeds McPhail Tank). McPhail Tank will be supplied by the Rosewood PS together with Rosalee Tank. This item was proposed to minimize transmission upgrades (Refer to Item 1).
6. Decommissioning of WKE lake intake.
7. Inactivation of the control valves currently separating these combined pressure zones.

Another key modification is the supply of water from the Rose Valley reservoir to the existing Sunnyside distribution area once treatment is provided. This change allows for the use of fewer treatment plants while maximizing the supply of water by gravity. The main upgrades required for this strategy are:

1. New transmission main from Lakeview (LID-PZ3) to Menu Tank (with new pressure reduce valve).
2. Open valve at the existing 300mm pipe connecting Sunnyside and Pritchard to allow connectivity between SS-PZ6 and Pritchard.
3. Decommissioning of Pritchard Tank. Pritchard tank has an HGL of 391m which is too low for the newly combined pressure zone.
4. Decommissioning of Sunnyside and Pritchard lake intakes.

Implementing the recommended distribution system changes will result in modifications to the pressure zones. **Figures 5.4** and **5.5** show the existing and proposed pressure zones.



**District of West Kelowna
Water Utility Master Plan**

**Water Distribution With
Proposed Upgrades**

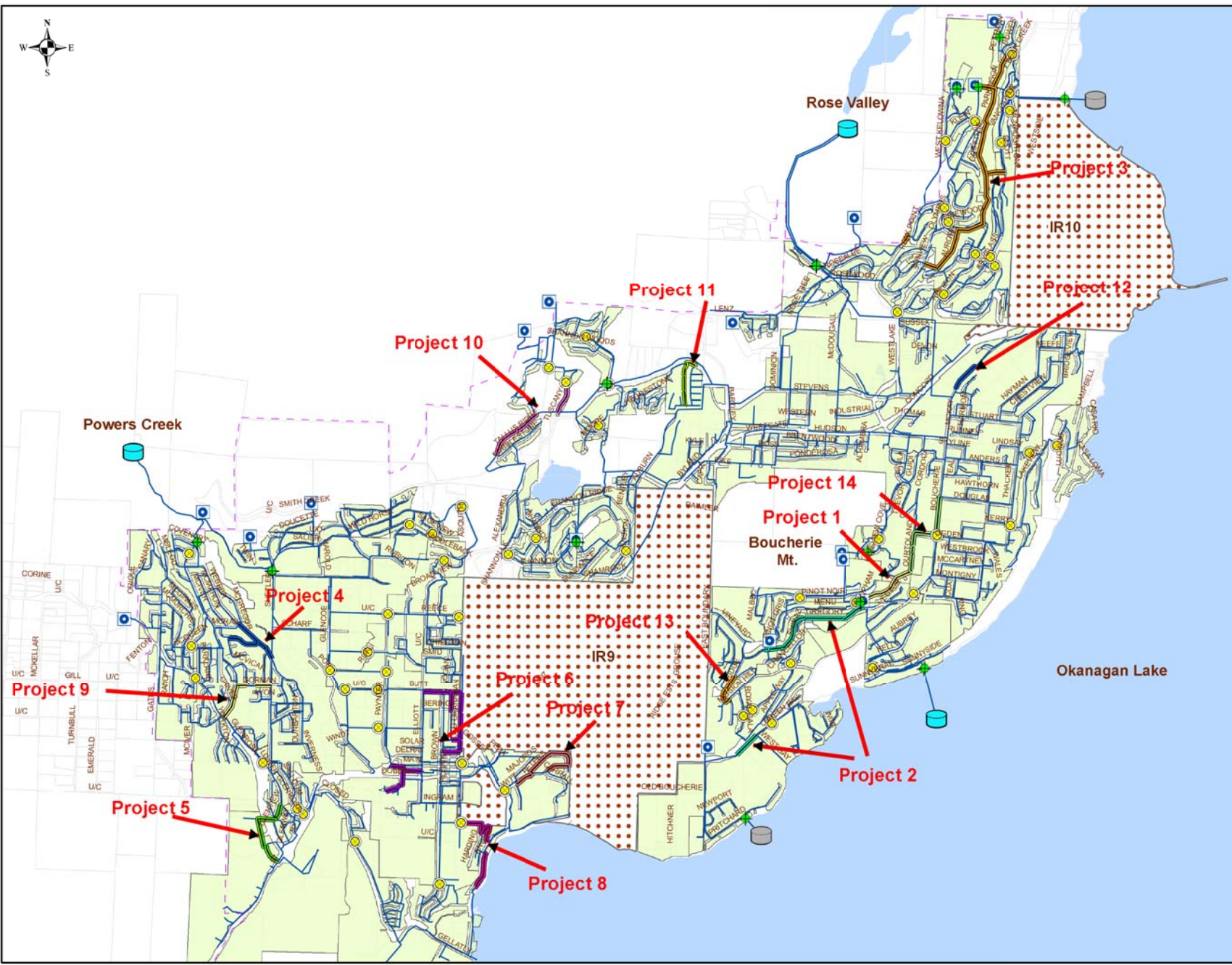
**Proposed Watermain Upgrades
(Existing Demand Condition)**

Legend

- Pump Station
- Intake
- Inactive Intake
- Storage Tank
- Pressure Reducing Valve
- Existing Watermain
- Service Boundary
- Un-irrigated Park Space

Figure No:
Figure 5.1

Project No: 60216671	Date: September, 2012
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**District of West Kelowna
Water Utility Master Plan**

**Water Distribution With
Proposed Upgrades**

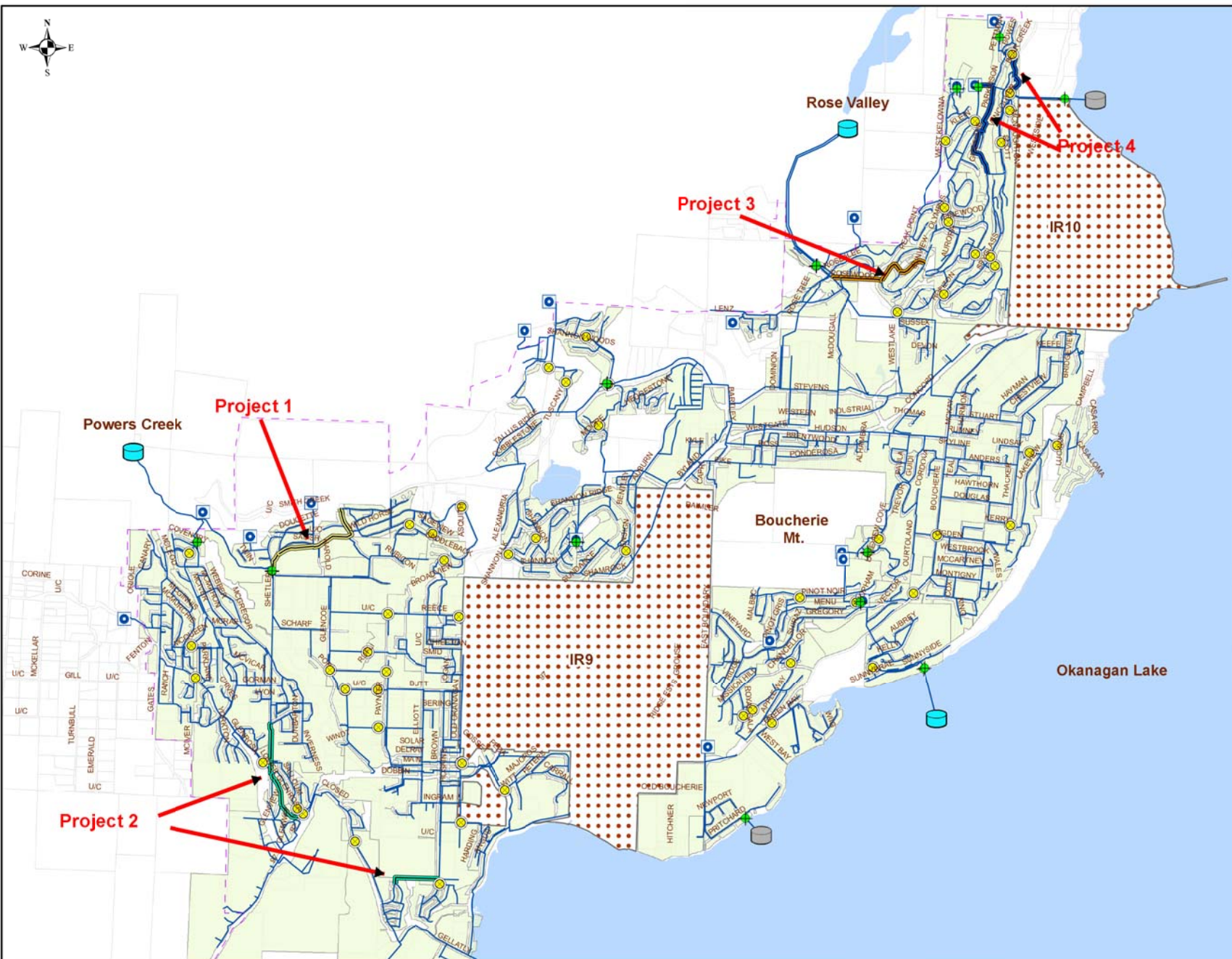
**Proposed Watermain Upgrades
(2032 Demand Condition)**

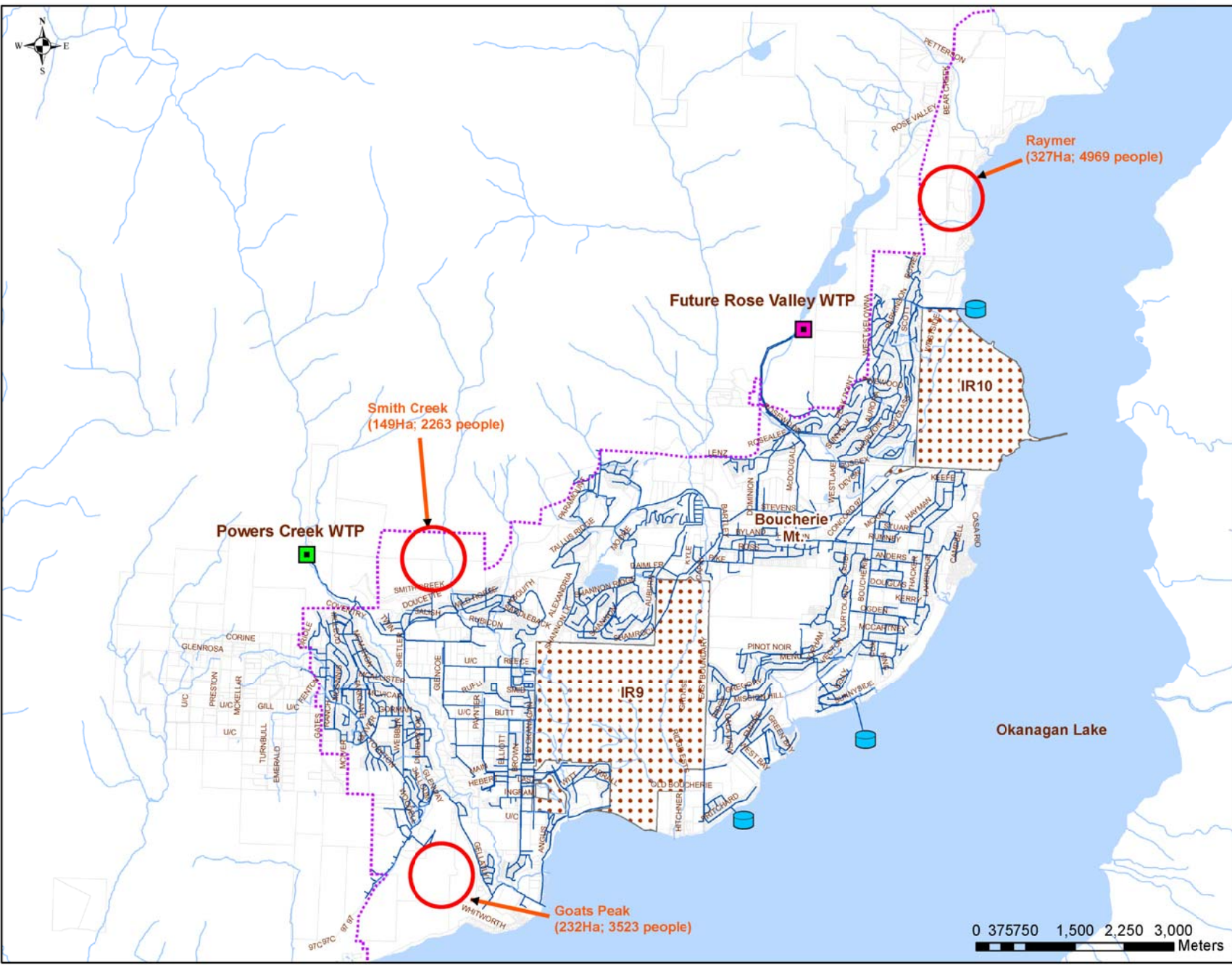
Legend

- Pump Station
- Intake
- Inactive Intake
- Storage Tank
- Pressure Reducing Valve
- Existing Watermain
- Service Boundary
- Un-irrigated Park Space

Figure No:
Figure 5.2

Project No: 60216671	Date: September, 2012
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**District of West Kelowna
Water Utility Master Plan**

**2032 Expansion
Growth Locations**

- Legend**
- Future Water Treatment Plant
 - Existing Water Treatment Plant
 - Intake
 - Existing Watermain
 - Streams
 - - - Service Boundary

Figure No:
Figure 5.3

Project No: 60216671	Date: September, 2012
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District of West Kelowna Water Utility Master Plan

Water Distribution System Existing Pressure Zone

Legend

- Pump Station
- Intake
- Storage Tank
- Pressure Reducing Valve
- Service Boundary
- Existing Watermain
- Streams
- Un-irrigated Park Space

Figure No:

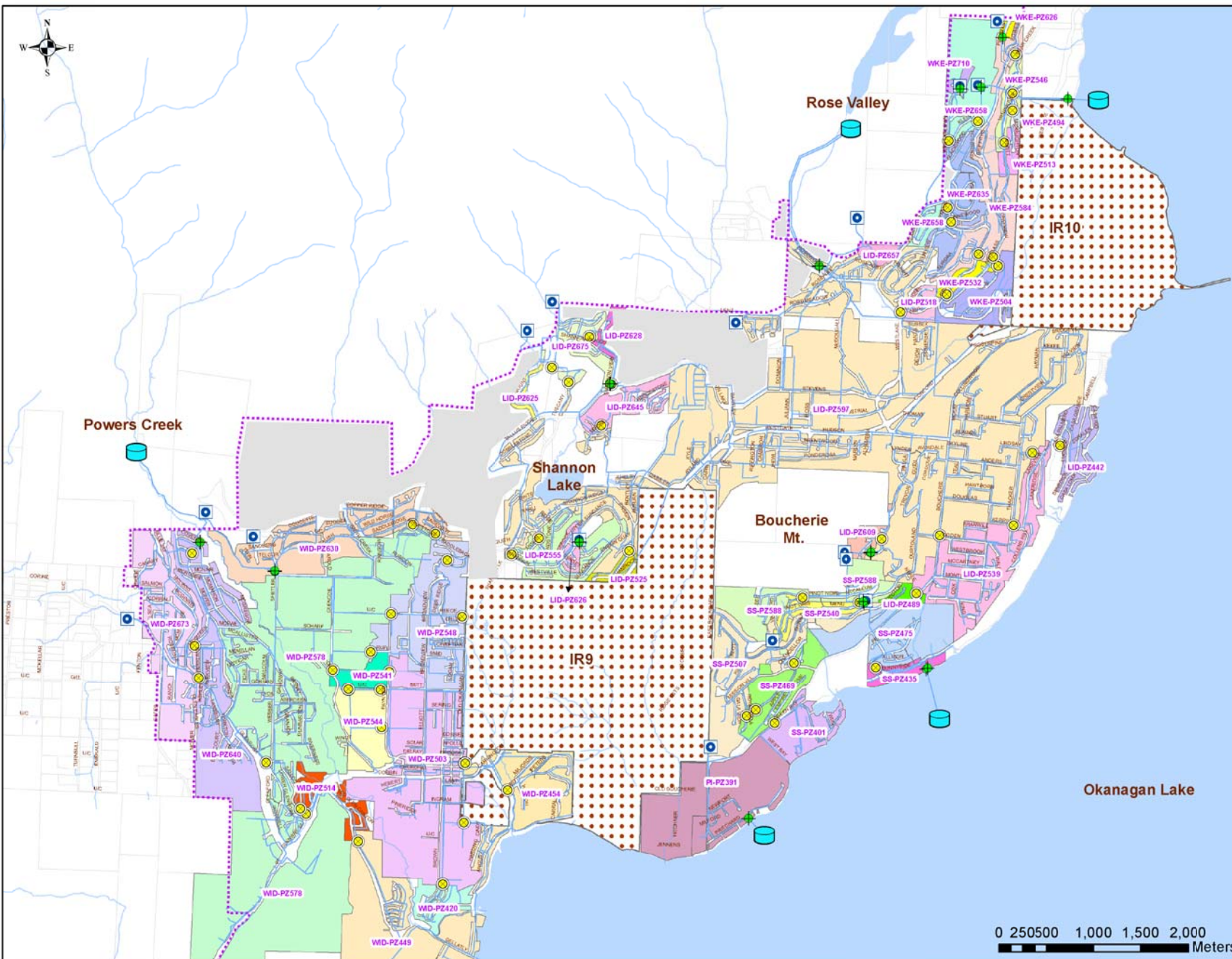
Figure 5.4

Project No:

60216671

Date:

September, 2012



0 250500 1,000 1,500 2,000
Meters



**District of West Kelowna
Water Utility Master Plan**

**Water Distribution System
Proposed Pressure Zone**

Legend

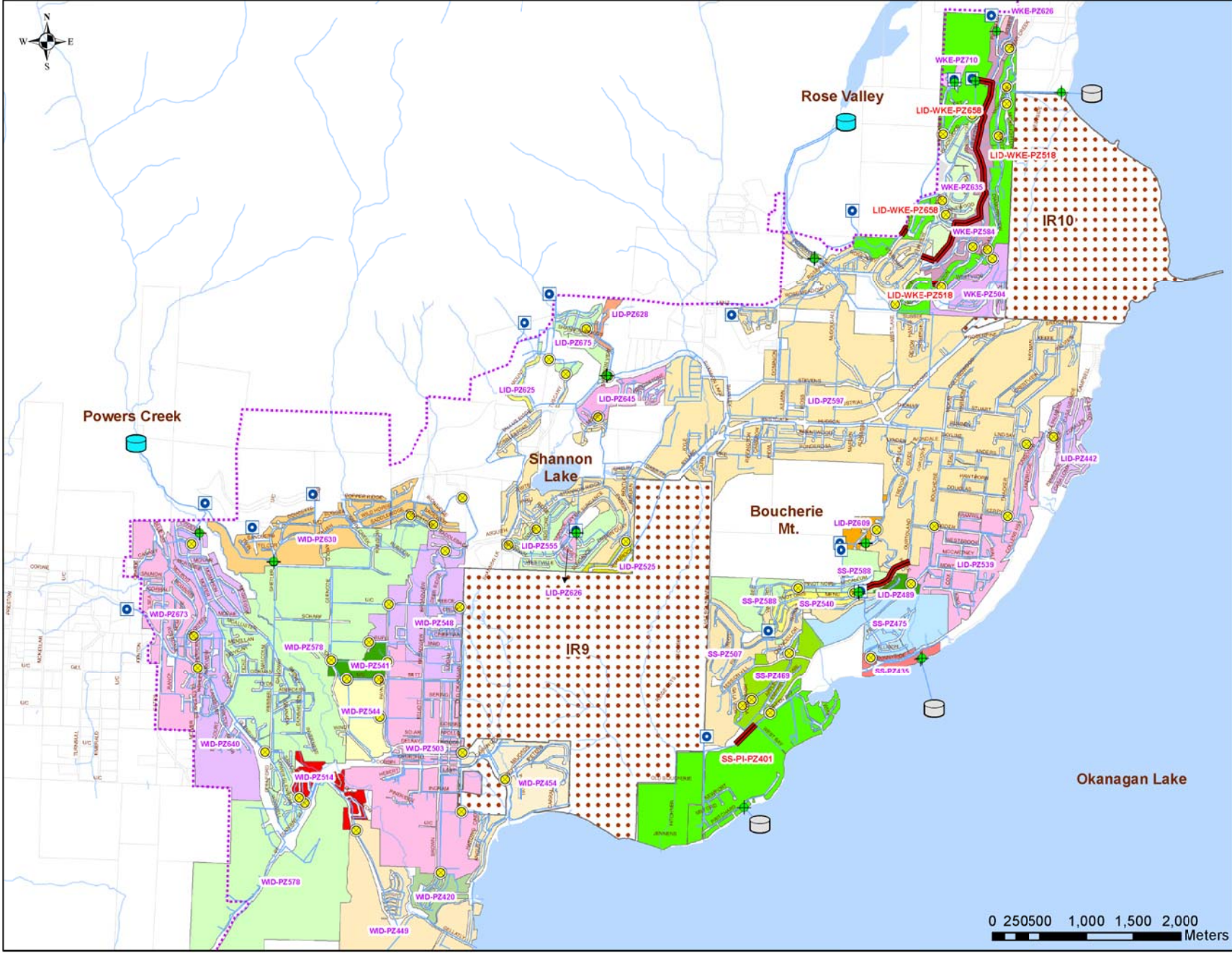
- Pump Station
- Inactive Intake
- Intake
- Storage Tank
- Pressure Reducing Valve
- Service Boundary
- Proposed Transmission Main
- Existing Watermain
- Streams
- Un irrigated Park Space

Figure No:
Figure 5.5

Project No: 60216671	Date: September, 2012
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0 250500 1,000 1,500 2,000
Meters



5.4 Distribution System Pump Station Capacity

The pumps represented in the model were only the distribution system's pumps. Intake pumps were not incorporated in the model and were subsequently not part of the pump capacity assessment. All of the hydraulic information for the pumps was obtained from existing hydraulic models. The information available in the model included pump diameter, power, design head, design flow, and/or pump curve.

All the distribution pumps in the DWK's water system network function concurrently with the tanks to deliver the required total water demand to the specific pressure zone(s) they service. The base assumption for the review of the DWK water system is that each storage tank is designed to meet the balancing (ie., fluctuation in daily water demand), fire, and emergency water demand for the zone(s) it is servicing. More detailed explanation about the three different storage components of a storage tank is provided in the next section of this report. The key assumption associated with ensuring the balancing tanks within the distribution network are adequately sized is that the pumps are designed to supply the MDD of the pressure zone(s) being serviced.

A pump capacity assessment was conducted based on the pump information available along with the calculated MDD for each pressure zone throughout the existing to 2032 demand scenarios. However, as noted earlier, some of the pumps incorporated in the model only had design point (flow vs. head) or power information. The pumps with limited information are listed below in **Table 5.1**. For pumps where available information is limited, it is recommended that head points are collected at a minimum 3 flow allowing for the annual performance of the pumps to be tracked and a more detailed assessment of the pump capacity determined.

Table 5.1 - Pumps Versus Service Zone MDD

PS Name	Information Available	Design Point		Existing MDD (L/s)	HGL Diff. - Feeder & Receiving Zones (L/s)
		Flow (L/s)	Head (m)		
Rosewood	Constant Power	NA	NA	2.14	60
Lakecove	Constant Power	NA	NA	3.94	12
Blackwood	Design Point	60	95	27.84	74
WKE PS	Design Point	110	265	54.77	244
McPhail	Design Point	45	55	0.68	52
Pettman	Design Point	1.25	45	0.33	42

As can be observed from the table above, most of the design point information is relatively off from what is required to meet the zone's MDD and/or HGL conditions. Further investigation is required to update this information and subsequently assess the capacity of these pumps.

The rest of the distribution pumps were assessed under the existing and 2032 conditions based on the current pressure zones as well as the adjusted Pressure zone boundaries. Under the adjusted pressure zone boundaries, there are four (4) pump stations to be decommissioned. The pump stations are the Okanagan Lake Intakes at West Kelowna Estates, Sunnyside and Pritchard as well as Blackwood pump station. This condition will in turn save the Operation and Maintenance costs and any future upgrades associated with these four pump stations. In addition to abandoning a few pump stations there are other facilities that need to be upgraded. The pump stations that required upgrades are listed in **Table 5.2**.

Table 5.2 - Pump Upgrade Requirement

PS Name	Current Capacity (L/s)	MDD (L/s)		Pump Capacity Requirement (L/s)	
		Existing	2032	Existing	2032
Menu - Lower Zone (to service SS-PZ2-507)	108	128.17	135.65	130	140
Lateral	120	77	145.18	-	150

Additionally, with the Adjusted Pressure Zone boundary, there is a need to have a new booster pump to feed Blackwood tank from Lakeview zone under the 2032 demand conditions. A pump with a capacity of 200 L/s and head of 10m would be required.

5.5 Hydrant Analysis

A key component to fighting a fire using the water supply distribution network is the availability of hydrants. The DWK bylaw does not specifically address hydrant spacing rather it emphasizes the need to be compliant with the Fire Underwriters Survey (FUS). The requirements of the FUS for hydrant spacing are:

- 90 m for commercial, industrial, institutional and multi-family residential areas; and
- 180 m for single family residential areas.

Using the hydrant locations from the hydraulic model, GIS analysis was completed to determine locations where there are no sufficient hydrants in the existing land-use. Based on this analysis it was determined that 174 new hydrants are required throughout the distribution network to meet the requirements of the FUS.

It is assumed that any re-zoning within the existing service area resulting in the need for more hydrants will be addressed by the development proponent. This same assumption is assumed to be valid for new development. This means all the hydrant deficiencies identified are based on the existing system requirements.

Figure 5.6 shows the existing and required hydrants locations across the DWK. It is assumed that a detailed site investigation will be completed for each hydrant prior to installing the unit.



District of West Kelowna Water Utility Master Plan

Hydrant Coverage

Legend

- Existing Hydrant
- Proposed New Hydrant
- Intake
- Service Boundary
- Streams
- Existing Watermain
- Multi Family and ICI Hydrant (Max. Separation: 90m)
- Single Family and Ag. Hydrant (Max. Separation: 180m)
- Un-irrigated Park Space

Figure No:

Figure 5.6

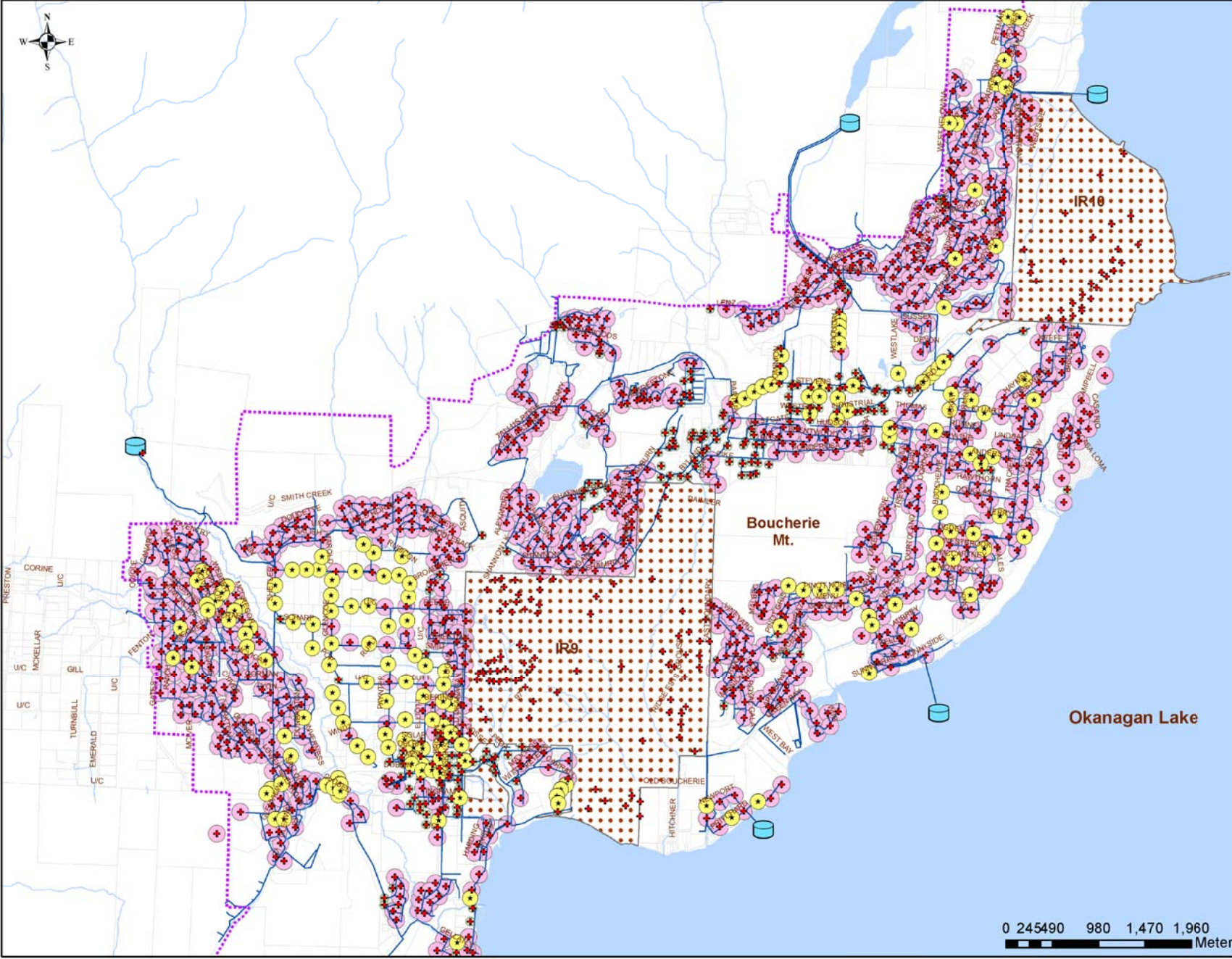
Project No:

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Date:

September, 2012

0 245490 980 1,470 1,960
Meters



5.6 Storage Assessment & Deficiencies

It is a common industry practice to include at least three distinct components of storage in the design of reservoirs. These storage components are presented in **Table 5.3**.

Table 5.3 - Treated Water Quality Goals

Parameter	Storage Volume (m ³)	Purpose
Balancing Storage	25% of the MDD	Balancing storage will allow the treatment facilities, transmission mains, and pump stations to be designed to meet or exceed the MDD, as the balancing storage is used to “shave” spikes in demand.
Fire Storage	Single and Dual Residential Multi Residential Institutional Industrial/Downtown Light Commercial & High Residential	Fire storage is the volume reserved in the reservoir at all times to fight fires in the service area. The Fire Underwriters Survey establishes guidelines for determination of fire flow and storage requirements under a variety of scenarios
Emergency Storage	25% of (Balancing Storage + Fire Storage)	Emergency storage is for covering interruptions to the supply.

In order to prevent transients in the system caused by valves opening and closing, it is standard practise to limit the passage of fire flow to one pressure reducing station. This means that in an area with as much variation in elevation as the DWK, it is important to have as few pressure zones as possible to avoid having duplicate fire storage.

Currently the water distribution system in the DWK is made up of roughly 45 pressure zones, many of which are at the same or somewhat similar hydraulic grade lines (HGL). This is primarily due to the amalgamation of the five former irrigation DWKs that previously operated independently. Consolidating pressure zones that are close to the same pressure as well as shifting pressure zone boundaries could greatly reduce the fire storage requirements. Emergency storage, as a function of balancing storage and fire storage, would also be reduced by one quarter the amount of the fire storage reduction, further reducing overall storage. **Table 5.4** shows the fire storage requirements under the current pressure zone configuration, and also shows where these requirements could be reduced by adjusting and combining pressure zones under an optimized scenario when pressure zones were consolidated and boundaries are modified. Estimates for the construction of storage facilities are based on a unit rate of \$500/m³ for new construction as per Section 3.

Table 5.4 - Reservoir Storage Assessment

Service Area / Pressure Zone	Local MDD (L/s)	Total MDD (L/s)	Balancing Storage (m³)	Fire Storage (m³)	Emergency Storage (m³)	Required Storage (m³)	Existing Storage (m³)	Shortfall (m³)
Lakeview PZ675	15.25	34.20	739	648	347	1,733	5,068	0
Lakeview PZ645	9.87							
Lakeview PZ628	4.56							
Lakeview PZ625	4.52							
Lakeview PZ658	2.48	2.48	54	0	13	67	974	0
Lakeview PZ597	462.44	503.09	10,867	2,430	3,324	16,621	4,440	12,181
Westbank PZ5626	5.22							
Westbank PZ555	24.23							
Westbank PZ525	4.99							
Westbank PZ518	6.21							
Lakeview PZ539	58.11	75.55	1,632	648	570	2,850	0	2,850
Lakeview PZ489	2.88							
Lakeview PZ442	14.56							
Lakeview PZ610	4.39	4.39	95	432	132	659	455	204
Sunnyside PZ588	12.36	20.52	443	648	273	1,364	1,500	0
Sunnyside PZ540	8.16							
Sunnyside PZ503	41.29	115.95	2,505	2,430	1,234	6,168	1,964	4,646
Sunnyside PZ469	18.84							
Sunnyside PZ401	55.82							
Pritchard	16.38							
Sunnyside PZ 475	14.95	19.70	426	432	214	1,072	266	806
Sunnyside PZ435	4.75							
Westbank PZ673	45.59	93.21	2,013	432	611	3,057	1,946	1,111
Westbank PZ640	47.62							
Westbank PZ630	145.18	145.18	3,136	432	892	4,460	1,000	3,461
Westbank PZ583	220.83	329.46	7,116	2,430	2,387	11,932	8,000	3,932

Service Area / Pressure Zone	Local MDD (L/s)	Total MDD (L/s)	Balancing Storage (m ³)	Fire Storage (m ³)	Emergency Storage (m ³)	Required Storage (m ³)	Existing Storage (m ³)	Shortfall (m ³)
Westbank PZ548	69.48							
Westbank PZ544	28.39							
Westbank PZ541	1.15							
Westbank PZ516	9.61							
Westbank PZ503	119.27	333.51	7,204	2,430	2,408	12,042	0	12,042
Westbank PZ454	25.89							
Westbank PZ449	178.40							
Westbank PZ420	9.95							
WKE PZ710	1.09	1.09	24	432	114	569	0	569
WKE PZ626	0.61	0.61	13	432	111	556	11	545
WKE PZ584	29.42	182.14	3,934	648	1,146	5,728	818	4,910
WKE PZ546	143.79							
WKE PZ532	5.66							
WKE PZ513	2.74							
WKE PZ494	0.53							
WKE PZ504	15.18	15.18	328	432	410	1,170	0	1,170

The Westbank Service Area is currently deficient of storage. The main storage for the Westbank Service Area is an 8,000 m³ reservoir at Powers Creek Water Treatment Plant. The reservoir has a TWL of 583 m which feeds directly into PZ583. The following storage deficiencies include:

- Additional storage is required in PZ583 to provide flows to PZ548, PZ541, PZ544, and PZ516.
- A reservoir is required in PZ503 to feed PZ420, PZ454 and PZ449.
- The upper pressure zones PZ673 to PZ630 both require additional storage.

There are a few scenarios that could be implemented in the Lakeview service area to reduce fire storage:

- Combine Lakeview PZ657 with WKE PZ658 which are within one metre of the same HGL; this would reduce storage required by 540 m³.
- Install transmission mains directly from PZ597 to zone PZ442 and PZ489, storage requirements would be reduced by 648 m³.
- PZ626 is at HGL 597 m and currently treated a part of PZ597, which means it will not require its own fire storage. If PZ626 is actually at HGL 626 m, it will then need a new storage tank with 648 m³ of fire storage.
- PZ675 feeds PZ625, PZ628 and PZ645, and there is excess storage in these zones which should be considered a deficiency as water is being pumped from PZ597 to PZ675 then returning to PZ597. Operational costs need to be compared to the value lost by abandoning a reservoir.

There are areas within the Lakeview Service Area where high static pressures are encountered. This pressure exceeds the bylaw pressure requirement, but the existing distribution system has functioned under this condition for many years without major issues. In consultation with the DWK, it was decided that the existing areas where the maximum static pressure within PZ597 is 1,100 kPa (160 psi), no changes will be made. This decision is based on the analysis that the cost to reduce the pressure in PZ597 will be far higher than the value of the operational benefit.

West Kelowna Estates Service Area has many pressure zones with moderate incremental HGL steps. The zones with a HGL lower than 597 m can be fed from the Lakeview Service Area without any pumping. The modifications proposed to the distribution system within West Kelowna Estates are:

- A connection could be implemented between PZ584 and PZ597 in the Lakeview Service Area.
- The lower section of PZ584 could be removed and combined with PZ546, PZ489, PZ513 and PZ532 all at a HGL of 535 m.
- This new zone, PZ535, could be combined with the old Lakeview PZ518, assuming the HGL of this zone has been increased to 535 m as discussed above.
- Fire flows for the new PZ535 could come from Lakeview PZ597, reducing the storage requirements within WKE from 6,600 m³ to 5,300 m³, saving \$675,000 on storage.
- PZ504 will need to remain at its current HGL and zone boundaries and will require its own fire storage unless it can be connected through a PRV to Lakeview PZ597 (the table above assumes this was not done).
- The tank at McPhail will need to be enlarged to serve PZ635 and PZ658.
- The two highest pressure zones in the West Kelowna Estates Service Area, PZ626 and PZ710 will each need their own fire storage.

The three reservoirs in the Sunnyside Service Area are positioned fairly well for fire storage but there are some long term challenges. The Mission Hill tank is currently providing storage for PZ401 which means fire flow is going through two PRVs; the Menu Road tank is too small to provide even a single family fire storage; and there is no tank to provide storage to any new developments at elevations higher than the currently developed areas of Sunnyside. The suggested approach to revise this is to complete the following:

- Combine pressure PZ401 with Pritchard by raising the HGL of Pritchard to 401 and build reservoir storage for this new pressure zone;
- Increase the capacity at Mission Hill to provide storage for PZ507 and PZ469; and
- Increase the capacity at Menu Road to provide storage for PZ475 and PZ435.

The result would be reducing the combined fire storage requirements of Pritchard and Sunnyside from 5,240 m³ to 4,590 m³, by not having to build fire storage for PZ401 and Pritchard separately. This reduces the total storage required for both DWKs from 10,900 m³ to 10,130 m³ which at \$500 per cubic metre works out to a difference of \$405,000.

Storage volumes calculated for the Sunnyside Service Area vary from previous calculations for several reasons. The MDD for the Sunnyside Service Area was increased from 12.05 ML/d to 12.71 ML/d to account for additional agricultural land. Future demand was further altered by a more accurate projection of where population growth will occur in the DWK. Also, the fire storage has been increased from past calculations in order to limit fire flows to passing a single PRV. Finally, the new calculations assume that fire flows for the Pritchard Service Area will come from the Sunnyside Service area. Due to the altered assumptions above, greater storage volumes are required to supplement Mission Hill and Menu Road, new storage is required in PZ401 and Boucherie Reservoir will have sufficient storage for the next 50 years.

The capital cost of all the pressure zone changes discussed in this section can be offset by the savings in storage tank construction. **Table 5.5** shows the current storage capacity of the DWK; the current storage requirements; the storage requirements based on population growth patterns; and corresponding capital cost to construct the additional storage.

Table 5.5 - Storage Requirements and Cost

Service Area	Current Storage Capacity (m ³)	Current Storage Requirements (m ³)	20 Year Storage Requirements (m ³)
Lakeview	7,602	20,833	21,930
Sunnyside / Pritchard	3,510	10,125	10,396
Westbank	10,946	26,050	31,492
West Kelowna	1,821	6,236	10,190
Total	23,879	63,244	74,008

6. Water Conservation

6.1 Benefits of Water Conservation

The Okanagan region has historically been one of the highest per capita consumers of water in Canada. For example, the water rate study conducted for the former Westbank Irrigation District by AECOM in 2009 observed that per capita domestic water consumption in the Westbank Irrigation District service area was about 37% higher than the Canadian national average¹. One of the reasons for this high level of water consumption is that until recently, the Okanagan has had access to exceptional sources of clean water at a very low cost of service. As planning advances to expand the use of water treatment facilities, there are considerable potential cost savings should the DWK take an aggressive approach to implementing state of the art water conservation strategies.

Water conservation offers many benefits to a water utility, including delaying or avoiding capital expenditure on source expansion, decreasing operating costs, avoiding environmental impacts and obtaining public recognition and participation. In addition, water conservation could present certain “co-benefits”, such as reductions in the energy required to treat and distribute drinking water and to collect and treat wastewater. AWWA Manual No. M52 on Water Conservation Programs¹ provides the following benefits of water conservation:

- Operations and maintenance cost savings by reducing the volume of water treated
- Future cost savings through deferral of capital investment as a result of population growth and expansion
- Environmental benefits: less water could be removed from the environment for human purposes
- Competing beneficial uses: more water could be available for competing beneficial uses such as agriculture, or recreation.
- Stewardship: utilities that conserve water demonstrate leadership in resource management.
- Regulatory compliance: some governmental/regulatory agencies require water conservation plans to qualify for permits, grants and loans.
- Public perception: the public often insists on a demonstration of efficient use of existing water supplies before supporting expansion of supplies to meet new water needs.

More information about the water conservation is included within **Appendix G**.

6.2 Water Conservation Measures

6.2.1 Water Distribution System Improvements – Water Loss and Leak Detection

Since the recent implementation of universal metering, the DWK can now estimate water losses seen in their distribution system. Based on source production and metering data received from the DWK, the unaccounted for water can be calculated at approximately 29% of total flows as seen in **Table 6.1** below. The source meter data indicates a different level of unaccounted for water than the water service meters. This would indicate some error in the water meters, but given the number of sources of flow meters this should be expected and can be refined in the future as existing flow meters are able to be replaced and recalibrated. Nevertheless, the unaccounted for water within the water distribution network is in the order of 25 – 30%.

Table 6.1 - Source and Meter Flow Volumes – 3rd Quarter 2010 to 2nd Quarter 2011

Total Flows – Sources (ML)	Total Flows – Meters (ML)	Δ (%)
9,488	6,749	2,739 (29%)

¹ Final Report: Westbank Irrigation District Water Rate Study, AECOM, 2009

Given the apparent high percentage of water loss, it would be beneficial for the DWK to assess the type of losses – apparent or real – and implement programs to reduce these losses. Leakage on water systems can be difficult to identify or detect. Water system pipelines are generally buried and leaks do not generally appear at the ground surface until they become large or are in poorly draining soils. The following are three recommended steps for a targeted leak detection and repair program.

- Further quantify the losses by completing a more detailed water balance.
- Establish a water loss target based on the value of water that is specific for the DWK.
- Find the leaks and complete the repairs.

6.2.2 Consumption-Based Metering and Billing

All domestic water customers within the DWK are metered and are charged water rates that are based on actual water consumption. This reflects the basis of a “user-pay” system whereby consumers that use more water will pay more than consumers who use less water.

Consumption-based billing was first implemented in the Westbank Service Area after the former Westbank Irrigation District commissioned a water rate study in 2009 prior to increasing water rates. This increase was primarily related to the need to pay for the costs of constructing the 54 ML/d Powers Creek Water Treatment Plant. In 2011, DWK council supported implementation of consumption-based rates for the former Lakeview, West Kelowna Estates and Pritchard Service Areas. The former Sunnyside Service Area implemented revised metered rates at this time.

While a simple volumetric water billing system will assist water conservation efforts, there are stronger financial incentives available to assist water conservation efforts especially at peak times. If DWK wishes to promote higher levels of water conservation through financial incentives, increasing block water rates that price incremental blocks of water at higher rates than previous blocks have been proven effective in reducing water consumption, especially at the single family detached household level. Increasing block rates target summer lawn sprinkling and other outdoor water use so that peak demand is reduced. The expanded use of higher block rates is an option for DWK in its efforts to reduce water demand closer to national averages.

6.2.3 Reducing Wasted Water

The reduction of water waste was one of the first methods of water conservation as these initiatives were typically the least expensive and easiest to implement. In the 1970s, this included auto-sensors in factories to turn off water when production lines were not in use, elimination of single-pass cooling, re-use of non-contact cooling water and low-flow toilets. These measures were low-technology and had a short pay-back period. Today, water waste reduction efforts employed in municipalities include:

- Low-flow fixture requirements on new construction;
- Irrigation system requirements on new construction.

6.2.4 Codes and Standards

Many provinces, including British Columbia have written-in water efficiency strategies in their building code regulations. In BC, *Living Water Smart* (<http://www.livingwatersmart.ca/message.html>), the province's Water Plan, sets out principles, targets and actions to support water management in BC. Part of this Water Plan includes revisions to the BC Building Code (Fall 2008) which now mandates minimum water efficiency requirements for fixtures.

Some municipalities are also taking the initiative to adopt water efficiency bylaws. For example, the cities of Edmonton and Calgary have passed by-laws mandating water-efficient toilets and low-flow showerheads in all

new residential developments. The City of Kelowna currently requires all homes constructed after 1994 to have low flow toilets and requires a Landscape Water Conservation report to be submitted prior to approval on all new residential and commercial irrigation system installations. It is recommended that the DWK gather feedback from Kelowna on the effectiveness of this program. If the program has proven successful in Kelowna, it may be worth considering within DWK.

6.2.5 Public Education

While the financial benefit of public information and education programs are hard to quantify, these programs are critical to building the conservation ethic in water customers. Some examples of public education initiatives are outlined below.

- Towel Use Signs for Hotels/Motels: Production of a laminated sign requesting patrons to hang towels on racks for re-use or throw them in the tub to request replacement.
- Information Booths at Community Events: Distribute brochures, fridge magnets, dye tablets for leaking toilets and water-saver kits.
- Water Audit Workshops for Large ICI Water Users: ICI and Agriculture represents 33% of the DWK's water consumption. Within this water use sector there are often a few large users that have a noticeable impact on overall water demand. Reducing their water use or shifting their water use to lower demand periods can have a meaningful impact on the DWK's maximum day demand. Identify the largest water uses and invite them to a free water audit workshop where they can learn how to reduce their water consumption.
- Information to Local Landscaping and Irrigation Companies: Distribute information about water-wise gardening and water restrictions to local landscaping and irrigation companies.
- Schools: Develop programs for schools such as a poster contest, water conservation curriculum guides and videos to promote water conservation to young people.

6.3 Existing DWK Water Conservation Strategies

6.3.1 Consumption-Based Metering and Billing

As discussed above, since 2011, consumption-based billing has been implemented in all Service Areas. This program should be continued. If water conservation efforts fail to meet expected targets, DWK should examine the expanded use of increasing block rates to provide further incentives for customers to participate in water conservation efforts.

6.3.2 Watering Restrictions

Currently, the DWK limits outdoor water use through sprinkling regulations. Throughout the irrigation season, Stage 1 Sprinkling Regulations are in effect, permitting outdoor sprinkling at non-agricultural properties based on property address and odd/even calendar days. Subsequent sprinkling regulations from Stage 2 – 4 are imposed when deemed necessary, with Stage 4 prohibiting outdoor water use for any purpose. Since the implementation of these regulations, the DWK has seen a reduction in peak flows and overall consumption.

6.3.3 Education

6.3.3.1 Okanagan Basin Water Board – Waterwise Initiative

The DWK is a partner in the Okanagan Basin Water Board's (OBWB) Waterwise Initiative. This initiative aims primarily to educate residents of the Okanagan Valley about water issues in our region. This includes promoting water conservation and protecting water quality. There are also tips on how to conserve water in the home, yard and business. The Waterwise website is easily accessed through a link on the DWK website.

6.3.3.2 DWK Website

The DWK website's "Conservation" section provides water conservation tips for residents in the home and yard and also provides details on reading residential water meters.

6.4 Recommended Water Conservation Initiatives

This section describes recommended water conservation measures that the DWK could employ in addition to the measures that they have already undertaken.

6.4.1 Water Loss Management & Leak Reduction

- Complete a water balance assessment based upon standards agreed upon as Best Practices by the AWWA and the International Water Association (IWA). Now that all domestic water accounts are metered, the data should be available to support this important effort. The output of the water balance assessment will quantify real and apparent water losses within the system in order to ascertain that actual volume of water leakage.
- Identify the acceptable level of leakage in the DWK water system (based on economic level of leakage or water demand management criteria) and move forward with a leak detection program if the acceptable level is being exceeded.
- Repair identified leaks as soon as they are identified; and
- Consider implementation of a pressure management within the DWK as a means to reduce overall leakage volumes.

6.4.2 Residential Water Conservation Initiatives

- Consider implementation of rebate programs for residents to replace existing low-efficiency fixtures low-flow models.
- Consider developing a bylaw mandating water-efficient toilets and low-flow showerheads in all new residential developments.

6.4.3 Industrial, Commercial, Institutional and Agricultural Audits and Workshops

- Identify the largest ICI and Agricultural water users by using metering data.
- Hold a free water audit workshop where these users can learn how to reduce their water consumption.
- Communicate to these customers how much they have historically spent on water, their impact on overall municipal water demand and how they can take steps to reduce their water consumption and reduce total peak demands.

6.4.4 Water Efficiency Bylaws

- Consider implementation of bylaws mandating water-efficient fixtures in all new developments including low-flow fixtures.

6.4.5 Customer Education Programs

- Consider customer education programs at schools, community events, and commercial users (landscape companies, hotels/motels).

7. Asset Inventory Review

The DWK of West Kelowna owns and operates water system infrastructure with a replacement value of approximately \$175 million. This inventory requires maintenance, and in the future will require renewal or replacement due to deterioration. Deterioration rates of water assets can vary greatly depending on physical and environmental factors including pipe material, age, size, installation techniques, pipe bedding, backfill, soil time and climate. Operational factors including pipe utilization, flow velocities, chemical/physical composition of flow and O&M practices also affect the rate of deterioration.

This portion of the Water Master Plan presents base data that can be used for renewal forecasting and to begin considering strategies that are appropriate for DWK in terms of asset management.

7.1 Inventory of Assets

An accurate and current asset inventory is an essential foundation for conducting asset management.

The following list outlines the major assets in the DWK water treatment and distribution system. Upland assets including minor items not mentioned here are described in further detail in Section 3 and **Appendix D**. Assets are grouped by Service Area for simplicity.

7.1.1 Westbank Service Area

- Upland Assets
 - Tadpole Lake and Headgate
 - Dobbin Lake and Headgate
 - Horseshoe Lake, Dams (3) and Headgates (3)
 - Powers Creek Diversion Pipeline
 - Paynter Lake, Dams (3) and Headgate
 - Jackpine Lake and Headgate
 - Lambly Lake, Dam and Automatic Headgate
- Powers Creek Intake
- Powers Creek Water Treatment Plant & Clearwell
- Reservoirs
 - Evergreen
 - Glenrosa
 - Smith Creek
- Pump Stations
 - Elliot Road
 - Coventry Crescent
- 105.2 km of watermain

7.1.2 Lakeview Service Area

- Upland Assets
 - Esperon Lake, Dam and Headgate
 - Dunwaters Diversion
 - Big Horn Reservoir, Dam and Headgate

- Rose Valley Reservoir
- Lambly Creek Intake
- Rose Valley Chlorination Facility
- Reservoirs
 - Lakeview Cove
 - Shannon Way
 - Rosealee Lane
 - Tallus Ridge
 - Shannon Woods
- Pump Stations
 - Lakeview Cove Road
 - Rosewood Drive
 - Shannon Way
 - Shannon View Drive
- 112.5 km of watermain

7.1.3 Sunnyside Service Area

- Sunnyside Intake and Pump Station – Okanagan Lake
- Reservoirs
 - Upper Boucherie
 - Mission Hill
 - Menu Road
- Pump Stations
 - Menu Road
- 27.4 km of watermain

7.1.4 West Kelowna Estates Service Area

- WKE Intake and Pump Station – Okanagan Lake
- Reservoirs
 - Pettman
 - McPhail
 - Blackwood
- Pump Stations
 - Pettman
 - McPhail
 - Blackwood
- 28.9 km of watermain

7.1.5 Pritchard Service Area

- Pritchard Intake and Pump Station – Okanagan Lake
- Reservoirs
 - Pritchard Drive
- 3.1 km of watermain

Photos of the major Lakeview, West Kelowna Estates, Sunnyside and Prichard facilities are included in **Appendix H**.

7.2 Forecasting Asset Renewal Timing and Magnitude

Assets will fail as their condition deteriorates. For most DWK water infrastructure, and especially the underground assets, these assets will provide full service as their condition deteriorates until a certain point in time when they will totally fail. Without the benefit of conducting condition assessments on all assets, it is difficult to determine exactly when to replace an aging asset. Typically, asset condition assessments undertaken by utilities along with break and repair records, help to predict the rate of asset deterioration and their associated replacement date. They also assist in prescribing maintenance activities. DWK has not begun the process of conducting asset condition assessments, and while watermain break incidents have been recorded, currently there is not a standard approach for the documentation of the watermain condition.

In the absence of asset condition records, AECOM has utilized expected service life, along with the actual age and material of each asset as a proxy for condition in preparing a high level infrastructure renewal forecast. By comparing the asset installation date to the expected service life, the asset replacement date can be forecasted. This forecast was then enhanced with a current replacement value to forecast the future asset replacement budgets on a year to year basis in current dollars.

7.2.1 Condition Assessment & Estimated Renewal Requirements

Age and material data for completing the condition assessment was compiled from 2010 PSAB and TCA information received from the DWK. The PSAB/TCA information was compared to the existing EPANET model pipe data for verification of existing pipe lengths. It was observed that the PSAB/TCA data contained slightly less total length of watermain than the model data (approximately 2.5% less). While the model data is likely more accurate as far as total length, it does not include pipe age and material information, thus, the PSAB/TCA will be used to complete the forecast.

Experiences with similar assets within the Okanagan region have been used to predict life expectancies for the DWK asset types. These expected service lives are presented in the table below along with actual quantities of each asset type.

Table 7.1 - DWK Asset Quantities and Estimated Service Life

	Asset	Unit	DWK Quantity	Average Age (Years)	Expected Service Life (Years)	
Watermains	Asbestos Concrete (AC)	lm	69,157	36	85	
	Cast Iron	lm	3,589	42	80	
	Ductile Iron (DI)	lm	45,426	30	90	
	Galvanized Steel	lm	3,349	40	80	
	HDPE	lm	182	46	80	
	PVC	lm	120,873	15	80	
	Steel	lm	33,953	48	75	
	Service Connection – Domestic	ea	10,280	26	50	
	Service Connection – Agricultural	ea	219	33	50	
Facilities	Hydrants	ea	1,041	21	60	
	PRVs - Small	ea	37	21	60	
	PRVs - Large	ea	4	26	60	
	Booster Stations - Small	ea	10	19	60	
	Booster Stations - Large	ea	3	27	60	
	Reservoirs	m ³ of storage	17,313	22	75	
	Reservoir Piping & Valves (per reservoir)	ea	18	22	50	
	Lake Intake & Pump Stations					
		Structural	ea	3	24	100
		Electrical & Controls	ea	3	24	30
		Piping & Valves	ea	3	24	30
		Treatment Plant – Powers Creek				
		Clearwell	ea	1	4	75
		Structure	ea	1	4	75
		Process Equipment	ea	1	4	30
	UV Disinfection Equipment	ea	1	2	30	
	Chlorination Equipment	ea	1	4	30	
	Treatment Plant – Rose Valley					
	Facility	ea	1	34	50	
	Intake Structure	ea	1	34	100	
	Chlorinator	ea	1	32	30	
	Auxiliary Power Unit	ea	1	32	30	
Upland Assets	Powers Creek Intake Structure	ea	1	41	100	
	Powers Creek Diversion Pipeline	lm	1	9	60	
	Lambly Creek Intake Structure	ea	1	41	100	
	Lambly Creek Dam and Headgate	ea	1	41	125	
	Dunwaters Diversion	ea	1	1	125	
	Rose Valley Diversion Pipeline	lm	1	20	60	

	Asset	Unit	DWK Quantity	Average Age (Years)	Expected Service Life (Years)
	Big Horn Dam	ea	1	18	125
	Rose Valley Dam	ea	1	34	125
	Upland Dam and Manual Headgate	ea	9	36	125

Using the expected service lives and unit replacement costs for each asset, one can estimate when each asset needs to be replaced. The replacement timing for the linear inventory was estimated using a Weibull probability distribution function, which simulates the failure density of a pipe inventory. The basis of the Weibull distribution is that the failure rate of a large group of similar assets (such as watermains) can be accurately estimated due to the fact that we know not all watermains of a certain material will require replacement at the end of their service life; some mains will require replacement prior to their full service life, and some will last longer than their service life. This probability is represented by the Weibull distribution.

Replacement timing for vertical assets (hydrants, boosters, PRVs, pumphouses, intakes, reservoirs, treatment plants and upland assets) was calculated based solely on the installation year and end of expected service life.

Figure 7.1 shows the estimated annual watermain replacement cost by Service Area for the 50 year horizon. Note “DWK” includes the Sunnyside, West Kelowna Estates and Prichard Service Areas. The 25 and 50-year average replacement costs are also shown at \$396,000 and \$767,000, respectively. This means that over 25 years, an estimated average of \$396,000 per year will need to be spent to effectively manage replacement and renewal of the watermains, and also prevent backlog. The majority of current replacement requirements are located in the Lakeview Service Area, and are associated with the large quantity of steel watermain installed in the 1950’s. The graph also shows that replacement requirements begin to escalate around 2040, at the 30 year horizon.

Figure 7.1 - Watermains Anticipated Replacement Cost (by Service Area)

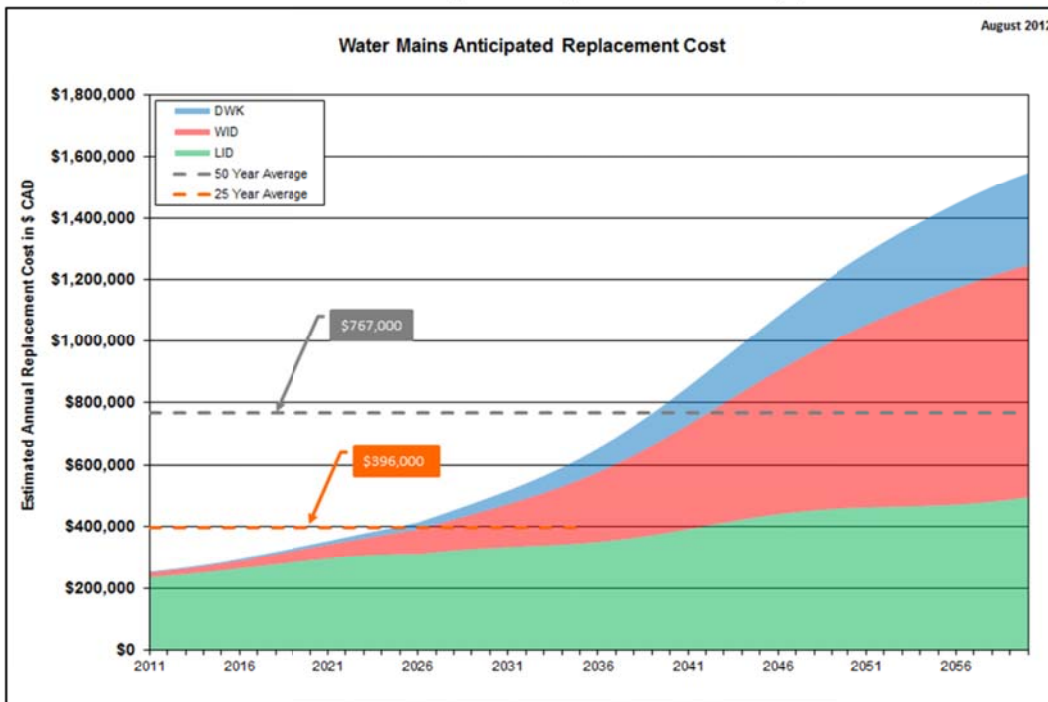
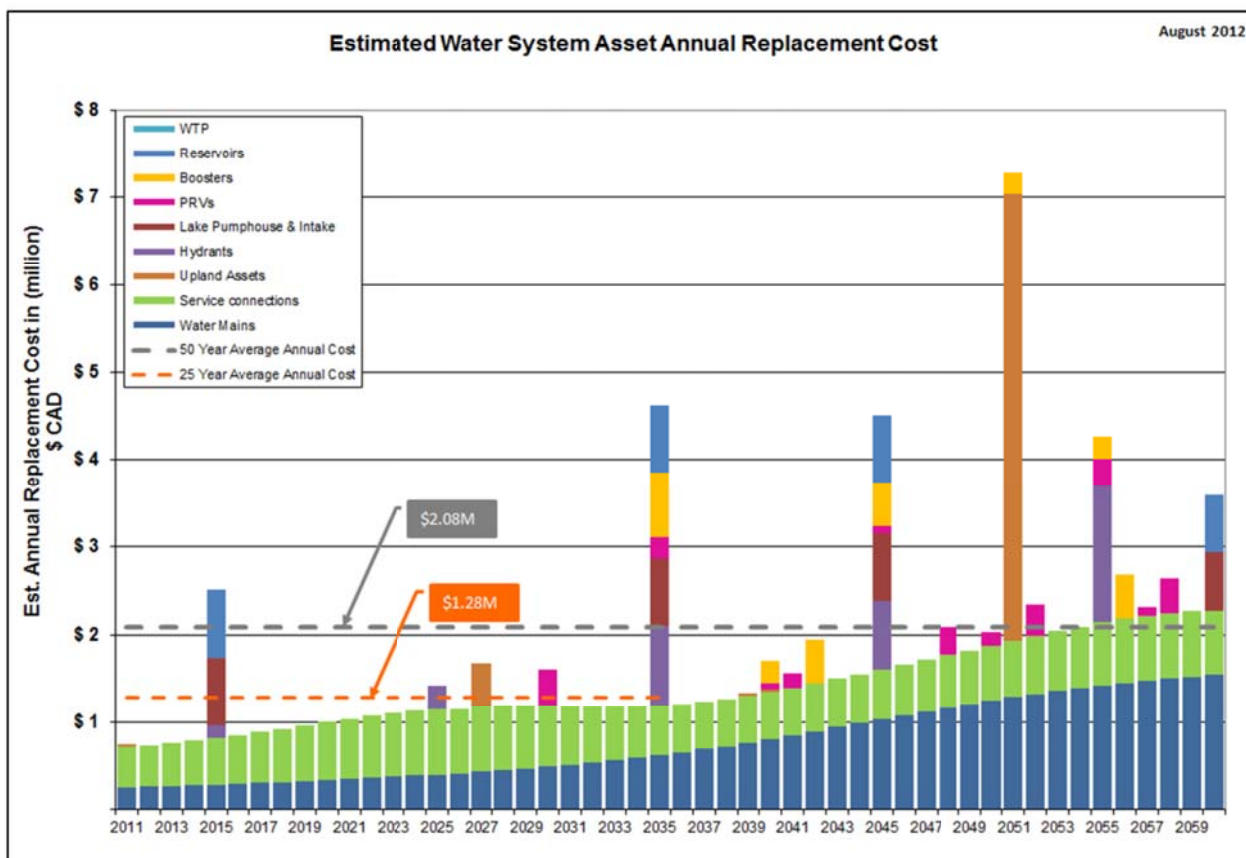


Figure 7.2 below shows the yearly estimated replacement cost for all water infrastructure owned by the DWK including linear and vertical assets. As seen in Table 8.1, major facilities including lake pumphouse and intakes, reservoirs, and treatment plants are further broken down by components including; process equipment, electrical, structural, etc. These components have varying expected service lives, and are treated as such. This variation in expected failure within a single facility can be seen in the “Lake Pumphouse and Intake” category; while the oldest lake pumphouse and intake is 26 years old (both West Kelowna Estates and Pritchard intakes were installed in 1985), the electrical components of those facilities have an expected service life of 30 years. The electrical components will be 30 years old in 2015, as seen in Graph 8.2.

For all water system assets, the 25-year average annual reinvestment requirements are estimated at \$1.28M per year. The 50-year annual average reinvestment requirements are estimated at \$2.08M per year.

Figure 7.2 - Water System Anticipated Replacement Cost



Graphs generated and costs prepared as part of this assessment are preliminary estimates that indicate the approximate cost magnitude of proposed asset replacement timing based on the industry accepted service lives. It is important to understand that the information displayed in these graphs is based on a number of assumptions and variables, and output results may be influenced by changes to input parameters.

From the data that is available, it is evident that DWK water system assets are still well within their expected life expectancies and at present do not currently represent a significant need for replacement. These projections can be used by management and councils to initiate discussion about renewal requirements and associated future funding needs. According to the 2012 Water Budgets received from the DWK, funds are currently being transferred to an infrastructure renewal reserve. This is a positive step that will ensure the DWK is well positioned to deal with water infrastructural renewal over the short and long term horizons.

7.2.2 Refining the Renewal Forecast with Asset Condition Data

The preceding renewal forecast was completed without using asset condition data. This is helpful in preparing a long term forecast but does not provide useful information in terms of setting asset maintenance and renewal priorities. Before DWK begins asset renewal planning, better information regarding DWK critical assets and critical asset condition will be required. DWK is therefore recommended to conduct a criticality assessment and then focus condition assessments and asset management strategies primarily on critical assets.

The following recommendations outline the basic method for completing criticality and condition assessments, which will allow the DWK to strategically plan for the maintenance, rehabilitation and replacement of water system assets.

1. *Undertake criticality assessments on DWK water system infrastructure to prioritize assets for condition assessment and renewal strategies.*

The intent of a criticality assessment is to answer questions such as “Which assets will have the greatest impact if a failure were to occur?” and “Which assets are most likely to fail?” by quantifying both the consequence of failure – who/what is affected by the asset failure, and the probability of failure – what is the likelihood the asset will fail under its current operating conditions. This allows municipalities to focus condition assessments on these assets before they fail.

2. *Consequence of Failure*

Determining the consequence of failure is a subjective process in which the municipality (operators, managers, council) must be heavily involved with the selection and ranking of parameters that drive failure impacts. Factors that affect criticality can be divided into four general categories including: economic; operational; social; and environmental influences. The parameters and factors must be ranked and weighted based on how a failed asset would affect the DWK. A few examples of factors and corresponding parameters are shown in **Table 7.2**, below.

Table 7.2 - Consequence of Failure Factors and Parameters

Factor	Parameter	Description
Economic – influence of the asset’s failure on monetary resources	Pipe size	Larger diameters may represent a higher cost to repair due to pipe cost and possible impacts to surroundings
	Material	Gauge of the relative costs for replacing a pipe of different material
	Accessibility	Identifies whether there are accessibility issues related to the pipe segment such as a pipe running underneath an existing structure
Operational – influence of the asset’s failure on operational ability	Redundancy	Identifies whether it is desirable to have redundancy at a location, so water delivery is maintained even if a pipe fails
	Flow Rate	Pipes with larger flow rates may represent a greater impact due to the loss of service of a greater number of customers
	Pressure	Loss of a pipe with higher pressure results in a greater impact to customers
Social – influence of the asset’s failure on society	Road Type	Interruptions on minor roads will have much less of an impact than interruptions on more significant routes
	Critical Customer	Identifies pipes that serve customers with a greater requirement for service reliability including emergency facilities, civic administration, schools, and recreation centers
Environmental – influence of the asset’s failure on the environment	Stream Classification	Identifies pipe proximity to different classes of fish-bearing watercourses
	Flow Rate	Pipes with larger flow rates may represent a greater impact due to the greater volume of runoff to streams

3. *Probability of Failure*

Probability of failure is based on four factors: age, estimated service life by material type (see Table 8.1), break history and pressure. **Table 7.3** describes these parameters. We understand that the DWK currently keeps paper records of main breaks and repairs, but these are not currently consolidated in a database. It is recommended that all historical and future break reports are recorded in DWK’s GIS database, so that information can be referenced for criticality assessments and other operational purposes.

Table 7.3 - Probability of Failure Factors

Factor	Description
Age vs. Est. Service Life	Provides an indication of the lifecycle stage of the asset; older assets are assumed to be in “worse” condition than newer assets of the same type
Break History	Identifies the number of breaks on a pipe segment as measure of the overall condition of the pipe
Pressure	Assesses the internal stresses imposed on the pipe

The system used to rank the factors associated with consequence of failure and probability of failure does not need to be complicated to be effective. A simple numeric, or “low-moderate-high” ranking system that can be duplicated from year-to year can provide an effective means of targeting further condition assessment efforts. Using results from the criticality assessment, assets can be ranked with respect to potential risk, and an educated decision can be made where to concentrate condition assessment efforts and corresponding maintenance and renewal activities.

4. *Direct condition assessments towards critical assets.*

Condition assessments involve the collection of data and information through various means to make a determination of the structural, operational and performance status of an asset. Data can be collected through direct inspection, observation and investigation, and indirect monitoring and reporting. Common direct condition assessment methods include visual inspection, pipe coupon sampling, electro-magnetic testing and acoustic testing. Condition assessments can also include failure analysis, which seeks to determine the cause of infrastructure failure in order to prevent future failures.

Determining the appropriate condition assessment techniques to employ is specific to each system. The method selected depends on many factors including: ease of access; pipe material and diameter; nature of information required; and suspected deterioration mode.

5. *Prioritize and ensure maintenance activities are undertaken on critical assets.*

It is unreasonable to assume that all possible preventative maintenance activities can be performed on every asset in the system, or even on all critical assets. Data collected during condition assessments will allow informed decisions to be made that help dictate what levels and types of maintenance or renewal techniques are performed in the system. In combination with continued preventative maintenance, this will maximize both the life of the asset and the effectiveness of the cost spent to perform maintenance activities.

Once DWK completes the criticality assessment and conducts a condition assessment program on critical assets, they will have the basis for a well planned asset renewal strategy whereby priority assets are being addressed. Given that DWK has begun planning financially for infrastructure renewal as of 2012, they will have begun taking responsible steps to ensure the integrity of the overall water system over the coming five year horizon.

8. Operation and Maintenance Assessment

As part of the incorporation of the new District of West Kelowna, the five smaller legacy water systems have been amalgamated into a larger utility operation. This resulted in the DWK recently merging the operations and maintenance (O&M) requirements of three former water utilities into a single organization. Staff and resources have now been realigned to ensure that all work can be completed in a reliable and cost effective manner.

The goal of an operations and maintenance plan is to ensure DWK water utility assets are being operated and maintained in a reliable and sustainable manner, and to ensure that potable water meets regulatory requirements. Adopting a proactive approach to managing maintenance, coupled with supporting policies, procedures, and systems, is the best approach to ensure the reliability, sustainability and safe operation of infrastructure assets. Well maintained assets reduce the risk of failure; regularly conducted preventive maintenance and inspections help identify problems before they become a serious and potentially costly issue, minimizing or eliminating consequences of asset failures when they do occur.

8.1 Current Organization and Operation of the Water Utility

Upon transfer of the former water irrigation DWKs to the newly formed DWK, efforts were made to amalgamate assets and staff in support of an efficient and effective transition. One aspect of this amalgamation was the management of assets such as yards, buildings, equipment and materials used for O&M of the utilities. In addition, staff and human resources were reorganized to support the new DWK.

8.1.1 Organizational Structure

Within the new water utility, there are approximately 7.9 full-time field employees (FTE = 2,080 hours per year) working on the distribution system, lake intakes and Rose Valley treatment facility; 1.75 field FTEs working at the Powers Creek Water Treatment Plant and 2.2 supervisory FTEs (managers and administration) overseeing the entire Water Utility.

To assess the current staffing levels of the DWK's water utility, a sample group of municipalities with similar populations was used for comparison. For each municipality, the number of Field FTEs and the annual water utility operating cost was normalized by total population. As seen in the table below, the DWK appears to be comparable, and likely on the low end for both number of field employees and annual operating cost when compared to the sample group. It should also be taken into consideration that at larger municipalities, some economies of scale will occur which will reduce these normalized values. Based on this information, it appears the current DWK water operations and maintenance staffing levels are adequate, and comparable with similar municipalities.

Figure 8.1 - Comparison of Unitized O&M Resources

Utility/Community	Population	km Watermain	2010 ML Treated	Total Field FTEs	FTEs/Population (,000)	Annual Water Utility Operating Cost	Annual Water Utility Operating Cost/Population
City A (Ontario)	23,800	155	7,172	9.8	0.41	\$ 3,570,000	\$150.00
District of West Kelowna	29,500	352	9,714	9.7	0.33	\$ 3,500,766	\$118.64
City B (BC/Okanagan)	62,600	404	14,603	18.0	0.29	\$ 4,697,850	\$75.00
City C (BC/Okanagan)	48,000	658	22,115	21.8	0.45	\$ 8,426,250	\$175.00

8.1.2 Yards & Equipment

After amalgamation, the decision was made to convert the former Lakeview Irrigation DWK Yard on Bartley Road to the new DWK Utilities Yard. The former Westbank Irrigation DWK Yard on Elliot Road was converted to the Roads and Parks department Yard. Today, there is little sharing of equipment or materials between Yards.

The Utility department’s Bartley Compound currently houses the following equipment, which is used only for water and sewer O&M:

- 1 backhoe (used to move sand around at the yards, rarely goes off-site)
- 1 tandem gravel truck
- 4 snowmobiles/quads/boat
- 15 fleet trucks used for the water utility
- Shop to store small tools, etc., with a drill press but no other major equipment

8.1.2.1 Current Daily Routine and Assignment of Maintenance Work

Maintenance work is generally assigned on a daily basis, depending on system problems and calls for service that have been reported since the previous shift. All water operators meet at the Bartley Compound at the start of each day. The three foremen meet with the supervisor each morning and plan the field crew work for that day. On Mondays, Wednesdays and Fridays, preventive maintenance (PM) activities are normally scheduled. The pump station PM and inspections take approximately half of a day. The PM routes are set up on a north-south basis (divided essentially by Highway 97) and field employees are rotated through these rounds to ensure staff is familiar with every facility. The other days of the week and remainder of the time is spent on routine operation and maintenance tasks including locates, minor repairs, customer call-outs, etc.

Preventive maintenance work conducted by water operators is recorded only in the pump log books (as evidence that pump station preventive maintenance has occurred), but not documented and tracked on work orders. This makes reporting and managing the completion of maintenance work subjective in term of tangible and measurable outcomes.

Corrective maintenance work orders and calls for service are documented only in terms of the nature of the work order or the call for service. Once the corrective work is completed, the repair incident is recorded on the work order form. The DWK is working on integrating these records into their GIS system for future reference. The resources and costs required to complete each work order is not documented and in house staff do not track their time to individual work orders. It is not possible to report the effort and cost of maintenance work to individual assets or even asset types (water mains, pump stations, etc.)

In the case of emergencies, DWK water operators can be called out for rapid response. DWK does not track emergency responses except for those that are required for regulatory purposes.

8.1.3 Contracted Work

For all types of maintenance work that requires excavation, the DWK has an as-and-when contract with a local construction company. This company has staff on call 24-hours a day, 7-days a week to respond to urgent and emergency maintenance work. DWK staff is currently satisfied with this arrangement and the level of service they receive from the contracted company as it provides the flexibility to add additional maintenance tasks without hiring additional employees, and also eliminates the need to purchase specialized equipment at a high capital cost.

8.1.4 Budgeting and Accounting for Maintenance

Presently, DWK budgets for maintenance fall under variety of expense classifications. DWK Water Utility expenditures remain separated amongst the three former utility jurisdictions. As of the 2012 budgets, even the expenditure accounts between the three former jurisdictions were different. Due to these budgeting conventions, it is not possible to manage, track or compare maintenance work through the course of a year and it is not possible to report how much is spent on maintenance as a budget line item. This makes reporting on maintenance outcomes from a financial basis very difficult.

Like many water utilities, the current DWK O&M plan is driven by budget. That is to say, the DWK is able to conduct only the work that their budget allows through the course of a year. Available resources (including in-house labour plus contracted services) are applied to the maintenance work that is most urgent. Once the resources are consumed, any remaining work is deferred or not completed. In the case of a water utility, this means that O&M resources are applied first to corrective needs and customer call outs to ensure that water service is continuous, and then applied to routine preventive maintenance as resources permit. If resources are limited, preventive maintenance tasks may be at risk of going incomplete. In most public water agencies, O&M budgets are usually subjected to annual inflationary increases only. Increases beyond this level are difficult to justify. This feature presents the following risks:

1. DWK is a growing and expanding jurisdiction. It is anticipated that new assets will be added to the current inventory, with a corresponding increase to the required volume of maintenance work. If O&M resources are indexed only to inflation, DWK will be under resourced to complete its full maintenance plan. DWK will have to defer an increasing volume of preventative maintenance work each year in order to meet its allowable budget.
2. As preventative maintenance work is reduced or goes incomplete on a continual basis, assets become at risk of premature failure. In time, this further compounds the volume of corrective maintenance as O&M resources are deployed to respond to growing number of service problems.
3. As the data in Section 7 presents, most DWK water assets have considerable remaining life. As assets continue to age, it is expected that corrective maintenance will gradually increase. In time, this further compounds the volume of corrective maintenance as O&M resources are deployed to respond to growing number of service problems.

To address these combined challenges, best practices support the use of an activity based process to advance an annual budget for maintenance. AECOM observed that the DWK does not currently have a documented maintenance plan for its water utility.

8.2 Operational Recommendations

To meet the goals of a successful utility, we recommend the DWK adopt and implement a Maintenance Plan for its linear and treatment facilities based on the following asset based framework.

As detailed in the American Waterworks Association's *Water Utility Management Manual*, The five basic features of a sound Maintenance Plan are:

1. Responsibility is clearly defined and vested in competent personnel.
2. Management states its maintenance objectives and makes its position clear.
3. Proper tools, instruments and maintenance facilities are provided.
4. Preventative maintenance is planned for and scheduled.
5. An adequate system of documented records is used to control the program.

8.2.1 Developing a Work Based Maintenance Plan

Development of a maintenance plan should be undertaken by management and direct field supervisors in order to accurately determine the activities required and assign the correct people to complete the activities. The steps to develop a maintenance plan are outlined below.

Step 1 – Document the complete inventory of assets that require maintenance; sorted by asset type. The extent of the asset inventory is a primary driver of maintenance work. If the asset inventory is expanding, maintenance requirements will also expand. The first step of the maintenance plan is to document the asset inventory by asset type.

Step 2 – Define the maintenance work (activities) that need to be completed for each asset type to ensure that potable water is safely and reliably provided to all customers. For water mains, maintenance tasks are fairly generic and common to most utilities. For more complex infrastructure including treatment facilities, pump stations, PRVs and intakes, maintenance activities will be specific to the nature of each facility/asset and based on asset's criticality and condition.

At the highest level, maintenance activities should be disaggregated into a Corrective Maintenance or Preventative Maintenance classification; both are briefly defined below. Ultimately, a successful Maintenance Plan should optimize maintenance practices to find the right balance of completing required corrective maintenance tasks, while ensuring that the utility's preventative maintenance program can be completed each year.

Corrective Maintenance: Corrective maintenance is work that is required to respond to the failure of an asset or to a condition that has, or will soon result in a loss of service. Corrective maintenance can vary depending on urgency. Non-emergency repairs can be planning and scheduling to ensure that the work is completed in an effective and efficient manner. Corrective maintenance will always account for a significant portion of maintenance work. While the year to year volume of corrective work can be generally predicted (based on historical trends), it is not possible to predict when and where the work will be required.

Preventative Maintenance (PM): Preventative maintenance is regular and periodic maintenance work that is pre-planned and can be scheduled in advance. PM work is required to ensure asset reliability and to ensure that the utility maximizes its return from the asset over a complete expected life cycle. Many utilities find that the PM work program is the first to suffer during difficult or overly busy times. As a result, most utilities are unable to complete their annual PM workload which ultimately results in higher levels of breakdown and reactive corrective

maintenance work in the future. Over time, the utility can become more and more reactive and the PM backlog becomes unmanageable.

Step 3 – Determine the required resources to complete the required maintenance activities and make those duties clear to the assigned individual(s). Once the expected resources required to complete the maintenance target have been estimated, total maintenance budgets can be forecasted. In the DWK's case, where some maintenance work is contracted out, part of this task may be deciding which maintenance activities must be kept in-house and which should be contracted out. This decision should be made based on the DWK's strategic plans and the economic business case which supports it.

Whether the Maintenance Plan activities are kept in-house, contracted out, or a combination of the two, the duties required for each task should be clearly communicated to assigned personnel.

Step 4 – Track the progress of maintenance plans and completed maintenance activities. Proper administration of a Maintenance Plan requires record keeping. All maintenance work orders should be tracked back to individual assets. Records, in the form of paper forms or through a computerized maintenance management system (CMMS) should report at least the following:

- Asset that the work order is tied to
- Work Order type (Corrective or PM)
- Description of maintenance work
- Cost of Work Order (Labour, equipment, materials)
- Work Order follow up: Was anything else noted through the completion of the Work Order

At the end of each year, DWK should summarize the completed maintenance plan, both in terms of the percentage of anticipated maintenance work that was completed, and the total cost for the completed maintenance. This information should be used to prepare the next maintenance forecast. As new assets are added or maintenance requirements change, the forecast should be revised and used to support the recommended maintenance budget.

8.3 Need for a CMMS at DWK

DWK does not currently utilize a computerized maintenance management system (CMMS) to support the operations and maintenance of the water utility activities. The DWK has just started to implement Tempest software for utility billing, but chose not to purchase the add-on to plan and track utility maintenance activities. A CMMS can be a useful tool to help plan and organize the various aspects of operating and maintaining a utility. One of the most significant benefits of a CMMS is the ability to generate a wide range of management and planning level reports to assist in budget setting and planning. A CMMS should provide the following productivity factors in the operation and maintenance of a utility:

- Control the utility's list of maintainable assets and the tracking of maintenance costs directly to assets
- Schedule preventive maintenance routes
- Control preventative maintenance procedures and documentation
- Facilitate work order analysis (problem identification)
- Provide maintenance budgeting and costing statistics
- Provide analysis tools for maintenance performance indicators

Due to the fact that at present, the DWK financial budget process does not support activity based accounting (where all activities are tracked back to individual assets), and the utility has not yet documented its recommended maintenance plan as presented in this section, a decision to implement a CMMS should be deferred until more

progress has been made in each of these areas. CMMS implementations are expensive and take considerable effort internally. Without a well-defined summary of specific and tangible business requirements, a CMMS implementation project will have considerable risk.

Once DWK has made progress in documenting and tracking its maintenance plan over a couple of years, the cost/benefit of a light duty CMMS could be business cased against its ability to provide enhanced maintenance activity cost tracking documentation and reporting. Once a maintenance plan is established, and reliable data is being reported each year, a CMMS will be much easier to implement and provide a greater benefit to the utility.

8.3.1 Measuring Effectiveness of a Maintenance Plan – Performance Indicators

AECOM noted that at present, there were very few key performance indicators in use to report on asset and maintenance management outcomes other than budget and regulatory compliance results. The scope of this study did not include the development of a maintenance performance management system, but through AECOM's experience in this area, it is possible to recommend a small number of performance indicators that are in wide use within the water utility industry.

Good performance measures serve to focus a utility's attention on the results of strategies and actions based on facts and data. A utility must ensure that consistent practices and procedures are in place for the monitoring, recording, analyzing and reporting of performance information. If not, inconsistent interpretation of definitions will result in different information being recorded by different parts of the organization – and possibly by different individuals or work teams.

Performance measures must generally meet the following criteria to measure utility performance:

1. **Practical:** Managers must be able to easily compile the data that supports the measure and be able to determine the impact of proposed actions on this measure.
2. **Accurate:** The performance measures must allow for a quality-assured process to collect, analyze and report performance that would provide consistent results irrespective of the person gathering the data. It must also accurately gauge progress towards goals.
3. **Easy to Understand:** Performance measures must have a clear meaning to decision-makers and stakeholders. Sometimes, measures that are preferred by technical experts have little meaning to a non-technical audience.

With regards to maintenance, the following performance indicators (PIs) are in wide use within the water sector and suit the performance reporting requirements of DWK. All of these performance indicators have been documented and advanced by the AWWA. PIs are used to measure the success of a utility's performance, and ultimately drive performance improvement. Once records of maintenance activities are tracked and recorded, this data can be used to determine if performance is improving or diminishing from year to year.

Table 8.1 - Suggested Key Performance Indicators

Name	Purpose	Numerator	Denominator	General Targets
Unplanned Disruptions of Water Service	Quantify the number of water outages experienced by customers (usually as a result of asset failure)	Number of accounts experiencing disruption (by DWK and/or Cal Water wide)	Total number of active accounts (by DWK and/or Cal Water wide)	While it is not possible to eliminate water outages completely, utilities target to minimize the number of unplanned disruptions.
System Renewal Ratio	To quantify the rate at which the utility is meeting its individual need for infrastructure renewal or replacement	Total actual expenditures reserved for, or spent on, renewal or replacement of assets (by DWK)	Total replacement value of the infrastructure (by DWK)	The system renewal ratio should consider the expected service lives of the individual asset categories. For example, if watermain have an expected service life of 100 years, sustainable reinvestment suggests that at least 1% of the replacement value be reinvested annually or set aside in reserves.
Preventive Maintenance Ratio	To document the progress from reactive to proactive maintenance	Annual Preventive Maintenance Budget (or person hours)	Total Maintenance Budget (or hours)	This measure should be monitored to determine if, as preventive maintenance is enhanced, there is an observed trend of increased preventive budget (or labor hours) to corrective maintenance.
Distribution System Integrity	High level quantification of the condition of the distribution system	Total Number of leaks + total number of main breaks requiring repair	Total length of the distribution system	Every system will encounter leaks or breaks requiring repair. Annual trending of this measure should be reviewed to ensure address unanticipated increases in breaks or leaks.
Drinking Water Compliance Rate	Quantify the percentage of time each year that each DWK meets all of the health-related standards in the US national Primary Drinking Water Regulations	Number of days in full compliance	365 days	DWK should strive to meet all compliance requirements.

The above table presents a small number of performance indicators that can be used to give the DWK an idea of how the utility is performing from year to year. The results for these PIs do not necessarily indicate a “good or bad” result but rather would provide the DWK the opportunity to better understand their utility, as well as what contributes to the performance result. In addition, since these indicators have been generally standardized in the industry, they can also support utility benchmarking comparisons, which is useful for identifying strengths and weaknesses.

8.3.2 Operational Arrangement

As mentioned above, the DWK currently utilizes a mix of internal staff resources and contractors to complete maintenance activities. DWK management and supervisory staff are currently satisfied with the blended process with the benefit that contract services reduce the number of DWK field employees and eliminate the need for specialized equipment that is needed only occasionally. Externally contracting work can be a flexible and effective means for

utility operation and maintenance. While there are obvious benefits, the utility must ensure that the appropriate maintenance work is being completed in an efficient and cost effective manner.

If the DWK continues to externally contract maintenance work, it is recommend that contracted work is issued on a work order that has been scoped and estimated by a DWK supervisor to ensure that DWK cost control is preserved. Each work order should be tracked to a specific asset (or group of assets). The contractor performing the work order should be required to submit records to document activity details so that DWK can attach the completed work order to the individual asset records (GIS or at some point in the future, a CMMS). This will allow the DWK to track asset based maintained history from both in house and contract services in the same way to support asset management decision making.

8.3.3 Summary of Recommendations

Table 8.2 below summarizes the current situation that DWK is experiencing with regards to forecasting and planning maintenance work along with the situation response that is anticipated through this study.

Table 8.2 - Current Maintenance Forecasting and Proposed Response

DWK Current Situation	Recommended Responses
Maintenance budgets have been set based on a process that generally applies local inflationary factors to previous budgets.	DWK should advance a budget setting process that is based on quantifying the actual work required to be completed in the period and translate the required volume of work to resource requirements and budgets
Current DWK accounting and budget processes have only a distant connection to the assets that require maintenance. Over time DWK will continue to grow as new assets are added. Maintenance budgets are at risk of not reflecting the work and resources required to adequately maintain assets, or meet DWK's established levels of service.	DWK should maintain a complete asset inventory with all of the required maintenance work that relates to each asset. DWK should also begin accounting for, and tracking maintenance activity costs back to individual assets.
DWK does not yet have a range of asset and maintenance management related performance indicators agreed upon for use in communicating asset and maintenance management progress with stakeholders. Current progress can only be measured through high level financial indicators (e.g.: budget compliance) or anecdotal reports.	A small range of asset management performance indicators were presented that are recommended for this purpose by AWWA. This will enable DWK to compare their progress with other water utilities and begin trend analysis report on asset management process improvements.

At present, there are insufficient records to determine if current maintenance practices are adequate to ensure the reliability of DWK assets over the long term. DWK has been successful at meeting most regulatory requirements over its history, but there is a risk that as its current asset inventories continues to grow and age, maintenance requirements will exceed the capacity of current DWK resources. It is recommended that the DWK generate and implement a maintenance planning process to accurately begin forecasting and planning for future maintenance needs. This will improve continuity of service for customers, promote greater economic efficiency within the utility, and ensure the DWK is receiving full value for their assets. The 5-Year operational recommendations for the DWK are:

1. Develop a consolidated annual maintenance plan along with activity based costing principle to track maintenance costs to individual assets.

2. Implement, follow through, and document the maintenance plan activities undertaken (whether completed in-house or contracted);
3. Measure the effectiveness of the maintenance plan using performance indicators or other means and use this information to update maintenance plans for future years;
4. Consider implementation of a CMMS once the Maintenance Plan has been successfully followed for a few years.

9. Financial Assessment and Rate Structures

9.1 Water Rates and Financial Strategies

In establishing the new DWK of West Kelowna, five former water utilities were consolidated into a single entity. Even though each of the five utilities have a different history from a development standpoint, and in some ways, have approached their mandate with different strategies, the overall water utility objectives are essentially the same and can be summarized as follows:

Table 9.1 - Core Water Utility Objectives and Applicability to DWK

Utility Objective	Detail
Meet Anticipated Water Demands	<ul style="list-style-type: none"> DWK must meet the water demand needs of both domestic and agricultural water customers.
Provide Acceptable Water Quality	<ul style="list-style-type: none"> Applicable water quality regulations are the same for all domestic water customers in the DWK service area. DWK is obligated to meet water quality regulations for all domestic water customers.
System Reliability	<ul style="list-style-type: none"> Water infrastructure must be maintained in a manner that ensures overall system reliability.
Customer Response	<ul style="list-style-type: none"> DWK must respond to water related complaints, service outages, and other disruptions to service in a standard manner that is the same for all customers (though they may differ between customer classifications)
Economic Efficiency	<ul style="list-style-type: none"> DWK must construct, operate and maintain the water system in an economically efficient manner that meets required levels of service and also ensures long term financial sustainability.

Given that the basic utility objectives are the same throughout the entire combined service area, DWK has an opportunity to leverage the benefits of economies of scale associated with a larger single utility so that the overall economic efficiency of operating the entire larger utility can improve to the benefit of rate payers. In order to take advantage of this economy of scale, the DWK water utility needs to be designed and managed as a single entity, with common levels of services for all customers within each customer classification (eg: domestic water customer and agricultural water customer). Once utility levels of service are consistent for all customers, it is logical that a single water tariff schedule apply to all customers within each customer classification.

The challenge in organizing the utility to begin taking advantage of economies of scale is that presently, one of the former utilities (WID) provides a significantly higher level of service with regards to domestic water quality, and as such charges higher rates for their water services. (Differences amongst the other former utilities are less significant). It will take a number of years to fully integrate the individual water systems and most importantly, provide enhanced water treatment necessary to meet water quality regulations to all domestic water customers. DWK requires a financial and management strategy in association with the engineering strategy to migrate water utility customers to an acceptable water rate strategy that enables the WID to operate as a single utility. This chapter presents water rate strategy alternatives and makes recommendations that are based on best practices and objectives of maximizing economic efficiency as part of this Water Master Plan.

9.1.1 Utility Management and Water Rate Strategy Required for 2014 and Beyond

Until January 2014, utility capital works and water rates will continue to be associated with the former water utilities. A council resolution passed on June 8, 2010 stated that, starting January 2011 for a period of 3 years, the Service Areas will maintain separate water rates and capital works programs. This provides adequate lead time to define an acceptable water utility management integration strategy that will best meet future utility and customer needs. Part of this strategy will require a customer education program to inform customers about the benefits of a single utility that is integrated and provides the long term ability to leverage economies of scale to the benefit of all customers. While there may be some local instances of a temporary imbalance between water rates and levels of service, the plan is to ensure that all customers receive a consistent quality of water and level of service that is priced according to the same water rate strategy.

9.1.2 DWK Customers and Water Products

DWK serves all water customers in the DWK, including domestic water users (household, commercial, and industrial customers) and irrigation users (bona fide farming operations). These two customer groups are defined in part by their different requirements for water. Domestic customers require water that is of high quality (that meets or exceeds all current and future regulatory requirements) throughout the year on a very reliable basis. Sufficient capacity must be available at all times for domestic and emergency purposes (such as firefighting). Irrigation water on the other hand, is used for the purpose of irrigation and does not require advanced treatment (only that it be safe for transportation and consumption by livestock). During winter months, the system can be closed.

The definition of "Irrigation Water Customer", however, needs to be clear. Since this water will be sold at a much cheaper rate, many domestic customers will prefer to use irrigation water for lawn watering, gardening, and hobby farm irrigation. Unless a firm definition is established to clearly define what customers are eligible for irrigation water, customers may be confused. It is recommended that the definition of irrigation water be tied to the use of water for the sole purpose of farming.

9.2 Cost Recovery from Rates, Fees and Charges

The DWK Water utility operates as a non-profit utility for the sole benefit of its water customers. As such, DWK costs and expenditures must be allocated to customers in a manner that is fair, equitable, and in a manner that meets any other policy needs the DWK may set as a priority (for example, water rate structure to promote water conservation).

Costs associated with operating the utility on a year-to-year basis will be recovered through a variety of rate structures, fees and charges. Within public water utilities, a general principle is to make the rates and fees as transparent as possible, and to insure that fees are equitable and fair to all water customers. Since all domestic water accounts are now metered, DWK has implemented consumption-based billing, which is regarded as a Best Practice in that it provides the ability for customers to be more responsible for water as they pay for only what they use. DWK has also implemented increasing block rates in all of the former water utilities, which provides a financial incentive to conserve water during the peak summer season through a high per unit charge of water.

Expenditures that are typical to all public water utilities (including DWK) include utility operations and maintenance costs, debt charges, capital costs associated with improving water quality and security of supply, and new capital costs associated with expanding the system for new customers and regional growth. Within DWK, it is recommended that water rates continue to be used to fund operations and maintenance of all facilities, existing debt requirements, and future debt on capital expenditures required for the purpose of meeting future water quality improvements. Federal and provincial infrastructure grants should be applied for when programs are in place to support public infrastructure needs.

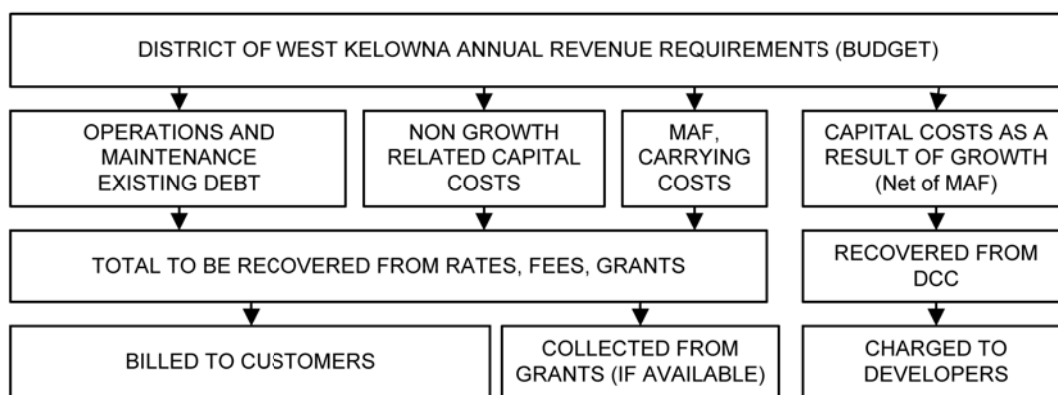
It is also recommended that Development Cost Charges be used to fund the cost of increasing capacity as a result of growth (DCC recommendations are presented in Section 10.6). DWK (or the legacy jurisdictions) presently have a mix of bylaws to recover a portion of growth related costs from developers or in some cases, no developer paid charges exist at all. This places an unfair burden on existing rate payers since water rates are used to fund all remaining capital projects. **Table 9.2** presents the existing development charges for development in the DWK where they exist.

Table 9.2 - Current DCC or Similar Bylaws in DWK Service Areas

Service Area	Development Charge?	Bylaw	Description
Westbank	Yes	Westbank Irrigation DWK Bylaw No. 640 – “Comprehensive Capital Expenditure Charge Amendment Bylaw 2007”	Schedule A sets charges for persons developing land in the Westbank Service Area.
Lakeview	Yes	Lakeview Irrigation DWK Bylaw No. 291 – “Comprehensive Capital Expenditure Charge Bylaw 2009”	Schedule A sets charges for persons developing land in the Lakeview Service Area.
Sunnyside	No		
West Kelowna Estates			
Pritchard			

It is recommended that DWK replace the legacy development charge bylaws with a consistent DCC bylaw that collects the cost of meeting new growth net of the municipal assist factor according to the BC Ministry of Community Services Development cost Charge Best Practice Guide. **Figure 9.1** presents a summary of the recommended allocation of revenue requirements to revenue sources where DCCs are used to help fund growth related capital costs.

Figure 9.1 - Recommended DWK Allocation of Budget to Revenue Sources (using DCCs)



9.3 Funding Capital Works

All capital works will be one of two categories: a) capital works as a result of system improvement or renewal, or b) capital works as a result of growth.

9.3.1 Capital Works as a Result of System Improvement

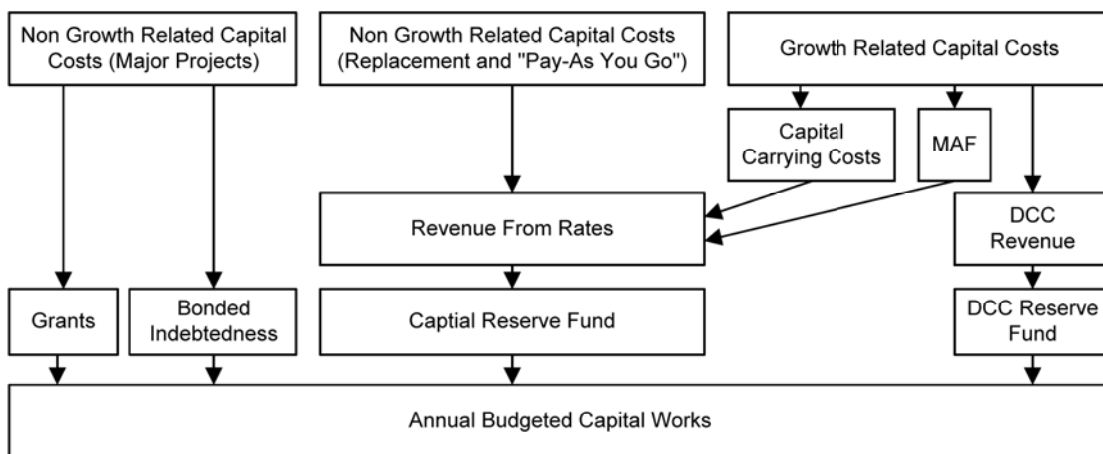
Capital works as a result of system improvement, re-investment and/or replacement will be paid through rates. Major capital works, such as water treatment facilities should be funded largely through debt. Grants, such as the Federal/Provincial Infrastructure Program, should be applied for and accessed as much as possible. In the case of water treatment, the cost of servicing the debt and the new costs associated with operating and maintaining the new works will be paid through domestic water rates only (and not the irrigation water rates). Smaller capital projects such as system upgrades or infrastructure renewal programs may be paid through rates on a “pay as you go” approach. This will require the use of a Capital Reserve Fund and contributions from rates.

9.3.2 Capital Works as a Result of Growth

It is recommended that any capital costs associated with expanding the supply of water or the capacity of the utility’s transmission system should be paid through Development Cost Charges (net of the Municipal Assist Factor). However, once all new capital works are in place all associated O&M expenses should be covered through water rates. This will require a new DCC bylaw. In association with the establishment of the proposed DCC bylaw, a DCC Reserve Fund must also be established. Planned expenditures from the DCC Reserve Fund would be made through the DWK annual budgeting process for the year capital projects are being undertaken.

Figure 9.2 presents the recommended allocation of capital projects to funding source where all DCCs are used to fund projects that are advanced due to the whole or partial needs of growth (net of the Municipal Assist Factor).

Figure 9.2 - Recommended DWK Funding of Capital Projects (using DCCs)



9.4 Water Rate Differences within DWK

The DWK includes five former water utilities which have substantial differences in water rates. While all of the domestic water connections within the DWK are fully metered and water is priced on a volumetric basis, there is a dramatic difference both in the price paid by Westbank Service Area domestic customers and in the water quality

level of service received by its customers. Since water is filtered and treated by a modern water treatment plant, Westbank Service Area customers enjoy the benefit of higher quality water than other DWK customers. As expected, Westbank customer rates are higher due to the capital cost of the Powers Creek Water Treatment Plant (WTP), and the higher annual operations and maintenance costs associated with the WTP.

There is far less of a difference between the Lakeview, West Kelowna Estates, Pritchard and Sunnyside Service Areas, and all of these customers receive unfiltered water at a substantially reduced price. In summary, the DWK is presently providing two distinct and important levels of service with regard to water quality, and this difference is priced accordingly.

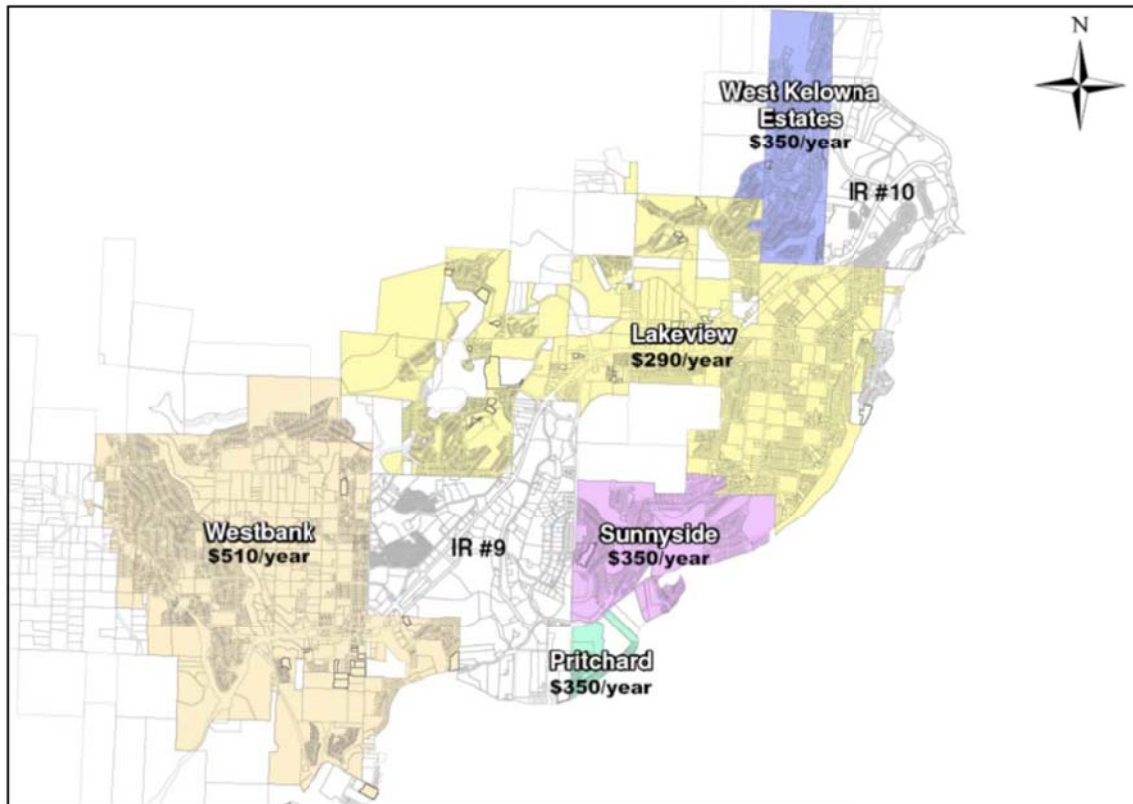
Based on data provided by the DWK, AECOM has conducted a comparison of the annual water utility bill for domestic customers within each of the former DWK water utilities. While each former water utility had a different water rate schedule that includes fixed fees, volumetric charges, and other service-related fees, this comparison has translated the water rate into a comparison of the final price for a domestic water account. Since the vast majority of the connections within DWK are a single family detached housing unit, this connection type is used in this comparison. **Table 9.3** illustrates the difference in yearly water cost for a single family unit in each of the five former water service areas.

Table 9.3 - Approximate Yearly Water Charge for a Single Family Detached Home in each of the Water Service Areas

	Westbank Irrigation DWK	West Kelowna Estates	Pritchard	Sunnyside	Lakeview Irrigation DWK
Low Consumption	\$380		\$250		\$190
Avg. Consumption	\$510		\$350		\$290
High Consumption	\$630		\$430		\$380

Source: DWK of West Kelowna Water Rates Calculator <http://www.DWKofwestkelowna.ca/index.aspx?page=579>

Figure 9.3 - Average Yearly Water Charge for a Single Family Detached Home in each of the Former Water Service Areas



Source: DWK of West Kelowna website; <http://www.DWKofwestkelowna.ca/index.aspx?page=413>

9.4.1 System Interconnection Part of Improved DWK Water System

The technical portions of the DWK Masterplan call for interconnections at strategic points between the former utilities so that the water system provides for better system redundancy and alternative water supply options. These interconnections will enable the DWK system to better balance water demands and alternative sources to various customers. It is also the objective of this Master Plan to recommend a water treatment strategy that will ensure that all DWK customers have access to drinking water that meets Interior Health regulations that are known as the 4-3-2-1-0 drinking water objective where:

- 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

This Water Master Plan is driven in part to provide an implementation plan so that DWK can meet this standard in a manner that is reliable and cost effective but recognizes that the former WID service area already has this capability. It will be important to ensure that former WID customers are not asked to pay twice for required water treatment facilities that are outside of the WID service area.

9.5 DWK Utility Management Alternatives After 2014

Recognizing that the DWK will maintain separate capital planning and water funds for the legacy service areas at least until January 2014, it is recommend that DWK begins planning for a more integrated water utility in the future. The current period of status quo presents a good timeframe to identify the preferred alternative and begin a process of customer education and communication so that customers can be informed and involved in the future of their water utility. Two alternatives are described below:

Alternative 1: Implement a strategy to complete the management integration of all former water utilities into a single entity and a single water fund to take advantage of economies of scale.

This alternative would seek and integrate the water utility to a single water fund so that efficiencies through economies of scale could be exploited to the benefit of all customers. The five former utilities would become interconnected according to this Master Plan and ultimately, all customers would be charged water rates according to a common water rate bylaw under a single water fund. Within this alternative, there are two implementation options.

Option 1: Starting in 2014, begin moving all water rates to the higher WID rate structure over a number of years. This would see customers outside of WID pay a higher rate than present while still receiving unfiltered drinking water. This incremental revenue would be directed to a dedicated capital reserve to be applied to future construction costs of water treatment plant(s). This capital reserve will service to reduce the debt that will be required by DWK, and will reduce future interest payments on debt.

Pros	Cons
<ul style="list-style-type: none"> • Begins to develop a capital reserve that can be applied to future construction costs, which will reduce the required debt to finance. • Will achieve the objective of a single water rate and administrative simplicity in a fairly short timeframe • Will enable the DWK to proceed with full integration of the former utilities according to the preferred distribution system management strategy. • Will require a single planning and budget setting process and the administration of a single water fund with regarded administrative burden 	<ul style="list-style-type: none"> • Could be interpreted as unfair as some customers will be paying for a level of service that they will not receive until water is filtered. • If water filtration is postponed or delayed, water rates will be unfairly high in some parts of DWK • Will require a proactive customer communication program so that customers understand the long term vision of the water utility

Option 2: Develop a single blended water rate (that would lower the WID rate and increase the other former area rates) to meet the year to year cash requirements of the overall DWK water utility.

Pros	Cons
<ul style="list-style-type: none"> Will achieve the objective of a single water rate and administrative simplicity in a fairly short timeframe Could advance water conservation efforts outside of WID service area and high volume consumption becomes increasingly expensive. 	<ul style="list-style-type: none"> Both water quality levels of service (filtered and unfiltered) will be provided at the same price until water filtration is available of all DWK water sources. This may be seen as unfair through the interim. Within the former WID service area, water conservation efforts may relapse and setback as customers see a price drop for water. Once new water treatment projects begin, former WID customers might be confused, as rates in their area will also increase to meet new revenue requirements.

Note: Option 2 under Alternative 1 is not recommended due to its complexity and lack of benefits and is not discussed any further in this section.

Alternative 2: Continue to manage the former services areas as two separate levels of service areas and increased rates within the unfiltered areas only as water treatment capital projects are constructed and commissioned. This alternative would see the consolidation of Lakeview, Sunnyside, Prichard and West Kelowna Estates under a single water fund as the unfiltered water quality level of service; and the WID area as the second water fund that features the higher water quality level of service (and higher water rates resulting from the Powers Creek WTP). These two water funds would be sustained until such time as water treatment is installed for all domestic water customers. Once the two service areas provide the same water quality level of service, final integration could then be considered.

Pros	Cons
<ul style="list-style-type: none"> The pricing is fair and equitable as customers pay for the level of service they receive Fairly simple customer communication messaging, as customers will not see significant change from the status quo until water treatment capital plan required funding. 	<ul style="list-style-type: none"> Administratively difficult to manage. Two plans and budgets are required along with extra administrative burden Does not provide the opportunity to benefit from the economies of scale that are expected from merging the three former utilities as a single operation. May stall water conservation efforts in the unfiltered water area as water rates remain relatively inexpensive Without a significant capital reserve, DWK will be burdened with higher cebt charges resulting in a more expensive water treatment program

9.5.1 Recommended Strategy

Both Alternative 1 and 2 are viable and have a range of associated pros and cons. Since Alternative 1 (Option 1) results in the most economically efficient and cost effective water utility in the shorter term, this option is recommended. Alternative 1 presents the following import strengths over Alternative 2:

- Provides a strong revenue source to begin building a capital reserve to fund anticipated water quality improvement projects outside of the former WID service area. Further, these contributions would not be made by former WID customers and thus is very fair. All customers contributing to this reserve would benefit from the water quality projects.
- A substantial capital reserve fund would reduce the total cost of the water treatment program by lowering debt charges.
- Would enable the utility to conduct a single water fund capital planning and budgeting process each year which reduces administrative burdens.
- Fully enables DWK to begin exploiting new economies of scale in seeking to improve operating efficiencies.
- Enables a strategy to provide stronger financial incentives to reduce water consumption through rates in a consistent manner across the entire DWK area.

9.5.2 Implementation Challenges

The largest challenge of Alternative 1 is that customers outside of the former WID area will be asked to pay a higher rate for water that will not receive treatment for a number of years. Even though the incremental revenue from the increased rate will be placed in a reserve to fund the water treatment capital program that will benefit them directly, some customers may find this unfair. This challenge can only be addressed through a public education and consultation process. Since no changes will occur until 2014 at the earliest, DWK has adequate time to educate customers of the various options and then seek meaningful input. Even within Alternative 1, there are a broad range of implementation options that can be considered and evaluated. DWK may find that customers will value the opportunity to provide input into the financial management aspects of the new Master Plan. This will also help implementation efforts once water rates are scheduled for adjustments.

9.5.3 Water Rate Cost of Service Study

Once DWK has determined a water utility integration and management strategy following 2014, it is recommended that a comprehensive water rate cost of service study be undertaken. This will be the first time that a standard rate model can be advanced for the entire DWK utility and will follow a period where DWK has had an opportunity to gather consolidated cost data to support the study. Of particular importance to support this study will be the availability and use of consolidated water meter data from all customers.

9.6 Implement a Development Cost Charge (DCC) Bylaw for DWK Waterworks

Development Cost Charges (DCCs) are monies that are collected from land developers by a municipality, to offset some of the infrastructure expenditures required to service the needs of new development. DCCs are a fair revenue source in which existing customers do not have to pay for growth related capital projects from regular water rates. Imposed by bylaws pursuant to the Local Government Act, DCCs can be used to fund growth related capital projects for water capacity expansion including plants, reservoirs and transmission mains. DCCs allow monies to be pooled from many developers so that funds can be raised to construct the necessary services in an equitable manner.

Since it is anticipated that significant development will occur in the DWK over the next 20 years, it is recommended that new development pay their fair share of expanding the DWK water system to accommodate growth. It is therefore recommended that the revised DWK DCC bylaw include a provision to charge development for growth related costs as allowed by the Local Government Act. Best Practices for calculating development cost charges are presented in BC Community Services Development cost charges Best Practices Guide.

The costs associated with operating the DWK water utility on a year-to-year basis will be recovered through a variety of rate structures fees and charges. DWK expenditures include utility operations and maintenance costs, debt charges, capital costs associated with improving water quality and security of supply, and new capital costs associated with expanding the system for new customers and regional growth. It is recommended that water rates be used to fund operations and maintenance of all facilities, existing debt requirements, and future debt on capital expenditures required for the purpose of meeting future water quality improvements. It is also recommended that Development Cost Charges be used to fund the cost of increasing capacity as a result of growth.

In general, it is recommend that any capital costs associated with expanding the supply of water, or the capacity of the utility's transmission system should be paid through Development Cost Charges (net of the Municipal Assist Factor). It is proposed that a separate DCC fund be established for each individual water fund in place after 2014 so that DCC revenue can be set aside for appropriate use. This will require new DCC bylaw specific to each DWK water fund.

In association with the establishment of the proposed DCC bylaws, a DCC Reserve Fund must also be established. Planned expenditures from the Reserve Fund would be made through the DWK annual budgeting process for the year the capital projects were being undertaken.

10. Conclusions and Capital Plan

10.1 Capital Works Program

Included within **Appendix I** is a detailed summary of the capital improvements recommended for the water distribution system for the planning horizon of this study. The total capital program is estimated to be roughly \$ 150 M, plus the ongoing cost of infrastructure renewal. The renewal of the existing infrastructure is estimated to be an additional \$ 1.8 M per year.

The capital projects are separated into three categories. Shown in **Table 10.1** are the projects that are essentially to the supply of Interior Health compliant potable water across the entire water service area. The exact timeline for the implementation of these projects will be based on the financial capacity of the District, but the conceptual plan is to construct a water treatment plant at the Rose Valley Reservoir in the near future. This treatment facility will be sized to convey water through a reconfigured network allowing for the gravity supply of water to Pritchard, Sunnyside and West Kelowna Estates.

Other high priority projects recommended in the next few years are further review of the water rates, planning studies to implement the master plan and work to reduce the volume of unaccounted for water. The current volume of unaccounted for water, based on the meter data, is high meaning there is potentially significant benefit to the DWK to finding the source of the unaccounted for water and reducing this flow to more typical values.

Table 10.1 – Initial Capital Plan

Project Number	Project Name	TOTAL (Rounded)
U-5	Dam Safety Review	\$ 450,000
TD-3	Pritchard Water Supply Modifications and Decommissioning of Lake Intake	\$ 3,500
TD-4	West Kelowna Estates (WKE) Transmission Main	\$ 2,470,000
D-13	Water Leak Detection Program	\$ 70,000
DF-1	Abandon West Kelowna Estates Intake	\$ 21,000
DF-2	Blackwoods Reservoir - Telemetry and Inlet Valve Improvements	\$ 70,000
DF-3	Sunnyside Intake Pump Control Upgrades	\$ 50,000
T-2	Rose Valley Water Treatment Plant	\$ 40,600,000
PZ-1	West Kelowna Estates Pressure Zone Adjustments	\$ 2,920,000
PZ-2	West Kelowna Estates/Lakeview Pressure Zone Adjustments I	\$ 110,000
PZ-3	West Kelowna Estates/Lakeview Pressure Zone Adjustments II	\$ 90,000
H-1	Fire Hydrant Coverage	\$ 1,830,000
ST-1	Development of a DCC Bylaw for all of DWK	\$ 20,000
ST-2	Water Rate Cost of Service Study	\$ 60,000
ST-3	Convert Steady State Hydraulic Model to Extended Period Simulation	\$ 60,000
ST-4	Water Conservation Program	\$ 600,000
	Sub-Total - 5-Year Capital Plan	\$ 49,424,500

The other significant deficiency within the existing system is the challenge of providing fire flow throughout the network. This deficiency is an existing condition that is partially mitigated by continuing to allow water to be conveyed through multiple pressure reducing valves to the point of diversion. Also, the system has the ability to provide some fire flow throughout the network meaning the expected risk associated with this deficiency is assumed to be lower than not provided treated water. For these reasons the storage and conveyance deficiencies associated with the supply of fire flow are deemed to be lower priority than the treatment improvements. The recommended projects for the next 5 – 20 years are provided in **Table 10.2**.

Table 10.2 - 20-Year Capital Plan

Project Number	Project Name	TOTAL (Rounded)
U-4	Lambly Lake Headgates Fuel Storage Improvements	\$ 140,000
TD-2	Sunnyside Transmission Main	\$ 570,000
D-1	Weber Road Watermain Upgrades	\$ 420,000
D-2	Glenorsa Industrial Area Watermain Upgrades	\$ 480,000
D-3	Old Okanagan/Butt Road Watermain Upgrades	\$ 850,000
D-4	Witt and Peters Road Watermain Upgrades	\$ 340,000
D-5	Angus Drive and Harding Road Watermain Upgrades	\$ 430,000
D-6	McIver and Gorman Road Watermain Upgrades	\$ 300,000
S-1	Connect Sunnyside and Pritchard - PZ401	\$ 1,810,000
S-2	Sunnyside Reservoir Storage Deficiencies - PZ475	\$ 460,000
S-3	Sunnyside Reservoir Storage Deficiencies - PZ503	\$ 1,520,000
S-4	West Kelowna Estates/Lakeview Storage Deficiencies - PZ657	\$ 190,000
S-5	West Kelowna Estates/Lakeview Storage Deficiencies - PZ710	\$ 320,000
S-6	West Kelowna Estates Storage Deficiencies - PZ626	\$ 310,000
S-7	West Kelowna Estates Storage Deficiencies - PZ504	\$ 660,000
S-8	Lakeview Storage Deficiencies - PZ539	\$ 1,600,000
S-9	Lakeview Storage Deficiencies - PZ597	\$ 6,840,000
S-10	Westbank Storage Deficiencies - PZ630	\$ 1,940,000
S-11	Westbank Storage Deficiencies - PZ673	\$ 630,000
S-12	Westbank Storage Deficiencies - PZ583	\$ 1,820,000
S-13	Westbank Storage Deficiencies - PZ503	\$ 6,780,000
	Sub-Total - 20-year Capital Plan	\$ 28,410,000

Provided within **Table 10.3** is a summary of the capital projects necessary to support additional growth within the water service area. To meet the future demands significant improvements are needed to the raw water supply infrastructure, treatment and distribution. The exact timing of the new projects will be the result of the actual growth rate within the service area.

Table 10.3 - Growth-Related/DCC Projects

Project Number	Project Name	TOTAL (Rounded)
U-1	Upland Storage Site - Lambly Creek Watershed	\$ 13,640,000
U-2	Esperon Lake Dam Upgrades	\$ 50,000
U-3	Big Horn Dam Automated Headgate	\$ 140,000
TD-1	Transmission Main from Okanagan Lake to Rose Valley WTP	\$ 16,860,000
TD-5	Transmission Main from Rose Valley WTP to Westbank Service Area	\$ 10,950,000
D-7	Tallus Ridge Watermain Upgrades	\$ 380,000
D-8	Auburn Road Watermain Upgrades	\$ 220,000
D-9	Boucherie Road Watermain Upgrades	\$ 130,000
D-10	Ridge Boulevard and Mission Hill Road Watermain Upgrades	\$ 230,000
D-11	Lakeview Distribution Upgrades	\$ 710,000
D-12	Sunnyside Distribution Upgrades	\$ 840,000
T-1	Powers Creek Water Treatment Plant Upgrades	\$ 12,600,000
T-3	Rose Valley Water Treatment Plant Upgrade	\$ 16,400,000
	Total - Development and Growth Projects	\$ 73,210,000

10.2 Conclusions and Recommendations

Provided within this report is a summary of the significant investigation and analysis of the existing water systems within the DWK. Based on the engineering effort expending during the completion of this project the key issues facing the DWK for the supply of potable water can be summarized as follows:

1. Data collection and management is a key component of effective operation of any water system. Given the somewhat recent combination of several different water systems that were operated independently, the background infrastructure records and on-going system monitoring currently varies. To improve the management of infrastructure records, it is recommended that a complete and comprehensive GIS be established for the water system infrastructure. It is our understanding that this work is ongoing by the DWK staff. Once the GIS based information is established ongoing effort is important to ensure the information within the GIS remains current, accurate and is easily assessable for both internal and external users.

The other element associated with effective operation of a water system is the tracking of key operating parameters resulting in the utility management being able to proactively identify issues and changing trends. The DWK staff with outside specialist assistance should develop a list of parameters that help the DWK track the health and function of the water utility.
2. Reducing the total volume of water consumed is critical for any utility as this allows for the deferral of capital improvement projects. Based on the work completed during this study the two key areas for improvement are continued reduction in the domestic customer water consumption and reducing the unaccounted for water. Across the DWK domestic customer meters were installed and there are ongoing water conservation education programs. It is recommended that these programs are continued.

The other focus should be reducing the unaccounted for water. Currently it is estimated that roughly 21% of the annual water used by the distribution system is unaccounted with the assumption that the water is leaking from the distribution network. This means that the unaccounted for water is about 6% more annually than the volume of water supplied to agricultural irrigation customers. To ensure the long term financial health of the utility the unaccounted for water should be between 10 – 15 %. Included within the capital program is an annual allowance to further study the water balance within the network allowing for a more focused identification of the leaks. Once the source of the unaccounted for water is found repairs should be completed immediately.

3. Based on the analysis completed, it was concluded that the agricultural allocation throughout the DWK is under used meaning the water utility has a commitment to supply significantly more water than currently used within the DWK. Based on a cursory review this item does not measurably impact the distribution system as the area of the network where agricultural water required is robust enough to deliver the total allocation. The items directly impacted by the underutilization of the agricultural allotment are:
 - a. Upland watershed capital storage improvement projects;
 - b. The justification for the construction of a dedicated irrigation network within the agricultural regions of the network; and
 - c. The size of the water treatment facilities.

If the entire irrigation allocation was used annually, upgraded upland raw water storage facilities would be required sooner. Also, given the impact to the existing Powers Creek water treatment plant and the proposed Rose Valley treatment facility, it is expected that a financially defensible argument could be generated to support the implementation of separation of the domestic and agricultural irrigation system. However, given actual volume of agricultural irrigation water being consumed the development of a dedicated distribution system for the supply of raw water to agricultural land is not justifiable.

The use of agricultural water within the distribution network is a critical issue for the DWK. It is recommended that this item is part of the ongoing monitoring program allowing the agricultural water usage trend to be developed. It is also recommended that the DWK embarks on a program of buying back or rescinding agricultural allocation for properties where the water is not used. This is important since potentially needing to supply the entire agricultural allocation is a significant liability for the DWK.

4. The DWK has the luxury of both upland gravity creek sources and Okanagan Lake. To date the DWK has had more than sufficient supply and licensed capacity to meet the needs of the customer base; however, to maintain sufficient supply significant historical investments have been made in the upland water supplies. It is the general observation that given the topography and the annual precipitation that the maximum practical utilization of the Powers Creek watershed is close to being reached. This means it was determined that once more raw water is needed, the benefit to cost is higher if investments are made in the Lambly Creek and Okanagan Lake. It is assumed that new storage facilities will be provided on Lambly Creek and a raw water pump station developed on Okanagan Lake to meet the long term raw water needs of the DWK. This decision is based on the determination that water raw water can be obtained at a lower capital cost from these sources.
5. Ensuring the supply of water during a drought is a major potential weakness and liability for many water utilities. The DWK is exposed to this exact issue given the highly variable nature of the water supply from the upland sources depending on the annual precipitation. In addition to the annual precipitation the other factor that the DWK cannot influence is climate change. The exact impact of climate change related to the ability of a watershed to produce raw water is the subject of debate, but there is some level of consensus that variability in weather patterns are expected to be more extreme than experienced in the past. This means that there is a potential for a drought to be worse than currently predicted by the existing return period curves. To mitigate this concern it is recommended that a raw water pump station and transmission main be constructed to convey Okanagan Lake water to the Rose Valley Reservoir treatment facility. This approach is cost effective

compared to significant raw water storage projects within the upland watershed and offers the significant additional benefit of improving the reliability of the system during a drought.

6. The existing Powers Creek water treatment plant provides the customers within the service area Interior Health complaint treated water. Unfortunately, the remainder of the customers within the DWK are provided surface water that requires treatment. Based on review of the available options the recommended solution to provide all the DWK customers treated water is:
 - a. Retain the existing Powers Creek facility and build a new water treatment plant at the Rose Valley Reservoir;
 - b. Reconfigure the distribution network allowing the gravity supply of treated water from the new Rose Valley Reservoir treatment facility to the existing Pritchard, Sunnyside and West Kelowna Estates supply areas.
 - c. As the treated water demands increase both the Powers Creek and the Rose Valley treatment facilities will be upgraded to increase the capacity.
 - d. To utilize the raw water capacity available from Lambly Creek and to meet the long term water demand, transmission mains are needed to interconnect the legacy Westbank Irrigation DWK distribution system to Rose Valley and a transmission main to improve the flow of water to the existing Sunnyside area.
7. There are some existing distribution system deficiencies within the service area. These items should be addressed as soon as possible. The other significant issue is a lack of storage, both for fire protection and balancing within the distribution network. This situation is the result of a legacy gravity system that relied on pipes sized to convey the peak water demands from the source. With the additional of treatment this benefit is no longer available to the distribution network since the treatment plant is sized to provide the MDD only. Also, to minimize transients and improve the flow of water throughout the network balancing tanks should be provided so a pressure reducing valve only serves one pressure zone. The additional of the balancing tanks results in significant fire storage being required throughout the distribution network.
8. The recommended annual infrastructure reinvestment for the DWK water system is \$ 1.8 M. This is an average annual cost that is expected to vary from year to year depending on the timing of major facility renewal needs. Currently, it is estimated that the infrastructure annual renewal value should be less than \$ 1.8 M, but it is still recommended that the capital amount be included in the budget. To enhance the accuracy of the reinvestment requirements more detailed condition assessments could be completed in the form of destructive testing.
9. The ultimate goal for the DWK is a unified water utility with common utility rates, development cost charges, construction standards and operational procedures. Realizing this goal will require incremental changes to the bylaws, rates, and operational procedures. To adequately establish the plan, further studies need to be completed as recommended within **Appendix I**.