Petition to Mayor and Council

November, 2024

To:
Mayor Gord Milsom and Council
West Kelowna, BC

From: Concerned Parents and Residents Served by the Rose Valley Water Treatment Plant.

Statement of Concern:
As parents and community members, we are profoundly concerned about the quality and safety of the water sourced from the Rose Valley Reservoir. Access to clean, reliable water that consistently meets and exceeds the Guidelines for Canadian Drinking Water Quality—and is aesthetically acceptable to residents—is a fundamental human right that impacts every aspect of our well-being. Contaminated or poorly managed water jeopardizes not only our physical health but also our children's development, concentration in school, and overall quality of life.

Our Requests:

1. Explore Alternative Funding:
We request that the Mayor and Council investigate alternative revenue sources, including general tax revenues and government transfers, to offset the financial levy as outlined under Section 210 (3) of the Community Charter. Ratepayers alone should not bear the financial burden of maintaining and improving water quality, especially given the uncertainties surrounding the current water source.

2. Conduct an Independent Review of the Water Utility Master Plan:
We urge the commissioning of an independent review of the water utility master plan, specifically examining the selection of the Rose Valley Reservoir as our drinking water source. This review should be conducted by independent experts whose firms were not involved in the 2014 Water Utility Master Plan. It is essential to assess whether there were oversights or negligence in this decision. We expect transparency and accountability from all officials and experts entrusted with our community's safety.

3. Prioritize Public Health in Water Management Policies:

We call for a reassessment of public health priorities in water management. The original plan weighted finished water quality at only 5% of the decision-making process, indicating that it was not considered a significant factor. Ensuring safe drinking water for all citizens is not only a responsibility but a moral imperative. Water must consistently meet and exceed the Guidelines for Canadian Drinking Water Quality and be of acceptable aesthetic quality for residents.

Conclusion:
This is an urgent call to action, not just for our individual families but for the entire community of 19,500 residents. Access to clean water that consistently meets and exceeds the Guidelines for Canadian Drinking Water Quality—and is aesthetically acceptable to residents—is essential for a healthy, thriving population. We demand transparency and accountability in its management.

Please sign this petition to demand an independent review of the water utility master plan and advocate for safe, clean drinking water in our community.

Sincerely
Olivia Lawson
Resident of Rose Valley

Valid West Kelowna Signatures as of November 2, 2024: 242

Letter to Mayor and Council

October 10, 2024

Good evening, Mayor and Council.

I attended the council meeting Tuesday in hopes of speaking as a delegation on the issue of Rose Valley Water. I was not given this opportunity since there is no procedure for a delegation on a late agenda item. After the meeting, I was disappointed to hear from one of you that "this wasn't the time for a delegation".

I came to the Council meeting to talk about the Rose Valley reservoir as a water source on behalf of residents. The community has raised concerns since the spring, and communication from the City has not been transparent enough.

In these communications, we keep hearing that there have been unanticipated changes in the source water. I came to demonstrate that these events were anticipated and in fact known issues with our water source.

I reviewed the 2014 Water Utility Master Plan, completed by AECOM in collaboration with the City. The Plan omitted material information that would have impacted the decision to select the Rose Valley Reservoir as a source. The City and AECOM supported the decision to select this source despite evidence they provided demonstrating it would not meet the standards that they set.

I have concerns that either the process was biased towards the selection of the Rose Valley Reservoir for cost reasons, and that health factors were intentionally ignored, or that the team working on the project didn't have the appropriate knowledge of water quality to be commenting on it.

I don't know which it is, but it's hard not to see the potential conflict in having the same group review and update the Plan.

<u>Quality Standards</u>

Pages 30 to 31 of the Plan outline various quality standards that must be met. In this, they make no mention of the Ambient Water Quality Criteria for Organic Carbon in British Columbia, guidance released in 1998 and later consolidated into the BC Source Drinking Water Quality Guidelines.

The guidance states:

"The water quality criteria for total organic carbon are 2 mg/L for treated water and 4 mg/L for source water. The criteria should not be exceeded at any time in drinking water systems that use chlorination for disinfection."

As an explanation the guideline states that "if TOC can be maintained below 2 mg/L in the drinking water effluent, there is a high probability that the THMs guideline of 0.1 mg/L (100ug/L) will not be exceeded (Martin 1994)."

Despite not referencing these guidelines, AECOM and the City did establish minimum standards to be met for any new water treatment facility. Notable objectives were:

- **Manganese:** <0.05 mg/L
    - Exceeded several times this year, and notably over the MAC in the summer.
- **Total Organic Carbon:** “Optimize reduction to meet THM and HAA goals”
- **Trihalomethanes:** <80ug/L on a locational annual average
    - This target was exceeded in February 2024 and again in August 2024, two of the three quarterly readings for 2024 so far.

Rose Valley Reservoir Quality Data

In their study, AECOM presented a summary of the Rose Valley Reservoir raw water quality data from the few years preceding the report:

- **Manganese:** 1 sample – 0.0629 mg/L – **25.8%** above the target set
- **Total Organic Carbon:** 14 samples
    - minimum of 6.5mg/L (**62.5% over limit**),
    - average of 10.7mg/L (**167.5% over the limit**),
    - maximum of 17.9 (**347.5% over the limit**).

Despite having evidence that the water would not meet the standards they had set, or the Organic Carbon criteria, and that this could lead to exceedances of the Guidelines for Canadian Drinking Water Quality in the long-term, this water source was still selected.

The Source Selection Decision

Appendix E of the Water Utility Master Plan includes minutes of a meeting from December 19, 2013, on evaluating long term water supply options. This memo outlines the 7 options and the scoring mechanism for selection.

Average Finished Drinking Water Quality was given only a 5% weight in the scoring. On describing this criterion, the memo states:

“Given that all the options result in the supply of compliant treated water this criterion is weighted low.”

Despite this, they then note that:

“The Powers Creek and Lambly Creek *(Rose Valley)* sources offer higher levels of natural organic matter and lower alkalinity. This means that this water source will naturally produce the **higher levels of disinfection by-products** and offer a water supply that is more corrosive to the distribution network than Okanagan Lake” and that these “are **known long term health concerns**”.

In the scoring table that follows, selection of **<u>unfiltered</u>** Okanagan Lake water was given a score of **5/5**. Selection of upland water sources only was given a score of **1.4/5**. They then went on to rate the selected system 4.3/5 as it includes future upgrades by connecting to Okanagan Lake sometime in the next few decades.

To summarize:

1. They said all sources would give us similar water and meet the standards, so they only gave water quality a 5% weight in the decision.
2. They set minimum water quality standards for this process and the data they had showed that Rose Valley Reservoir did not meet those standards.
3. The data also showed that the source water did not meet the Ambient Water Quality Criteria for Organic Carbon in British Columbia.
4. And when they scored the options, they gave the upland sources **<u>on filtration</u>** a score that was 72% lower than the score that was given to the Okanagan Lake source that would be **unfiltered** until some time after 2032. This demonstrates that they knew that this was a bad water source.

This decision directly contributed to the issues we saw this summer, and the taste and odour that residents continue to complain about.

While they may argue that the filtration process is meant to reduce the total organic carbon to an acceptable level, there is evidence that it does not.

<u>Water Test Results – City of West Kelowna</u>

I only have one test result for total organic carbon that came in a package I received for May 15, 2024:

Raw water – Total Organic Carbon: 6.84mg/L (**exceeds standard by 71%**)

Treated Water – Total Organic Carbon: 2.81 mg/L (**exceeds standard by 40.5%**)

These results represent the low end of the range that was in the source samples included in the Water Utility Master Plan. I suspect that TOC was significantly higher in February when THMs were higher, and that the sample data from the Plan suggests that we'll continually be dealing with high TOC and THMs.

Given what we know, there are obvious concerns about continuing to use the Rose Valley reservoir as our primary source. And given the potential conflicts of interest, I don’t know how we can rely on the same consultants to advise on the future of our water.

Scott Beaton

West Kelowna Resident

Letter from Nelson Fok

October 26, 2024

Abbreviation

ALARA As low as reasonably achievable
AO Aesthetic Objective
BDCM Bromodichloromethane
DCA dichloroacetic acid
DBP Disinfection by-products
HAA Haloacetic Acid
HBV Health Based Value
MAC Maximum Acceptable Concentration
mg/L milligram per liter
Mn Manganese
TCA Trichloroacetic acid
THM Trihalomethane
TOC total organic carbon

City	Date	Mn	HAA	THM	Others
2011 steven R	July 24	0.0912			
Raw WTP	July 10	0.111			Iron 0.059
RV trails	May 13	0.00478	0.0224	0.0278	DCA 0.0104
	Feb 14		0.0372	0.0582	Chloroform 0.0554
Thacker	May 13	0.00328	0.0214	0.0340	BDCM 0.0021 DCA 0.0112
	Feb 14		0.0418	0.0714	Chloroform 0.0680
Shannon way	May 13	0.00174	0.0241		BDCM 0.0026 DCA 0.0126
	Feb 14		0.0429	0.0806	Chloroform 0.0768
RV raw	May 15	0.0163		0.0253	Color 22; TN 0.468 TOC 6.84
Treated meter	May 15	0.0052	0.0178	0.0253	DCA 0.0078
Menu Rd pump	May 13	0.00572	0.0234	0.0319	DCA 0.0099
	Feb 14		0.0418	0.0686	Chloroform 0.0654
Pritchard Park	May 13	0.00224	0.0297	0.0383	DCA 0.0138
	Feb 14		0.0510	0.0880	Chloroform 0.0838
Viognier Prv	May 13	0.0120	0.0241	0.0692	BDCM 0.0038; chloroform 0.0654 DCA 0.0116
	Feb 14		0.0415	0.0985	Chloroform 0.0939
Blackwood	May 13	0.00392	0.0252	0.0379	DCA 0.0118
Horizon tap	May 13	0.00585	0.0269	0.0366	DCA 0.0129

community	Date	Mn	HAA	THM	Others
1341 sink	Aug 14	0.0221	0.104	0.175	Chloroform 0.170 DCA 0.0524 BDCM 0.0046

Chronicle of Events:

May 2024

Rose Valley Water Treatment Plant, located at 1500 Rosewood Drive, started to provide service to the residents in the City of West Kelowna. The source of the water is from Rose Valley Lake, a men-made reservoir with water coming in from Bear Creek. The plant uses coagulation, flocculation, dissolved air flotation, sand anthracite filtration, ultraviolet (UV) disinfection and chlorination to improve the taste, colour, and smell of water.

Soon after commission, the treated water has a brown color to it and was attributed to the presence of Manganese (Mn) in the source water. The presence of this inorganic at such a high level was not noted during the initial assessment of the source water and may be attributed to 2023 McDougall Creek wildfire in the area.

The City acknowledged discoloration in July and advised residents to use an alternative source from the bulk filling stations at Asquith Road and Shannon Lake Road if deemed necessary.

July 23

The city provided information to the public regarding the presence of Mn in water, noting that the level is below Maximum Allowable Concentration (MAC) as listed in the Canadian's Guidelines for Canadian Drinking Water Quality, but exceeded the Aesthetic Objective of 0.02 mg/L.

City stated that "…results show that standards set out in the Drinking Water Protection Regulation continue to be met. These ongoing samples, tests and analyses have indicated that the discoloration is aesthetic, appearing as turbidity. Currently, the drinking water objectives for chlorine and bacterial quality are being maintained. The City continues to consult with water quality consultants and Interior Health regarding the aesthetic conditions and the safety of the water, and no Water Quality Advisory or Boil Water Notice is currently required…"

July 31

Monitoring at sampling sites in Zone 2 of the former West Kelowna Estates System of the Rose Valley Water Service Area found Mn level to have marginally exceeded the MAC levels with readings of 0.127 mg/l, 0.13 mg/l and 0.168 mg/l. In consultation with Interior Health, it was determined that a water quality advisory was not required. However, out of an abundance of caution, the city suggested parents who are constituting formula for infants should use an alternative water source.

Aug 1

City stated that "…To control high level of Mn in source and treated water, the city decided to pre-chlorinate to oxidize soluble Mn to insoluble precipitate so it can be filtered out. Some of the operational adjustments include implementing an advanced oxidation system into the treatment process to help remove dissolved manganese. Further, dosing with chlorine early in the treatment process allows manganese to be removed through the dissolved air flotation and filtration processes in the plant. There may still be some minor discoloration and/or odor, but the water continues to meet federal and provincial standards…"

The city claimed to continue to monitor the situation and treatment process and assured the public that the water is safe to drink.

The increased use of chlorine for oxidation may have resulted in the increase production of disinfection by-products (DBP) such as Trihalomethanes (THMs) and Haloacetic Acids (HAA).

Aug 6

The city reported that the THM reading at the Rose Valley Water Treatment Plant 'vault' was 0.125 mg/L or 0.025 mg/L above the MAC. The city stated that "…This one MAC exceedance did not require an advisory because the requirements for THMs and HAAs are based on annual averages…" and "…Health Canada states that health risks associated with chlorine disinfection byproducts are much less than those associated with consuming inadequately disinfected water…"

Oct 8

An update to council recognized the presence of DBP and suggested the exploration of aeration in RV Lake or the use of permanganate to control Mn levels. One of the councilors suggested that consumers do not feel safe regarding the water and suggested better sharing of current results and to consider Power Creek water diversion to RV as emergency

Oct 18

Due to lower levels of manganese in the source water, the city has removed the pre-oxidation process and returned to regular typical water treatment processes

Manganese MAC 0.12 mg/L and AO 0.02 mg/L

Background Information

MAC of 0.12mg/L is based on intake by 6-month-old infants. AO of 0.02 mg/L is intended to minimize the occurrence of discoloured water complaints based on the presence of manganese oxides and to improve consumer confidence in drinking water quality and to reduce consumer complaints regarding discoloured water and staining of laundry.

Infants are the most sensitive subpopulation to the health effects of manganese, having higher absorption and retention of manganese than adults. The MAC is established at a level to be protective of neurological effects in infants, the most sensitive population. Evidence also suggests that exposure to manganese in early life, during a critical period of development of the dopaminergic system and may result in lasting neurotoxic effects in adults. The HBV (same as MAC) was established for the most sensitive subpopulation, and is also protective for chronic exposure in children and adults. In addition, exposure to manganese in drinking water at levels at or below the HBV is not expected to result in other types of toxicity that have been associated with exposure to manganese.

Other Jurisdiction: Minnesota's Department of Health developed a tiered guidance document based on the same endpoint and key study used by Health Canada to derive its HBV. A level of 0.1 mg Mn/L was established for infants less than one year old, and 0.3 mg Mn/L for children over one year old and adults

Comments:

The city's statement on Mn exceeding AO is correct but not technically accurate. The water is safe based on health parameters, but not acceptable, which is the purpose of AO. There was also no mention of staining laundry and what consumers can do to lighten the stain. I do not know if there has been any staining of fixtures, but the city can also provide info on how to remove fixture and laundry stains.

On July 31, the city noted Mn level slightly exceeded the MAC but concluded that an advisory is not needed (readings of 0.127 mg/l, 0.13 mg/l and 0.168 mg/l). The city suggested parents who are constituting formula for infants should use an alternative water source. Issues:

1- MAC of 0.12 mg/L for Mn is based on harmful effect of Mn on neurological development in infants with an average weight of 7 kg. For an infant with a weight of 6 kg, the MAC goes down to 0.1 mg/L and 0.08 for a 5 kg infant. 0.168 mg/L of Mn is high for these infants. It is impossible to say if short exposure to high Mn can cause any neurological development, but precautionary principle should take place. In practice, no mother would use colored water to make infant formular for their infant. The city should suggest parents not to use colored water to make infant formular for infants regardless of Mn level, as it may fluctuate;
2- The timing of tests also plays an important role. If you look at testing results, for Feb and May samples, results took about 10 days, which is pretty normal. In July, testing results came back within 2 days. I do not have the July 31 testing results, but the question should be asked: how long before the result came back and how long the Mn level exceeded the MAC? Was it just 24 hours or 3 days? There is a need for assurance that Mn testing is done not only daily, but the sample must be analyzed and reported back within 24 hours. Otherwise, infants may be using water with high Mn for days; and

3- This is just my opinion, but I would suggest any parents with infants (under 1 year) on formula should registered with the city and that the utility DELIVERS water to these parents on a regular basis. There should not be that many infants in the area so it should not be that labour intensive. Parents are busy enough and to go get proper water is added work that they do not need. As it is the city's responsibility to provide acceptable and safe water, the least they can do, and the right thing to do, is to deliver water to families with infants. This is what I would do if the utility was in my area and not based on any requirements.

<u>Conclusion:</u>

The water is safe for consumption for the public (children and adults) but more can be done to assure a safe and adequate supply for infants (under 1 year)

Disinfection by-products (DBP)

<u>Background Information</u>

Trihalomethanes (THM) MAC 0.100 mg/L

The maximum acceptable concentration (MAC) for trihalomethanes1 (THMs) in drinking water is 0.100 mg/L (100 μg/L) based on a locational running annual average of a minimum of quarterly samples taken at the point in the distribution system with the highest potential THM levels

Bromodichloromethane (BDCM) 0.016 mg/L

The maximum acceptable concentration (MAC) for bromodichloromethane (BDCM) in drinking water is 0.016 mg/L (16 μg/L) monitored at the point in the distribution system with the highest potential THM levels

Haloacetic Acids (HAA) MAC 0.08 mg/L and ALARA

The maximum acceptable concentration (MAC) for total haloacetic acids in drinking water is 0.08 mg/L (80 μg/L) based on a locational running annual average of a minimum of quarterly samples taken in the distribution system. Utilities should make every effort to maintain concentrations as low as reasonably achievable (or ALARA) without compromising the effectiveness of disinfection.

DBP is formed when a disinfectant, such as chlorine, reacts with natural organic compounds in the source water, forming by-products that can be toxic at higher levels. As natural organic compounds (such as humic and fulvic acids) cannot be properly measured, total organic carbon (TOC) is often used as a surrogate to indicate the likelihood and potential for DBP formation during treatment. DBP levels increase with higher levels of disinfectants, higher level of precursors, contact time and temperature. Raw water sample taken on May 15 (RV Raw) showed a TOC reading of 6.84 mg/L. The Ambient Water Quality Criteria for Organic Carbon in BC (1998) recommended a source water TOC of 4 mg/L. The source water therefore has the potential to produce high levels of DBP.

It should be noted that disinfection is one of the most important components of water treatment and health risk related to DBP formation is secondary to proper disinfection. As a result, Health Canada suggested that utilities should not compromise disinfection efficiency to lower DBP levels.

The city's 'Summer 2024 – update' noted that on Aug. 6, the THM reading at the Rose Valley Water Treatment Plant 'vault' was 0.125 or 0.025 mg/L above the MAC. The city stated that "…this one MAC exceedance did not require an advisory because the requirements for THMs and HAAs are based on annual averages…" and "…Health Canada states that health risks associated with chlorine disinfection byproducts are much less than those associated with consuming inadequately disinfected water…".

Testing submitted by citizen on Aug 14 showed THM level at 0.175 mg/L and BDCM at 0.0046 mg/L.

The statement by the city again is correct but technically not accurate.

THM MAC is based locational running annual average, not 'annual average'. DBP levels increase with contact time and temperature. As a result, the longer the water with DBP precursors is in contact with chlorine, the more DBP will be produced. The highest level of DBP would be in homes furthest away from the water treatment plant. DBP levels also fluctuate with water temperatures, with more being produced in the summer months, when the water is warmer (and more chemical reactions) vs winter months.

Kelowna temperature is highest in July and lowest in January. DBP samples should therefore be taken in July, October, January and April. The distribution area in West Kelowna is not that great but the city should have done some testing to determine if the DBP levels would differ substantially from the treatment plant to users furthest away from the plant. DBP samples should not be taken from treatment plant 'vault' (whatever that means) unless it has been established that the levels at the plant and in the distribution system are the same. Running average means continuous quarterly samples and the average of four samples calculated continuously and not based on 'annual' calendar averages.

Therefore, it is impossible to determine if the water is 'safe' for consumption based on one set of data taken in July. The city should have a second set of samples from October for disclosure. It should also be noted that there are three DBP MAC- THM, BDCM and HAA. The city should disclose readings for all three DBP on a quarterly basis (I could not find any October data).

It is noted that the city stopped pre-chlorination of the water on October 18 as the source water Mn has dropped. There should be a corresponding decrease in DBP levels.

The city's statement that "…Health Canada states that health risks associated with chlorine disinfection byproducts are much less than those associated with consuming inadequately disinfected water…" is correct. However, it should be noted that the high DBP level in West Kelowna is not because of the need to properly disinfect the water, but rather to control Mn level, so this statement is not valid. If the Mn level is low in source and treated water, there would be no need to pre-chlorinate, and the water would still be properly disinfected by chlorine after filtration. The present problem of DBP is due to the need to chlorinate before filtration to control Mn. The health risk of DBP formation and levels should be compared to the risk of high Mn for infants and consumer acceptance and NOT proper disinfection.

FYI, for normal water treatment, filtration would remove most of the DBP precursors (TOC) so when chlorine is added after filtration, the amount of DBP formed would be limited (as in RVWTP before Mn was a problem). Pre-filtration chlorination is needed to oxidize soluble Mn to insoluble form so the precipitates can be filtered out. This would result in the formation of DBP which are much smaller than the TOC precursors and not properly removed by filtration.

The three DBP MAC also have different health implications.

For THM, the MAC calculation is based on chloroform. Chloroform is the most common tri-halomethane present in water but also of the lesser health concerns. Of greater concern would be the brominated DBP. As a result, MAC was developed for BDCM.

For HAA, the MAC is set at 0.08 mg/L. However, of the five HAA, DCA is of the greatest concern. Based on regular risk assessment, the MAC should be set at 0.01 mg/L. Health Canada, however, realized that this cannot easily be achieved by water treatment plants and therefore set the MAC at a higher than usual level of 0.08 mg/L but recommended that the level should actually be As Low As Reasonably Achievable (ALARA).

It should be noted that the MAC for DBP is based on lifetime exposure risk. An increase in DBP level of a year or so should not pose a major health risk.

Comments:

If the city is continuing with pre-chlorination, it should release locational DBP testing results for THM, BDCM and HAA for October. In theory, July was the warmest month so the DBP level should be highest. Since the value only just exceeded the MAC, the annual locational average should be below the annual MAC reading. This is assuming the data reflects highest locational readings.

If the city is discontinuing pre-chlorination, there is no reason for DBP levels to remain high. Filtration should reduce TOC level in source water. Monitoring and reporting of DBP should, however, be continued.

CURRICULUM VITAE
NELSON M. FOK

E-mail:[redacted]

EMPLOYMENT

Health risk assessment and management; water safety; policy evidence-based information and knowledge translation; research and analysis of emerging issues

September 2014 to 2020	Principal, *Enviro*Health Consulting Edmonton, Alberta
September 1995 to April 2019	Adjunct Professor (1995 to 2019) and Associate Director (2013 to 2018) Department of Public Health, Concordia University of Edmonton, Alberta
April 2009 to August 2013	Provincial Manager, Scientific Advisory Team, Environmental Public Health Alberta Health Services, Alberta
November 1989 to April 2009	Science & Technical Director, 2008-2009; Associate Director, 2002-2008; Manager, Research & Development, 1999-2002; Senior Advisor, Health Risk Assessment, 1995-1999: Environmental Public Health, Capital Health Associate Director, 1992-1995; Senior Advisor, 1989-1992: Environmental Health, Edmonton Board of Health, Edmonton, Alberta
February 1985 to October 1989	Public Health Inspector Leduc-Strathcona Health Unit, Sherwood Park, Alberta
May 1984 to November 1990	Owner/Manager High Road to China, West Edmonton Mall, Edmonton, Alberta

EDUCATION

1990-1992	Provisional Ph.D., Environmental Science Department of Civil Engineering, University of Alberta Courses: Epidemiology; Waste Management; Water Quality Management
1981-1985	Master of Science, Environmental Science Department of Civil Engineering, University of Alberta Courses: Environmental Impact Assessment; Environmental Engineering; Air Pollution; Occupational Health; Water and Wastewater Treatment; Industrial and Hazardous Waste Management; Hydrogeology; Water Chemistry
1978-1980	Diploma in Environmental Health British Columbia Institute of Technology, Burnaby, B.C.
1972-1976	Bachelor of Science, Biochemistry University of British Columbia, B.C.

NELSON M. FOK

PROFESSIONAL APPOINTMENTS

Adjunct Professor, Concordia University of Edmonton, Environmental Health Program, courses on Health Risk Assessment, Water Quality, Ambient/Indoor Air Quality and Waste Management, 1995 to 2019
Adjunct Assistant Professor, Faculty of Medicine, Department of Public Health Sciences, University of Alberta, 1994 to 2008
Advisor, National Collaboration Centre for Environmental Health (NCCEH), Canada, 2013-2019

CONSULTANT PROJECTS

Alberta Health, Drinking Water Safety Plan, 2018-2019
Alberta Environment and Sustainable Resource Development, Transportation of Water Samples, 2014-2015
Public Health Agency of Canada, Climate Change and Public Health Toolkit, 2015

PROFESSIONAL COMMITTEES AND ACTIVITIES

Children's Environmental Health Clinic, Edmonton, Advisory Board Member, 2015 to 2019
Expert Elicitation on Enteric Illness, Centre for Food-Borne, Environmental and Zoonotic Infectious Diseases. Public Health Agency of Canada, 2014
Leadership Competencies for Public Health Practice in Canada, Expert Advisory Committee, Public Health Agency of Canada, 2014
Alberta Environment and Sustainable Resource Development, Standards Advisory Panel 2014
Editorial Board, *Environmental Health Review*, 2012 on
Canadian Standard Association (CSA) Technical Committee (2009 to 2013)
C-EnterNet Advisory Committee (2006 to 2012)
National Collaborating Centre in Environmental Health (NCCEH) Advisory Board (2006 to 2019), Board Chair, 2009-2015
Member, NSF International Committee on Water Additive Committee (1993-1999)
Provincial committees: Operational Guidelines for Composting Facilities and Compost Final Product Quality (1993-96); Guidelines for Health Impact Assessment for Landfill Siting (1992-4); Health Assessment of Sour Gas Siting Requirement (1993-4); Petroleum Contaminated Soil Risk Assessment (1992-95); Technical Advisory Committee on Drinking Water (2000-2013); Cross Ministry Water Strategy Drinking Water Working Group (2002); Alberta Swimming Pool Technical Advisory Committee (2003-2013); Coalbed Methane (2006); Public Health Management Committee (2012-2013); Scientific Advisory Committee on Food Consumption Advisories (2012); Committee on Lead Service Line (2012-2013), Committee on Blue Green Algae (2012-2013); Drinking Water Technical Working Group (2015 on); Lead in Drinking Water Working Group (2015 on); Technical Committee on Reclaimed Wastewater (2016 on);
Reviewer, *Canadian Journal of Public Health*, Canadian Public Health Association, 1994-2010; and *International Journal of Environmental Research and Public Health* 2009

AWARDS AND RECOGNITIONS

CIPHI Life Member Award, Canadian Institute of Public Health Inspector, 2016
Nelson Fok Award, Alberta Health Services, 2013
100 Members of Distinction, Canadian Institute of Public Health Inspector CIPHI 2013
'REACH' Award of Distinction, Capital Health 2008
'AAPEX' Alberta Agriculture Performance Excellence Awards, Rural Water Quality Information Tool (RWQIT) development team, 2007
'REACH' Award of Distinction, Wabamun Spill Core Response Team, Capital Health, 2006
'REACH' Award (Recognition for Excellence and Achievement in Capital Health) *for Team Work* (Wabamun Train Derailment), Capital Health, 2006
'REACH' Award for Team Work (Environmental Action and Control), Capital Health, 2005

Alexander Officer Award, Canadian Institute of Public Health Inspectors (Safe Drinking Water Technical Advisory Committee), 2004
Alexander Officer Award, Canadian Institute of Public Health Inspectors (Capital Health), 2003
'REACH' Award for Team Work (World Track and Field Championship team), Capital Health, 2002
'*Outstanding Preceptor Award'*, Medical Students' Association, Faculty of Medicine and Dentistry, University of Alberta, 2000-2001
'*REACH*' *Award for Leadership*, Capital Health, 2001
L.E. Stewart Award, Canadian Institute of Public Health Inspectors (Alberta Branch), 1998
Environmental Health Review Award, Canadian Institute of Public Health Inspector, 1997
L.E. Stewart Award, Canadian Institute of Public Health Inspectors (Alberta Branch), 1994
Recognition from Canadian Institute of Public Health Inspector for Outstanding Efforts (Edmonton Board of Health) in the Protection of Environmental and Public Health, 1991

PROFESSIONAL AFFILIATION

Canadian Institute of Public Health Inspectors; Air & Waste Management Association
American Water Works Association; International Association for Food Protection
Canadian Water Works Association

PUBLICATIONS

Contributor, "WW-Nelson-Do", CIPHI-Alberta Branch Newsletter, 2014 on
Editor for *Canadian Environmental Health Information Clearinghouse*, 1996 to 2009
Editor for *Food Council News*, 1998 to 2009
Editor for *Environmental Health Monitor*, 1999 to 2009
Editor for *Communicable Disease-Corner*, 2000 to 2004
Contributor, *Family Health/Your Health*, 1995 to 2009
Contributor, "Journal Review", *Environmental Health Review*, 1994 on

MANUALS/BOOKS

International Association of Food Protection, *Procedures to Investigate Waterborne Illness*, Third Edition, 2016
Honish L, Fok N and Dimock S, *Child Care Facility Environmental Public Health Information Manual*, Capital Health, 2009
Galbraith C et al., *Capital Health's Safe Food Program: Review and Enhancement*, Capital Health, 2008
Fok N (Technical Editor) *Environmental Public Health Field Manual for Private, Public and Communal Drinking Water Systems in Alberta*, Alberta Health and Wellness, First Edition, 2002; Second Edition 2004; Third Edition 2007
Emde KME et al, *Estimating Health Risk from Infrastructure Failures*, AWWARF, 2006
Fok N., Honish L, Zazulak I *et.al*, The Role of Public Health Agencies in Preventing *Giardia* Outbreaks, in *Giardia, The Cosmopolitan Parasite*, Chapter 12, pp127-134, Editors Olson B.E., Olson M.E. and Wallis P.M., CABI Publishing, New York, 2002
Emde KME et al., *Waterborne Gastrointestinal Disease Outbreak Detection*, American Water Works Association Research Foundation and American Water Works Association, 2001
Fok N., I. Zazulak, and W. Hohn. *Enteric Disease Manual*, 1996
Fok N., E. Zazulak, and T. Mak. *Child Care and Environmental Health. Information Manual.* 1993
L. Boychuk and Fok N. *Placement of Pets and Animal in Long-Term Care Facilities*, 1992
Fok N. *Chemical Spill MSDS Manual*, 1991

NELSON M. FOK

JOURNALS and PROCEEDINGS

Fok N, Health and Utilities- Working Together to Prevent Waterborne Outbreaks, *Proceedings of the Western Canada Water Annual Conference*, Winnipeg, Sep 20-23 2009

Emde KME et al, Development of an Alberta Program for Public Health Auditing of Unlicensed Drinking Water Supplies, *Proceedings of the 59th Annual Conference of the Western Canada Water and Wastewater Association*, Edmonton, Oct 23-26 2007

Emde KME et al, Development of a Joint Emergency Training Program for Water Utilities, Regional health Authorities and Alberta Environment, *Proceedings of the 59th Annual Conference of the Western Canada Water and Wastewater Association,* Edmonton, Oct 23-26 2007

Emde KME et al, Water Distribution Infrastructure Failures: Emergency versus Repairs? *Proceedings of the American Water Works Association Annual Conference*, Toronto, ON, June 24-28

Fok N and Emde KME, Beyond Source - To - Tap: The Complete Role of the Health Department in Water Safety, Proceedings, *12th Canadian National Conference*, CWWA/ACEPU, Saint John 2007

Fok N. *Pseudomonas aeruginosa* as a Waterborne Gastroenteritis Pathogen, *Environmental Health Review* 49(4):121-127, Winter 2005

Emde KME and Fok N, Public Water- Public Health, *Proceedings of the National Environmental Health Association Annual Conference*, Providence, Rhode Island, June 26-29 2005

Kwon E. et al, Arsenic on the Hands of Children after Playing in Playgrounds, *Environmental Health Perspectives*, 112(14):1375-1380, October 2004

Emde KME et al, Planning a Public Health Water Quality Strategies for Regulated and Unregulated Public Drinking Water Supplies in the Capital Health Region, *Proceedings of the 11th Canadian National Conference & 2nd Policy Forum on Drinking Water*, Canadian Water and Wastewater Association Biennial Meeting, Calgary AB, April 3 to 6, 2004

Fok N, Risk Evaluation of Arsenic Exposure in Playground, *En. Health Review*, 47(2):51-58, 2003.

Fok N, Changing Faces of Drinking Water Treatment, *En. Health Review*, 43(4):98-102, 1999

Gammie L, Goatcher L. and Fok N., 'A *Giardia/Cryptosporidium* Near Miss?' proceeding, National Water and Wastewater Forum, *CWWA/ACEPU*, Quebec City, 1998

Fok N, Indoor Air Quality-New Findings to An Old Problem. Part I and Part II, *En. Health Review*, 40(2):48-52, Summer, 1996; and 40(3):70-74, 1996

Kindzierski WB and Fok N, Burning Scrap tires in Cement Kilns: Should We Be Concerned About Hazardous Air pollutants? Proceedings, *Air & Waste Management Assoc 87th Annual Meeting*, 1994

Fok N, Composting and Health: A Review, *Environmental Health Review*, 37(3):66-69, 1993

Fok N, Ozone and Skin Cancer: Fact and Fiction, *En. Health Review*, 37(1):10-13, 1993

Fok N, D. Langier-Blyth, J. Steele. Diaper Service - Operational Guideline, *Environmental Health Review*, 35(2):41-43, 1991

Fok N, Inorganic and Physical Parameters for Drinking Water, *En. Health Review*, 34(1):15-19, 1990

Fok N, Water Quality and Plumbosolvency, *Environmental Health Review*, 33(3):69-74, 1989

Fok N, Modified Atmosphere Packaging: A Public Health Concern, *Environmental Health Review*, 32(4):100-104, 1988

Fok N, Huck P.M., Walker G.S. and Smith D.W. Evaluation of Drinking Water Treatment Alternatives for Taste and Odour Reduction, *Water Pollution Res. J. (Canada)*, 19(1):119-132, 1984

Fok N, Environmental Impact of Injection Wells, *Environmental Health Review*, 27(2):25-30, 1983

Fok N, Use of Ultraviolet in Water and Wastewater Treatment, *En. Health Review*, 26(3):75-79, 1982

THESIS

Fok N, Huck P.M. and Smith D.W. The Use of Ozone, Chlorine Dioxide, and Activated Carbon for Taste and Odour Removal in the City of Edmonton Water Treatment Plant, M.Sc. thesis, Department of Civil Engineering, University of Alberta, 1985

CONFERENCE AND WORKSHOP PRESENTATIONS

Special Invitation:

Fok N, Guest Lecturer, Food and Waterborne Outbreaks, Epidemiology and Control of Infectious Diseases SPA 697, University of Alberta, 2009 on

Fok N, Science-Based Boil Water Advisories and Panellist, Drinking Water – Issuing and Rescinding Boil Water Advisories, Canadian Water and Wastewater Association, National Water and Wastewater Conference, Whistler BC, Oct 25-28, 2015

Fok N, From Food Safety Surveillance to Risk Management and Communications, Macau University of Science and Technology, Macau October 30, 2013

Fok N, From Food Safety Surveillance to Risk Management and Communications, Hong Kong Polytechnic University, Hong Kong October 23 2013

Fok N, Public Health's Role in Safe Drinking Water and The Application of Risk Assessment in a Health-Based Safe Drinking Water Program., International Symposium on Drinking Water Quality, Shijiazhuang, Hebei, September 7 2012

Fok N, Application of Risk Management Principles and Food Safety; Food Safety: Compliance, Inspection and Risk Management and Food Safety and Risk Communication. Presentations at Human Health Risk Assessment and Management, Food Safety and Environmental Consummation, Chinese Center for Disease Control and Prevention, Hangzhou, Zhejiang, China Sep 19-21 2011

Fok N, Risk Communication in Practice, Post-Conference Workshop in Risk Communication, National Collaborating Centre for Environmental Health, 77th CIPHI National Educational Conference, Halifax NS, June 30 2011

Fok N, Risk Communication in Practice, Workshop in Risk Communication, National Collaborating Centre for Environmental Health, CIPHI Ontario Branch Educational Conference, London ON, Oct 3 2009

Fok N, Active Surveillance, Safe Drinking Water Course and Panellist, National Collaborating Centre for Environmental Health, Kananaskis AB, May 3 2009

Fok N, Seminal Speaker in the launching of Food Safety and Occupational Health programs plus presentations on Environmental Health Program in Canada and Emerging Environmental Health Issues, College of the North Atlantic- Qatar, Doha Qatar, November 4-6, 2008

Fok N, Role of Public Health in Preventing Waterborne Outbreaks, Safe Drinking Water Course and Panellist, National Collaborating Centre for Environmental Health, St. John's NL, July 24 2008

Fok N, Zhejiang Institute of Public Health Inspection, Zhejiang Province, PR China, Dec 18-21 2004

Fok N, Panellist- Surveillance Issues, Food & Waterborne Infectious Disease Threats Symposium, Southeastern Center for Emerging Biologic Threats, Atlanta GA, Nov 16, 2004

Fok N, K. Emde, J Talbot, D. Smith, 'Overview of Available Good Practice for Detection of Waterborne Disease' Keynote presentation, 'Emerging Risks to Drinking Water Supplies' OECD, Cuervanaca, Mexico, July 28-30, 2003

Invited participants (only Canadian among twelve US representatives) to 'Virtual Bistro' by US Department of Agriculture (USDA), a pilot program in food safety, 2002

CONFERENCE/WORKSHOP PRESENTATIONS

Fok N, Radon WTF (What's True/False), 14th CIPHI Saskatchewan Professional Education and Development Seminars, Saskatoon, SK, Oct 17-18, 2023

Fok N, Wildfire: Air Quality Health Index and Health Impacts, CIPHI Environmental Public Health Week, Sep 25-Oct 1, 2023

Fok N, Risk Communication and Anti-Vaxxer, CIPHI Alberta Fall Workshop, Edmonton AB, Oct 23-25, 2022

Fok N, Living in a Microplastic World, CIPHI National Annual Educational Conference, Durham ON, Sep 11-14, 2022

Fok N, Climate Change and Water Quality/Quantity, Calgary Drinking Water Workshop, Health Canada, Calgary, AB, May 18, 2022

Fok N, Point of Use Devices and Bottled Water, Edmonton Drinking Water Workshop, Health Canada, Edmonton, AB, May 2, 2019

Fok N, Water Wells and Setback Distances, Working Well Delivery Staff Training Session, Alberta Agriculture and Forestry, Leduc AB, Feb 28, 2019

Fok N, MAC and Safe Drinking Water, Drinking Water Chemical Parameter Education Session, Edmonton, AB, Feb 12, 2019

Fok N, Microbial and Chemical Contamination from Onsite Wastewater Systems, CIPHI Alberta Branch Fall Workshop, Edmonton AB, October 1-2, 2018

Fok N, False Positive *E. coli* Results- How to Make an informed Decision, CIPHI 84th Annual Education Conference (AEC), Saskatoon, SK, September 17-19 2018

Fok N, Lead in our Water and Food Environment, CIPHI 84th Annual Education Conference (AEC), Saskatoon, SK, September 17-19, 2018

Fok N, Lead and the Water Environment, CIPHI Alberta Branch Fall Workshop, Fort McMurray AB, September 21-22, 2017

Fok, N. Waterborne Pathogens, Drinking Water Workshop, Health Canada, Calgary AB, December 1 2016

Fok N, Opportunistic Premise Plumbing Pathogens, CIPHI Saskatchewan 9th Annual Professional Education and Seminar, Saskatoon, SK November 8, 2016

Fok N, Chloramination- Dispelling the Myth, National Canadian Water and Wastewater Conference, Toronto, Nov 13-16, 2016

Fok N, Opportunistic Premise Plumbing Pathogens, CIPHI Annual Educational Conference, Edmonton, Alberta Sep 25-28, 2016

Fok N, Flint Crisis- Can It Happen in Canada? CIPHI Annual Educational Conference, Edmonton, Alberta Sep 25-28, 2016

Fok N, Boil Water Advisories: Basing on Science and Not End-product Testing, CIPHI-Alberta Annual Workshop, Olds AB, Oct 14-15, 2015

Fok N, New Food Trends & Farmers' Markets, Aligning Food Safety Systems in Alberta, CIPHI-Alberta Annual Workshop, Edmonton AB, Sep 25-26, 2014

Fok N, Disinfection By-Product Dynamic in Chlorinated Swimming Pool, CIPHI 80th Annual Educational Conference, St. John's, Newfoundland, July 13-16, 2014

Fok N, National Collaboration Centre for Environmental Health, American Industrial Hygienist Association, Alberta Local Section Annual Symposium, Edmonton, March 14, 2014

Fok N, Chloramine- Dispelling the Myth, BC Centre for Disease Control (BCCDC) - Grand Rounds Environmental Health Seminar Series, February 27 and May 29, 2014

Fok N, Public Health & Water: Municipal Oversight and Issues, The WaterWise Alberta Series, AWWOA, Edmonton, September 19, 2013

Fok N, Water Safety, Community and Hospital Infection Control Association – Northern Alberta, 1st Telehealth Education Day, Edmonton, September 13, 2013

Fok N and Ponto J, Improving Conventional Investigations of Legionnaire's Disease, 79th CIPHI Annual Educational Conference, Winnipeg, June 23-26, 2013

Fok N, Evidence in Action: National Collaborating Centres Working with You, Canadian Public Health Association 2013 Annual Conference, Ottawa, June 9-12, 2013

Fok N, *E. coli*, The Misunderstood Microbial Indicator, BC Centre for Disease Control (BCCDC) - Grand Rounds Environmental Health Seminar Series, April 25, 2013

Fok N, Inspection of Care and Laundry Facilities, AHS Linen & Environmental Services Leadership Conference, Edmonton, June 6, 2012

Fok N, Safe Housing Program, NCCEH Health Promotion Workshop, Vancouver May 31, 2012

Fok N, Research and Surveillance Initiatives, Alberta Occupational and Environmental Health Symposium, Human Services Alberta, Calgary, March 8, 2012

Fok N, Endocrine Disruptors, Pharmaceutical and Personal Care Products in Surface and Drinking Water, CIPHI Manitoba Branch Annual Education Conference, Winnipeg Manitoba, September 14, 2011

Fok N, Incorporating Practice-Based Evidence into Decision Making, CIPHI Manitoba Branch Annual Education Conference, Winnipeg Manitoba, September 14, 2011

Fok N, It is Just a Number, Alberta Water & Wastewater Operators Association 36th Annual Operators Seminar, Banff, AB, March 16, 2011

Barm, Prabjit (NCCEH) and Fok N, 'Power Lines and Health: The Evidence and Public Policy', CIPHI NL and Labrador Branch Annual Conference, St. John's, Newfoundland and Labrador, November 4, 2009

Fok N, Health and Utilities- Working Together to Prevent Waterborne Outbreaks, Western Canada Water 61st Annual Conference, Winnipeg Manitoba Sep 20-23, 2009

Fok N, 'How to Make Your Home Environmentally Healthy' Being Healthy Inside and Out, Merck Frosst Special Event, Minerva Senior Studies Institute, Grant MacEwan College, Edmonton AB, June 18, 2009

Fok N, 'Food Safety at Large Events – Beijing Olympic', Kentucky Association of Milk, Food and Environmental Sanitarians (KAMFES) 2009 Annual Conference, Louisville, Kentucky Feb 17-19, 2009

Fok N, 'Waterborne Pathogen', Health Protection Forum, Health Canada, Red Deer Dec 11, 2008 and Grand Prairie Jan 15, 2009

Fok N, 'Emerging Water Issues', Health Protection Forum, Health Canada, Red Deer Dec 11, 2008 and Grand Prairie Jan 15, 2009

Fok N, 'How to Make Your Home Environmentally Healthy', Speaking of Women's Health Conference, Ed Oct 4, 2008

Fok N and Emde K, 'Health-Based Safe Water Program', CIPHI 74th Annual Educational Conference, St. John's NL, July 20-23, 2008

Fok N and Honish L, 'Practice-Based Evidence to Evidence-Based Practice: Linking Foodborne Illness Surveillance Information to Restaurant Inspection Outcomes', CIPHI 74th Annual Educational Conference, St. John's NL, July 20-23, 2008

Galbraith C et al., 'Safe Food Assurance Program', CIPHI 74th Annual Educational Conference, St. John's NL, July 20-23, 2008

Fok N, 'Chemical Exceedance: Disinfection By-Products and Water Avoidance Advisories', Alberta Environment Drinking Water Workshop, Edmonton June 12, 2008

Emde KME et.al, 'Development of an Alberta Program for Public Health Auditing of Unlicensed Drinking Water Supplies', 59th Annual Conference of the Western Canada Water and Wastewater Association, Edmonton, Oct 23-26, 2007

Emde KME et al, 'Development of a Joint Emergency Training Program for Water Utilities, Regional Health Authorities and Alberta Environment', 59th Annual Conference of the Western Canada Water and Wastewater Association, Edmonton, Oct 23-26, 2007

Fok N, et al, 'Safe Food Assurance Program – Knowledge Translation, Program Review and Enhancement', CIPHI (Alberta) 8th Annual Educational Workshop, Edmonton, Oct 4-5, 2007

Emde KME et al, 'Water Distribution Infrastructure Failures: Emergency versus Repair?' AWWA Annual Conference and Exposition, Toronto, ON, June 24-27, 2007

Fok N, 'Working with Health Departments to Prevent Waterborne Outbreaks', Alberta Water & Wastewater Operators Association 32nd Annual Operators Seminar, Banff, AB, March 13-16, 2007

Fok N, 'Cumulative Risk Assessment', Keynote Address, Synergy Conference, Industrial Heartland Collaboration to Address Resident Interests, Fort Saskatchewan Oct 21, 2006

Fok N, 'Nosocomial Outbreak Prevention', CIPHI 72nd Annual Conference, Regina, SK, June 26-28, 2006

Fok N and Emde KME, 'Beyond Source-to-Tap: The Complete Role of the Health Department in Water Safety', 12th Canadian National Conference and 3rd Policy Forum, CWWA, Saint John, New Brunswick, Apr 1-4, 2006

Fok N, 'What Are We Really Inhaling in the Air We Breathe?' Managing Respiratory Care in the Community, Best Practice Conference, Edmonton Nov 4, 2005

Fok N, 'Waterborne Diseases', Managing Respiratory Care in the Community, Best Practice Conference, Edmonton Nov 4, 2005

Fok N, 'Tools and Techniques to Prevent Waterborne Outbreaks', CIPHI 71st Annual Educational Conference, Toronto, Sept 26-28, 2005

Emde KME and Fok N, 'Public Water – Public Health', National Environmental Health Association Annual Conference, Providence RI, June 26 to 29, 2005

Fok N, 'Use of Disinfectants for Effective Environmental Cleaning', Infection Prevention and Control in a Health Care Setting Conference, Nursing Continuing Education Courses, Edmonton, March 23 2005

Fok N, 'Tools, Techniques and Methods for Safe Drinking Water – Public Health Perspectives', CIPHI (Alberta) Annual Workshop, Edmonton AB, Oct 7-8 2004

Emde KME, Smith DM, Fok N et.al., 'Public Health Considerations in Operating and Maintaining Drinking Water', Cold Regions Engineering & Construction Conference, Edmonton, May 16-19 2004

Fok N, 'HACCP: What It Is and What It Isn't', Risk Management Strategies for Drinking Water Utilities, Role of HACCP, NSF International and World Health Organization, Ann Arbor, Michigan May 4-5 2004

Emde KME, Fok N et.al., 'Water Main Breaks: When Are They an Issue of Water Emergency or Just a Repair?', 11thCanadian National Conference and Policy Forum on Drinking Water, Calgary Alta, April 3-6 2004

Emde KME, Szmetan L and Fok N, 'Planning a Public Health Water Quality Strategy for Regulated and Unregulated Public Drinking Water Supplies', 11th Canadian National Conference, CWWA, Calgary AB, April 3-6 2004

McLeod K, Mikkelsen P and Fok N (presenter), 'Environmental Health Field Manual on Private and Public Water Supplies', 11th Canadian National Conference, CWWA, Calgary Alberta, April 3-6 2004

Fok N, 'WNV-The First Year', Managing Respiratory Care in the Community, Best Practice Conference, Nov 7, Edmonton, 2003

Fok N and Kielly R., 'From Boil Water Advisories to No-Drinking Water Advisories', CIPHI 69th Annual Educational Conference, Edmonton, Alta, June 23-26, 2003

Liou C, Lu X, Fok N, Hoffman H, C Le, 'Arsenic from Wood Treated with CCA', CIPHI 69th Annual Educational Conference, Edmonton, Alta, June 23-26, 2003

Fok N, 'Mold, the Inside Story', Managing Respiratory Care in the Community, Best Practices Conference, Edmonton, Nov 7-8, 2002

Fok N, 'Norwalk-Like Virus- An Emerging Waterborne Pathogen?', Western Canada Water and Wastewater Association 54th Annual Conference, Regina, Sask., Oct 22-25, 2002

Fok N, 'Waterborne Outbreak Prevention – The Inside of a Water Treatment Plant', CIPHI 68th Annual Educational Conference, Fredericton NB, July 29-31, 2002

Fok N, 'Risk Assessment as a Public Health Protection Tool', CIPHI 68th Annual Educational Conference, Fredericton NB, July 29-31, 2002

Fok N, 1st Annual Food Safety Conference, Northern Health Authority, Prince George, B.C., June 7, 2002

Fok N, 'Enteric Disease within Capital Health Region, Rates and Most-Likely Causes', Public Health Science Grand Round, University of Alberta, November 28, 2001

Fok N, 'Role of Public Health Agency in the Prevention of Waterborne Disease', Water Pathogens Workshop, Western Canada Water & Wastewater Association, Edmonton, Alberta, Oct 28-30, 2001

Predy G. et.al., 'A Survey of Baseline Levels of Endocrine Disruptors in Breast Milk in Capital Health Region Women, Alberta, Canada', poster presentation, 5th International Symposium on Biological Monitoring, Banff, Alberta, Sep. 18-21, 2001

Fok N, 'New Advances in Food Safety', Regional Nutrition and Food Service 5th Annual Conference, Edmonton, Alberta, April 27-28, 2001

Fok N, Honish L., Zazulak I and Gammie L. 'Role of Public Health Agencies in the Prevention of Giardiasis', International Conference on *Giardia*, Canmore, May 2000

Laird J. et.al, 'Evaluation of Water Delivery to Patients in Capital Health', 4th Annual Nutrition and Food Service Research Day, Edmonton, Alberta June 19 2001

Probert S. T. Mak, E. Zazulak, N. Fok (Presenter), 'IAQ in a Canadian Elementary School', Air & Waste Management Association 93rd Annual Conference, Salt Lake City Utah, June 19-22, 2000

Emde K., Gammie L., Barry M.A., Fok. N., et.al., 'Surveillance for Waterborne Disease in Communities', poster presentation, American Water Works Association Annual Conference, Denver Co., June 18-22 2000

Gammie L., Pelletier D., Fok N, ‘Development of “Boil Water Advisory” Guidelines for a Water Utility’, 9th National Drinking Water Conference, Canadian Water Works Association, Regina Sask., May 2000

Fok N, ‘Hantavirus: The Mystery of a Killer Unravelled’, Managing Respiratory Care in the Community, Edmonton, Alberta, April 27-28, 2000

Fok N, Honish L. and Hislop N. ‘Regulatory vs Risk Management Approach to Ethnic Food’, CIPHI 66th Annual Educational Conference, Vancouver, B.C, April 8-12, 2000

Fok N, Milroy S., Les Gammie, Emde K., Talbot J., ‘HACCP & Waterborne Diseases Surveillance’ CIPHI 66th Annual Educational Conference, Vancouver, B.C, April 8-12, 2000

Fok N, ‘Boil Water Advisory-When and How’, CIPHI 65th Annual Conference, Saskatoon, Sask., May 10-12, 1999

Fok N, ‘New Initiative for the Food Program’, CIPHI 65th Annual Conference, Saskatoon, Sask., May 10-12, 1999

Fok N, ‘Enteric Diseases - An Outcome Based Program’, Third Annual Designing Community Health Conference, Edmonton, Alberta, Nov. 19-20, 1998

Gammie L., Goatcher L. and Fok N., ‘A *Giardia/Cryptosporidium* Near Miss?’, National Water and Wastewater Forum, CWWA/ACEPU, Quebec City, Quebec, October 26-30, 1998

Fok N, ‘The Monitoring and Reduction of Waterborne Diseases’, CIPHI National Conf., Ottawa On., Aug 24-26, 1998

Fok N, and I. Zazulak, ‘Causes and Trends of Enteric Diseases’, CIPHI National Conf., Ottawa On., Aug 24-26, 1998

Fok N, and I. Zazulak, ‘Enteric Disease Investigation’, Canadian Public Health Association 89th Annual Conference, Montreal, Quebec, June 7-10, 1998

Fok N, ‘Enterics in Travellers’, 2nd Annual Travel Health Conference, Calgary Alberta, June 1, 1998

Fok N, ‘Pets in Institutions’, CDC-Zoonotic Conference, Alberta Health, Edmonton Alberta, Dec 8-9, 1997

Fok N, ‘Program Outcome Indicators’, CIPHI, 62nd Annual Conference, Banff, Alberta, April 28-30, 1997

Fok N, ‘Environmental and Human Health’, Striking a Balance, 1996. A Community Conference for a Sustainable Edmonton, Edmonton Alberta, June 7-9, 1996

Fok N, ‘Risk Assessment as a Risk Management and Administrative Tool’, CIPHI 61st Annual Conf. Victoria B.C., September 25-28, 1995

Fok N, W. Hohn and I. Zazulak, ‘The Risk Evaluation, Implementation and Monitoring of an Enteric Program’, CIPHI 61st Annual Conference, Victoria B.C., September 25-28, 1995

Fok N, ‘Sick Building Syndrome: An Investigation of Indoor Air Quality’, Can. Cardiovascular Society Conference and Can. Association of Cardio-Pulmonary Technologists, Ed., Alberta, Oct 25-29, 1994

Kindzierski W.B. and Fok N. (presenter), ‘Burning Scrap Tires in Cement Kilns: Should We Be Concerned About Hazardous Air Pollutants?’ Air & Waste Management Association 87th Annual Meeting & Exhibition, Cincinnati, Ohio, June 19-24, 1994

Fok N, W. Kindzierski, M. Prior, S. Hrudey, ‘Balancing Risk and Reason: Emergence of Risk Assessment as a Method for Judging Environmental Health Priorities’, Canadian Public Health Association 85th Annual Conference, Edmonton Alberta, June 12-15, 1994

Fok N, ‘*Giardia* in Edmonton’, AWWA Satellite Teleconference, 'Preventing Waterborne Disease: Is Your System at Risk?', local presentation, Edmonton, Alberta, April 8, 1994

Fok N, Risk Seminar, Environmental Studies Institute, Grant MacEwan Community College, 1994

Fok N, ‘Water Play Tables in Childcare Centers’, CHICA-Canada, Edmonton Alberta, April 20-22, 1993

Fok N, ‘Use of Alum in Drinking Water: Aluminium and Alzheimer's Disease’, CIPHI Conf., Ed., July 30-Aug 2, 1991

Fok N, ‘Health Impact Assessment and Landfill Siting Process’, CIPHI Conference, Ed., July 30-Aug 2, 1991

Fok N, ‘Water Play Tables Study’, CIPHI Conference, Edmonton Alberta July 30 to August 2, 1991

Huck P.M. and Fok N, ‘Pilot Scale Evaluation of Ozone and Chlorine Dioxide for the Reduction of Specific Organics’, AWWA Annual Conference, Dallas Texas, June 10-14, 1984

City of West Kelowna - Water Test Results

February 14, 2024

CARO ANALYTICAL SERVICES

CERTIFICATE OF ANALYSIS

REPORTED TO	West Kelowna, City of 2760 Cameron Road West Westbank, BC V1Z 2T6		
ATTENTION	Dan Ricciuti	**WORK ORDER**	24B1773
PO NUMBER	800133	**RECEIVED / TEMP**	2024-02-14 14:11 / 10.1°C
PROJECT	Sunnyside Water Service Area - THM/HAA	**REPORTED**	2024-02-23 14:36
PROJECT INFO	SUNNYSIDE THM/HAA/LSI	**COC NUMBER**	NO #

Introduction:

CARO Analytical Services is a testing laboratory full of smart, engaged scientists driven to make the world a safer and healthier place. Through our clients' projects we become an essential element for a better world. We employ methods conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts. CARO is accredited by the Canadian Association for Laboratories Accreditation (CALA) to ISO/IEC 17025:2017 for specific tests listed in the scope of accreditation approved by CALA.

Big Picture Sidekicks

You know that the sample you collected after snowshoeing to site, digging 5 meters, and racing to get it on a plane so you can submit it to the lab for time sensitive results needed to make important and expensive decisions (whew) is VERY important. We know that too.

We've Got Chemistry

It's simple. We figure the more you enjoy working with our fun and engaged team members; the more likely you are to give us continued opportunities to support you.

Ahead of the Curve

Through research, regulation knowledge, and instrumentation, we are your analytical centre for the technical knowledge you need, BEFORE you need it, so you can stay up to date and in the know.

If you have any questions or concerns, please contact me at bwhitehead@caro.ca

Authorized By:

Brent Whitehead
Account Manager

CARO
ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	West Kelowna, City of	**WORK ORDER**	24B1773
PROJECT	Sunnyside Water Service Area - THM/HAA	**REPORTED**	2024-02-23 14:36

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
MENU RD PUMP STATION (24B1773-01) | Matrix: Water | Sampled: 2024-02-14 10:33						
Calculated Parameters						
Total Trihalomethanes	**0.0686**	MAC = 0.1	0.00400	mg/L	N/A	
Langelier Index	**-0.5**	N/A	-5.0		2024-02-21	CT9
Field Parameters						
pH	**7.6**	7.0-10.5	0.1	pH units	2024-02-14	
General Parameters						
Alkalinity, Total (as CaCO3)	**98.2**	N/A	1.0	mg/L	2024-02-17	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0	mg/L	2024-02-17	
Alkalinity, Bicarbonate (as CaCO3)	**98.2**	N/A	1.0	mg/L	2024-02-17	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0	mg/L	2024-02-17	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0	mg/L	2024-02-17	
Conductivity (EC)	**223**	N/A	2.0	µS/cm	2024-02-17	
Solids, Total Dissolved	**136**	AO ≤ 500	15	mg/L	2024-02-17	
Temperature, at pH	**20.5**	N/A		°C	2024-02-17	HT2
Haloacetic Acids						
Monochloroacetic Acid	< 0.0020	N/A	0.0020	mg/L	2024-02-21	
Monobromoacetic Acid	< 0.0020	N/A	0.0020	mg/L	2024-02-21	
Dichloroacetic Acid	**0.0205**	N/A	0.0020	mg/L	2024-02-21	
Trichloroacetic Acid	**0.0213**	N/A	0.0020	mg/L	2024-02-21	
Dibromoacetic Acid	< 0.0020	N/A	0.0020	mg/L	2024-02-21	
Total Haloacetic Acids (HAA5)	**0.0418**	MAC = 0.08	0.00200	mg/L	N/A	
Surrogate: 2-Bromopropionic Acid	*108*		*70-130*	%	*2024-02-21*	
Total Metals						
Calcium, total	**29.4**	None Required	0.20	mg/L	2024-02-21	
Volatile Organic Compounds (VOC)						
Bromodichloromethane	**0.0033**	N/A	0.0010	mg/L	2024-02-22	
Bromoform	< 0.0010	N/A	0.0010	mg/L	2024-02-22	
Chloroform	**0.0654**	N/A	0.0010	mg/L	2024-02-22	
Dibromochloromethane	< 0.0010	N/A	0.0010	mg/L	2024-02-22	
Surrogate: Toluene-d8	*78*		*70-130*	%	*2024-02-22*	
Surrogate: 4-Bromofluorobenzene	*80*		*70-130*	%	*2024-02-22*	
PRITCHARD PARK (24B1773-02) | Matrix: Water | Sampled: 2024-02-14 11:11						
Calculated Parameters						
Total Trihalomethanes	**0.0880**	MAC = 0.1	0.00400	mg/L	N/A	
Langelier Index	**-0.4**	N/A	-5.0		2024-02-21	CT9
Field Parameters						
pH	**7.8**	7.0-10.5	0.1	pH units	2024-02-14	

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	West Kelowna, City of	**WORK ORDER**	24B1773
PROJECT	Sunnyside Water Service Area - THM/HAA	**REPORTED**	2024-02-23 14:36

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
PRITCHARD PARK (24B1773-02) | Matrix: Water | Sampled: 2024-02-14 11:11, Continued						
General Parameters						
Alkalinity, Total (as CaCO3)	**97.5**	N/A	1.0	mg/L	2024-02-17	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0	mg/L	2024-02-17	
Alkalinity, Bicarbonate (as CaCO3)	**97.5**	N/A	1.0	mg/L	2024-02-17	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0	mg/L	2024-02-17	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0	mg/L	2024-02-17	
Conductivity (EC)	**228**	N/A	2.0	µS/cm	2024-02-17	
Solids, Total Dissolved	**145**	AO ≤ 500	15	mg/L	2024-02-17	
Temperature, at pH	**19.9**	N/A		°C	2024-02-17	HT2
Haloacetic Acids						
Monochloroacetic Acid	**0.0022**	N/A	0.0020	mg/L	2024-02-21	
Monobromoacetic Acid	< 0.0020	N/A	0.0020	mg/L	2024-02-21	
Dichloroacetic Acid	**0.0243**	N/A	0.0020	mg/L	2024-02-21	
Trichloroacetic Acid	**0.0246**	N/A	0.0020	mg/L	2024-02-21	
Dibromoacetic Acid	< 0.0020	N/A	0.0020	mg/L	2024-02-21	
Total Haloacetic Acids (HAA5)	**0.0510**	MAC = 0.08	0.00200	mg/L	N/A	
Surrogate: 2-Bromopropionic Acid	*112*		*70-130*	%	*2024-02-21*	
Total Metals						
Calcium, total	**26.9**	None Required	0.20	mg/L	2024-02-20	
Volatile Organic Compounds (VOC)						
Bromodichloromethane	**0.0041**	N/A	0.0010	mg/L	2024-02-22	
Bromoform	< 0.0010	N/A	0.0010	mg/L	2024-02-22	
Chloroform	**0.0838**	N/A	0.0010	mg/L	2024-02-22	
Dibromochloromethane	< 0.0010	N/A	0.0010	mg/L	2024-02-22	
Surrogate: Toluene-d8	75		*70-130*	%	*2024-02-22*	
Surrogate: 4-Bromofluorobenzene	77		*70-130*	%	*2024-02-22*	
VIOGNIER PRV (24B1773-03) | Matrix: Water | Sampled: 2024-02-14 10:02						
Calculated Parameters						
Total Trihalomethanes	**0.0985**	MAC = 0.1				
Langelier Index	**-0.6**	N/A				
Field Parameters						
pH	**7.6**	7.0-10.5	0.1	pH units	2024-02-14	
General Parameters						
Alkalinity, Total (as CaCO3)	**99.5**	N/A	1.0	mg/L	2024-02-17	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0	mg/L	2024-02-17	
Alkalinity, Bicarbonate (as CaCO3)	**99.5**	N/A	1.0	mg/L	2024-02-17	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0	mg/L	2024-02-17	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0	mg/L	2024-02-17	

Sample result not statistically different from an overlimit result based on measurement error (QA sheet not included, but similar CARO QA shows +/-10%). Sample is on new water system, before prechlorination, and suggests possible long-term issues given high TOC content in the reservoir. Follow-up testing was not provided and may not have been completed.

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	West Kelowna, City of	**WORK ORDER**	24B1773
PROJECT	Sunnyside Water Service Area - THM/HAA	**REPORTED**	2024-02-23 14:36

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
VIOGNIER PRV (24B1773-03) | Matrix: Water | Sampled: 2024-02-14 10:02, Continued						
General Parameters, Continued						
Conductivity (EC)	**242**	N/A	2.0	µS/cm	2024-02-17	
Solids, Total Dissolved	**144**	AO ≤ 500	15	mg/L	2024-02-17	
Temperature, at pH	**19.8**	N/A		°C	2024-02-17	HT2
Haloacetic Acids						
Monochloroacetic Acid	< 0.0020	N/A	0.0020	mg/L	2024-02-22	
Monobromoacetic Acid	< 0.0020	N/A	0.0020	mg/L	2024-02-22	
Dichloroacetic Acid	**0.0179**	N/A	0.0020	mg/L	2024-02-22	
Trichloroacetic Acid	**0.0237**	N/A	0.0020	mg/L	2024-02-22	
Dibromoacetic Acid	< 0.0020	N/A	0.0020	mg/L	2024-02-22	
Total Haloacetic Acids (HAA5)	**0.0415**	MAC = 0.08	0.00200	mg/L	N/A	
Surrogate: 2-Bromopropionic Acid	*107*		*70-130*	%	*2024-02-22*	
Total Metals						
Calcium, total	**26.4**	None Required	0.20	mg/L	2024-02-20	
Volatile Organic Compounds (VOC)						
Bromodichloromethane	**0.0046**	N/A	0.0010	mg/L	2024-02-22	
Bromoform	< 0.0010	N/A	0.0010	mg/L	2024-02-22	
Chloroform	**0.0939**	N/A	0.0010	mg/L	2024-02-22	
Dibromochloromethane	< 0.0010	N/A	0.0010	mg/L	2024-02-22	
Surrogate: Toluene-d8	*76*		*70-130*	%	*2024-02-22*	
Surrogate: 4-Bromofluorobenzene	*77*		*70-130*	%	*2024-02-22*	

Sample Qualifiers:

CT9 Results were based on lab temperature.

HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.

CARO ANALYTICAL SERVICES

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO	West Kelowna, City of	**WORK ORDER**	24B1773
PROJECT	Sunnyside Water Service Area - THM/HAA	**REPORTED**	2024-02-23 14:36

Analysis Description	Method Ref.	Technique	Accredited	Location
Alkalinity in Water	SM 2320 B* (2021)	Titration with H2SO4	✓	Kelowna
Conductivity in Water	SM 2510 B (2021)	Conductivity Meter	✓	Kelowna
Haloacetic Acids in Water	EPA 552.3*	Liquid-Liquid Microextraction, Derivatization and GC-ECD	✓	Richmond
Langelier Index in Water	SM 2330 B (2021)	Calculation		N/A
Solids, Total Dissolved in Water	Solids in Water, Filtered / SM 2540 C* (2020)	Solids in Water, Filtered / Gravimetry (Dried at 103-105C)	✓	Kelowna
Total Metals in Water	EPA 200.2 / EPA 6020B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	✓	Richmond
Trihalomethanes in Water	EPA 5030B / EPA 8260D	Purge&Trap / GC-MSD (SIM)	✓	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Glossary of Terms:

RL	Reporting Limit (default)
<	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
°C	Degrees Celcius
AO	Aesthetic Objective
MAC	Maximum Acceptable Concentration (health based)
mg/L	Milligrams per litre
pH units	pH < 7 = acidic, ph > 7 = basic
µS/cm	Microsiemens per centimetre
EPA	United States Environmental Protection Agency Test Methods
SM	Standard Methods for the Examination of Water and Wastewater, American Public Health Association

Guidelines Referenced in this Report:

Guidelines for Canadian Drinking Water Quality (Health Canada, September 2022)

Note: In some cases, the values displayed on the report represent the lowest guideline and are to be verified by the end user

CARO ANALYTICAL SERVICES

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO	West Kelowna, City of	**WORK ORDER**	24B1773
PROJECT	Sunnyside Water Service Area - THM/HAA	**REPORTED**	2024-02-23 14:36

General Comments:

The results in this report apply to the received samples analyzed in accordance with the Chain of Custody document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Caro will dispose of all samples within 30 days of sample receipt, unless otherwise agreed. The quality control (QC) data is available upon request

Results in **Bold** indicate values that are above CARO's method reporting limits. Any results that are above regulatory limits are highlighted red. Please note that results will only be highlighted red if the regulatory limits are included on the CARO report. Any Bold and/or highlighted results do not take into account method uncertainty. If you would like method uncertainty or regulatory limits to be included on your report, please contact your Account Manager:bwhitehead@caro.ca

Please note any regulatory guidelines applied to this report are added as a convenience to the client, at their request, to help provide some initial context to analytical results obtained. Although CARO makes every effort to ensure accuracy of the associated regulatory guideline(s) applied, the guidelines applied cannot be assumed to be correct due to a variety of factors and as such CARO Analytical Services assumes no liability or responsibility for the use of those guidelines to make any decisions. The original source of the regulation should be verified and a review of the guideline(s) should be validated as correct in order to make any decisions arising from the comparison of the analytical data obtained to the relevant regulatory guideline for one's particular circumstances. Further, CARO Analytical Services assumes no liability or responsibility for any loss attributed from the use of these guidelines in any way.

Excerpts from 2014 Water Utility Master Plan

November 28, 2014

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
Escherichia coli	organisms/ 100 mL	No detectable *Escherichia coli*
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	• 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
Cryptosporidium parvum	log reduction	> 3-log (99.9 %) removal or inactivation
Giardia Lamblia	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

Exceeded in single result included in this report. Exceeded regularly in 2024.

TOC limit in BC is 4mg/L and was exceeded in all available test results in this report.

Likely exceeded in Q3 2023 to Q2 2024 running average at highest reading point (around Viognier). Likely to be exceeded in calendar 2024.

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 where 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

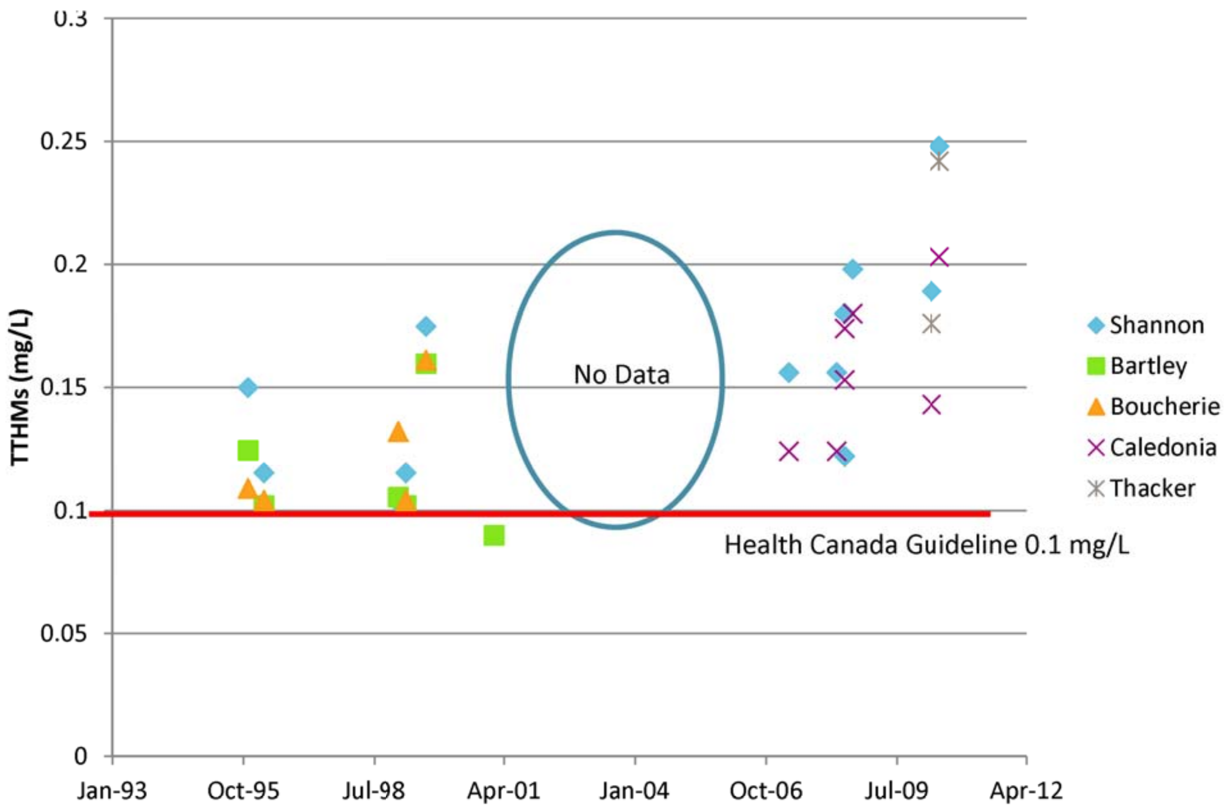
While not yet updated in the Canadian Drinking Water Quality Guidelines, several research papers had been released which informed the updates to the guidelines that demonstrated risks in infants.

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.

BC Guidelines not referenced, nor was reference given to the ability of the plant to reduce these to an acceptable level.

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.

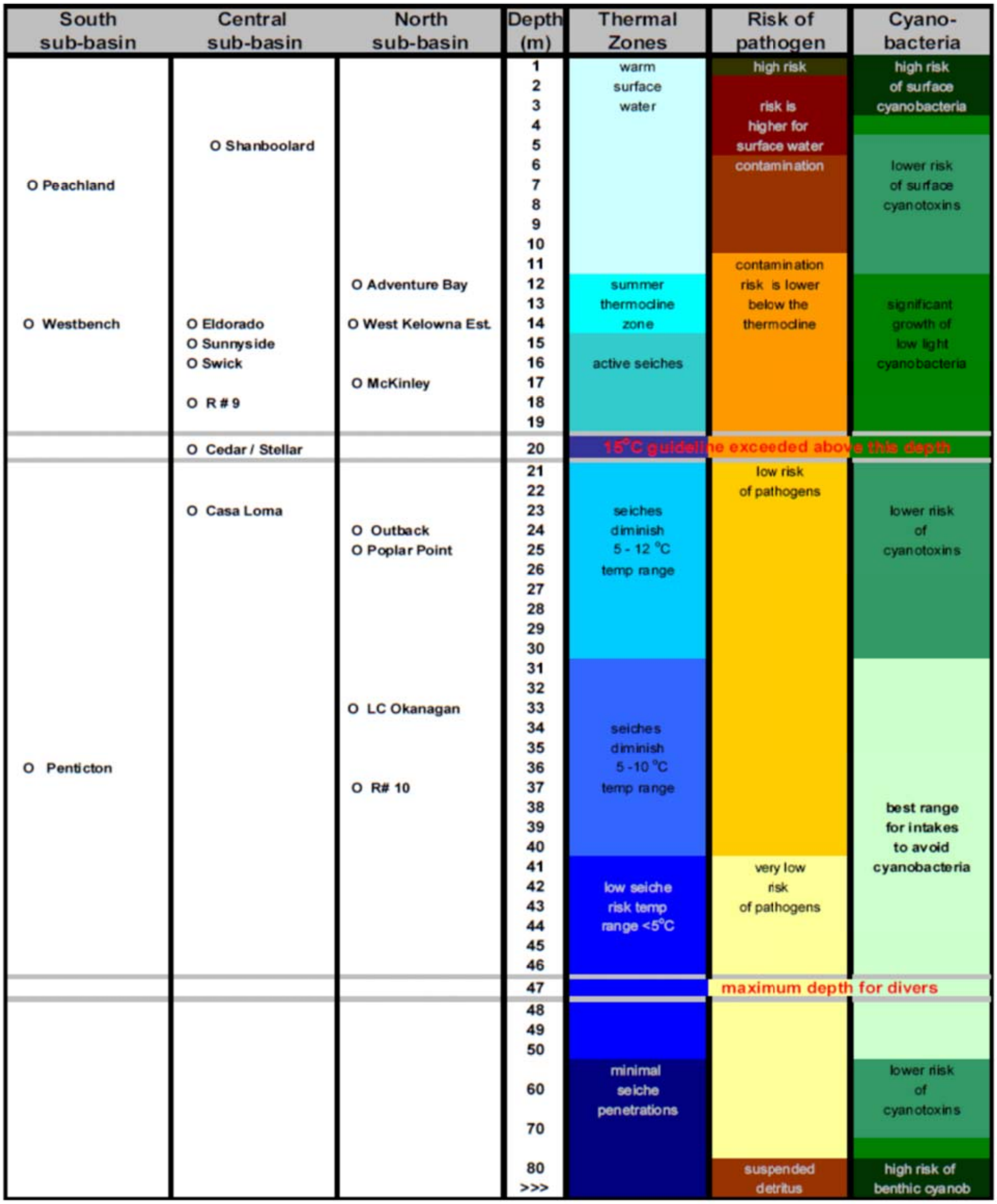
The raw water quality data available from the existing DWK facilities that divert water from Okanagan Lake is somewhat limited, however, several other water purveyors of similar size divert water from Okanagan Lake and have completed extensive source sampling. Specifically, since the 1996 *Cryptosporidium* 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 Shanboolard
O Peachland
O Adventure Bay
O Westbench
O Eldorado
O West Kelowna Est.
O Sunnyside
O Swick
O McKinley
O R # 9
O Cedar / Stellar
O Casa Loma
O Outback
O Poplar Point
O LC Okanagan
O Penticton
O R# 10
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 60 70 80 >>>
warm surface water
summer thermocline zone
active seiches
seiches diminish 5 - 12 °C temp range
seiches diminish 5 -10 °C temp range
low seiche risk temp range <5°C
minimal seiche penetrations
high risk
risk is higher for surface water contamination
contamination risk is lower below the thermocline
low risk of pathogens
very low risk of pathogens
suspended detritus
high risk of surface cyanobacteria
lower risk of surface cyanotoxins
significant growth of low light cyanobacteria
lower risk of cyanotoxins
best range for intakes to avoid cyanobacteria
lower risk of cyanotoxins
high risk of benthic cyanob
15°C guideline exceeded above this depth
maximum depth for divers

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 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.

Do we have pilot testing demonstrating that the DBP limits could be met given the variation in source water quality?

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.

Appendix E

Detailed Review of the Long Term Water Supply Options

AECOM
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Minutes of Meeting

To	DWK – Rob Hillis	Page	1
CC			
Subject	Water Master Plan Supplemental – Long Term Water Supply Options		
From			
Date	December 19, 2013	Project Number	60216671

Background

The District of West Kelowna (District) has requested that AECOM further develop technical aspects of the Master Water Plan document dated October 15, 2012. The specific items included within this scope of work and addressed in this memorandum are:

Seven options are included within this memorandum for the long term supply of water within the DWK water service boundary. These options are:

a. Option 1 – Maintain current system, treatment at all sources;
b. Option 2 – Centralized treatment at Powers Creek and Rose Valley using all three raw water sources;
c. Option 3 – Centralized treatment and raw water supply from Powers Creek and Rose Valley;
d. Option 4 – Complete separation of the domestic and agricultural distribution networks;
e. Option 5 – Separation of Sunnyside Only;
f. Option 6 – Complete System Separation with Early Upgrade at Powers Creek; and
g. Option 7 – Rose Valley Filtration Deferral Using Okanagan Lake as Raw Water Source.

This memo will address the four items above and provide a comprehensive document to supplement the existing Master Water Plan.

Long Term Water Supply Options

Option 1 – Expand Water System in Current Configuration

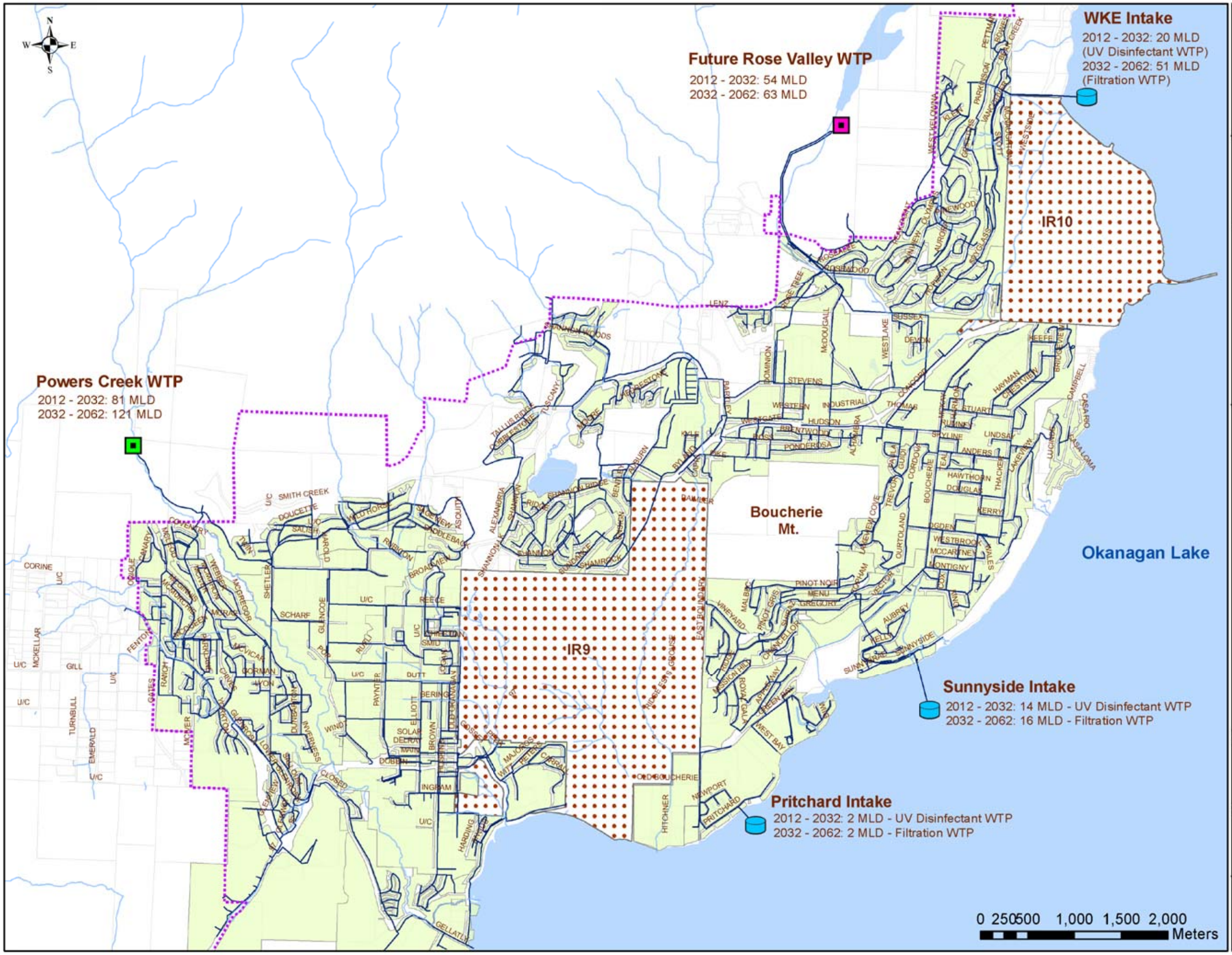
This option maintains the current configuration of the distribution system with treatment being added at all the existing facility locations. The geographic location of the new infrastructure is provided on **Figure 1**.

In summary the key infrastructure being added with this option is:

- Immediate Infrastructure Upgrades (Now – 2032):
  - Extend the intake and add 2-stage disinfection at the existing Pritchard Pump Station. Also required are building and mechanical improvements to the existing facility.
  - Extend the intake and add 2-stage disinfection at the existing Sunnyside Pump Station. The existing facility is relatively new so facility improvements are assumed to not be required.
  - Extend the intake and add 2-stage disinfection at the existing West Kelowna Pump Station. It is assumed that the existing facility needs to be completely re-constructed and a right-of-way obtained. Part of obtaining a new right-of-way will be securing sufficient land for the future.
  - Maintain the existing Powers Creek water treatment plant; and
  - Construct a new water conventional water treatment plant and treated water clearwell at the Rose Valley Reservoir site.
- Future Upgrades (2032 to 2062):
  - Add membrane filtration at the Pritchard, Sunnyside and West Kelowna Estates pump stations;
  - Further expand the existing Powers Creek water treatment plant;
  - Additional storage is required on Powers Creek to ensure there is enough flow during a 50 year drought. It is assumed that the additional storage will be provided at Lambly Lake.
  - Expand the Rose Valley water treatment plant to 63 ML/d. In this option, Rose Valley water treatment plant is small enough that there is sufficient infrastructure in the water shed to reliably ensure the supply of water during a 50 year drought. This option includes no watershed improvements for the Lambly Creek source.

Option 2 – Centralize Upland Treatment Using All Three Raw Water Sources

This 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 2**. In summary the key infrastructure being added with this option is:



District of West Kelowna

Water Utility Master Plan

Option 1

Treatment at the 5 Existing Water Sources

Legend

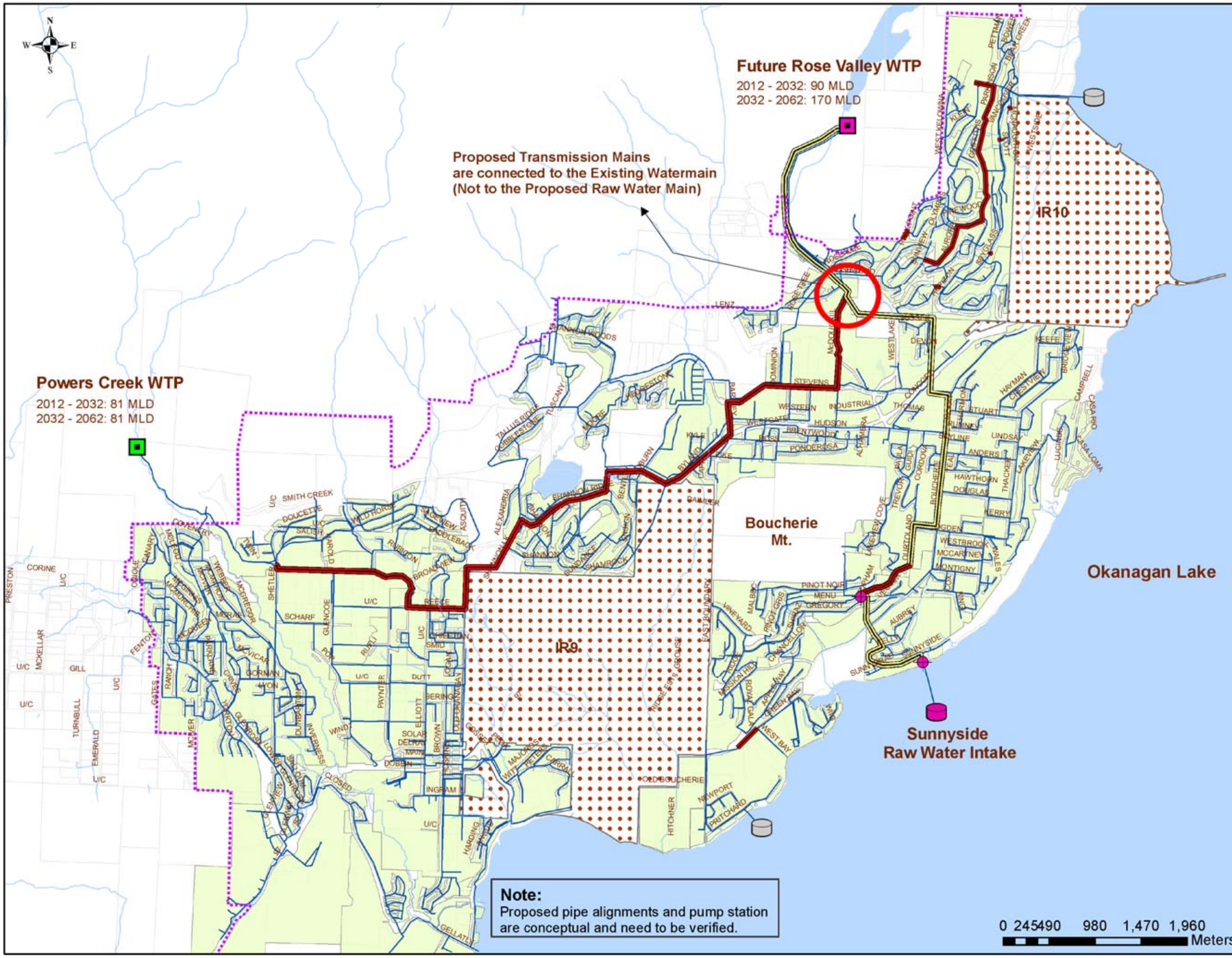
- Future Water Treatment Plant
- Existing Water Treatment Plant
- Active Intake
- Service Boundary
- Existing Watermain
- Streams
- Un-irrigated Park Space

Figure No: Figure 1

Project No: 60216671

Date: September, 2012

AECOM



District of West Kelowna

Water Utility Master Plan

Option 2

Rose Valley Treatment/ Interconnect

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 2

Project No: 60216671

Date: September, 2012

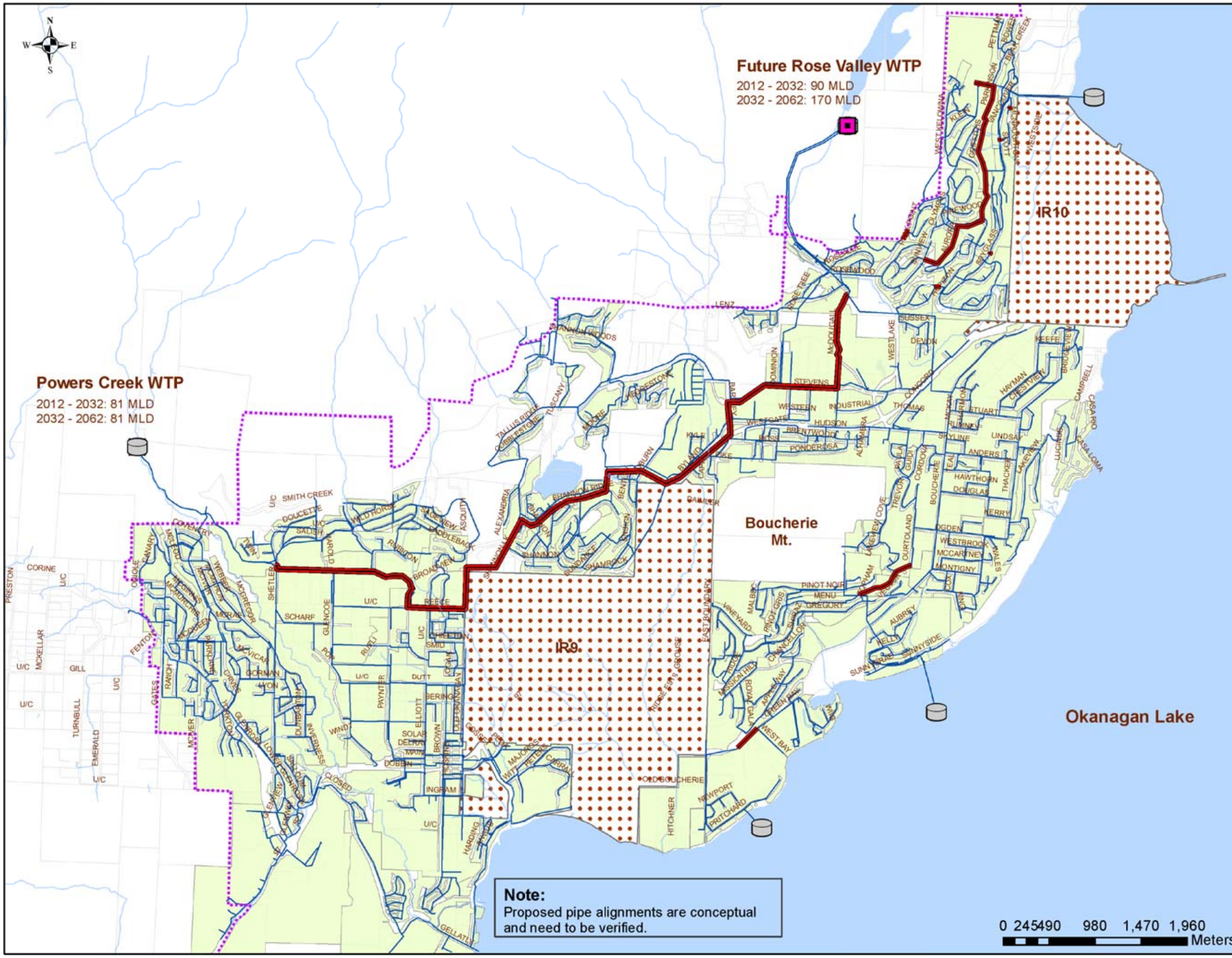
- Immediate Infrastructure Upgrades (Now – 2032):
  - Maintain the existing Powers Creek water treatment plant. Depending on the actual demands some expansion may be required prior to the 20 year design horizon;
  - Construct a new water conventional water treatment plant and treated water clearwell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

<u>Option 3 – Centralized Upland Treatment Using Only the Upland Raw Water Sources</u>

This 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 for this option additional upland storage will be provide for the Lambly Creek portion of the watershed. This option does not include any further expansion of the Power Creek watershed as this area is arguably already producing all the water it can sustainable yield, whereas more water can be produced by the Lambly Creek portion of the watershed. To meet the future demands of the legacy Westbank Irrigation District portion of the distribution system a transmission main will be provided in the future to convey water from the Rose Valley site across the western portion of the distribution system.

The geographic location of the new infrastructure is provided on **Figure 3**. In summary the key infrastructure being added with this option is:

- Immediate Infrastructure Upgrades (Now – 2032):
  - Same as Option 2
- Future Upgrades (2032 to 2062):
  - Further expand the Rose Valley water treatment plant;
  - Install an interconnecting gravity transmission main to feed the legacy Westbank Irrigation DWK 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;
  - To provide an additional 6,650 ML flow at the Rose Valley water treatment plant while accounting losses, 9,500 ML must be stored by adding more dams to Lambly Creek.



District of West Kelowna

Water Utility Master Plan

Option 3

Rose Valley Treatment/ Interconnect/ No Okanagan Lake

Legend

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

Figure No: Figure 3

Project No: 60216671

Date: September, 2012

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Option 4 – Complete System Separation

Option 4 relies on the treatment plant located at Powers Creek and a new plant at Rose Valley Reservoir dam site. This option is similar to Option 2 presented in the Master Water Plan but examines the impact of separating the domestic and agricultural distribution systems in order to reduce the cost at the Water Treatment Plants. In this option Powers Creek WTP will supply water to the Westbank Irrigation District (WID) and Rose Valley WTP will provide water to LID, Sunnyside, Pritchard, West Kelowna Estates (WKE) as well as supply water to WID.

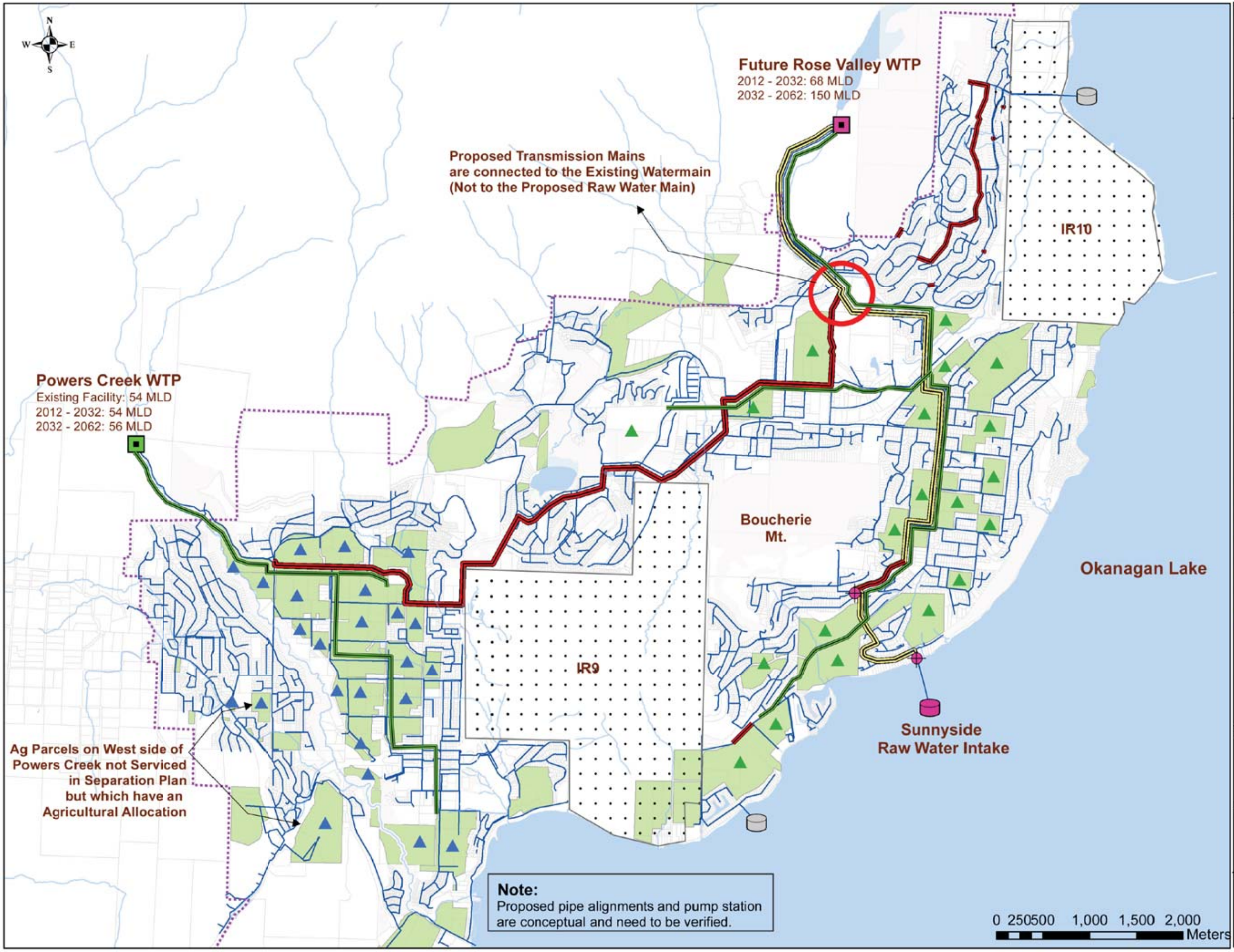
Figure 4 shows the conceptual design of the new agricultural water distribution system for the DWK. Lots with agricultural water allocation were noted in light green with green triangles denoting lots in the Rose Valley source area and blue triangles denoting lots in the Powers Creek source area.

For the Lakeview Service Area, allocation is based on 70 litres per minute per hectare (as per the former LID bylaw). For the Sunnyside and Pritchard service areas, allocations were not provided by the District. Allocations were assigned based on OCP-designated agricultural parcels, and whether the GIS database included the parcel in the respective service area (for example, some agricultural lots on Okanagan Lake are service by private intakes). The allocation of 70 litres per minute per hectare was used for Sunnyside and Pritchard parcels. The Rose Valley source areas have a total agricultural allotment of 19.7ML/d.

For the WID Service Area, agricultural allotment is governed by the dole valve size of each service. The agricultural lots west of Powers Creek have not been included in system separation due to the length of pipe required to provide service to only five parcels. These lots account for 7.5% for the agricultural allotment in WID, the remaining allotment was divided between the lots on the east side of Powers Creek. System separation reduces treated water demand to 25.3 ML/d of the total 27.6 ML/d of agricultural demand in WID.

In summary the key infrastructure being added for this option is:

- Immediate Infrastructure Upgrades (Now – 2032):
    - Maintain the existing Powers Creek water treatment plant;
    - Construct a new 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 WKE. This allows the existing WKE pump station to be abandoned;
    - Install separate agricultural distribution network to convey non-potable water from Powers Creek to agricultural lots within WID;
    - Install separate agricultural distribution network to convey non-potable water from Powers Creek to agricultural lots within Lakeview, Sunnyside and Pritchard.
- Future Upgrades (2032 to 2062):
    - Further expand the Rose Valley water treatment plant;
    - If demand requires, re-rate the basins at Powers Creek WTP to slightly increased capacity;
    - 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 WID 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.



District of West Kelowna

District of West Kelowna

Water Utility Master Plan Supplement

Option 4

Rose Valley Treatment /
Interconnect /
Full Agricultural Twinning

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
- Proposed Ag Transmission Main
- Service Boundary
- Existing Watermain
- Streams
- OCP Agricultural Zoning
- Parcels with Ag Allocation Powers Creek Source
- Parcels with Ag Allocation Rose Valley Source

Figure No: Figure 4

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Option 5 – System separation of Sunnyside Only

Option 5 is a variation of Option 4. In this option system separation is implemented only in Sunnyside. This is done by using the existing Sunnyside lake intake to convey agricultural water. System separation in Sunnyside reduces the treated water demand by 5ML/d.

Figure 5 shows the conceptual design of the Sunnyside agricultural system. Lots with agricultural water allocation were noted in light green with green triangles denoting lots to be serviced by the Sunnyside agricultural distribution system.

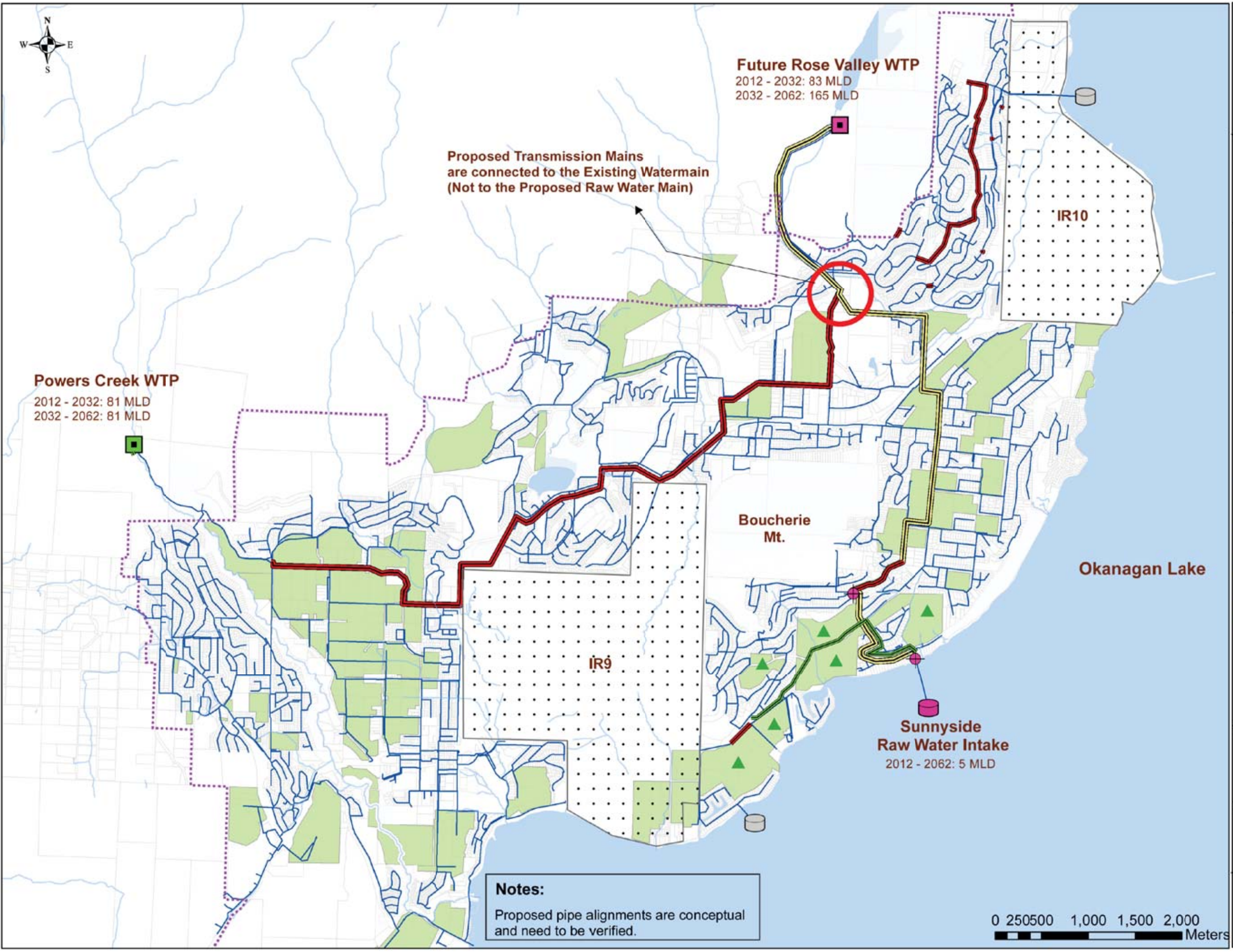
In summary the key infrastructure being added for this option is:

- 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 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 WKE. This allows the existing WKE pump station to be abandoned;
  - Install separate agricultural distribution network to convey non-potable water from Okanagan Lake to agricultural lots within Sunnyside.
- 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 WID 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.

Option 6 – Complete System Separation with Early Upgrade at Powers Creek

Option 6 is a variation of Option 4 in which Powers Creek is upgraded to a capacity of 81ML/d immediately and is used to supply treated water to the entire DWK through a low lift pump station that would be constructed in WID. Upgrading Powers Creek makes it possible to delay the construction of the Rose Valley WTP by 5 years. Complete system separation throughout the DWK reduces treated water demand sufficiently to make this option possible. As in Option 4, WID will have 92.5% of its agricultural demand serviced by the agricultural distribution system.

Figure 6 shows the conceptual design of the new agricultural water distribution system for the DWK. Lots with agricultural water allocation were noted in light green with green triangles denoting lots in the Rose Valley source area and blue triangles denoting lots in the Powers Creek source area



Notes:

Proposed pipe alignments are conceptual and need to be verified.

WEST KELOWNA

District of West Kelowna

Water Utility Master Plan Supplement

Option 5

Rose Valley Treatment / Interconnect / Partial Agricultural Twinning

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
- Proposed Ag Transmission Main
- Service Boundary
- Existing Watermain
- Streams
- OCP Agricultural Zoning
- Ag Parcels Serviced by Sunnyside Intake

Figure No:	
Figure 5	
Project No:	Date:
60216671	July, 2013

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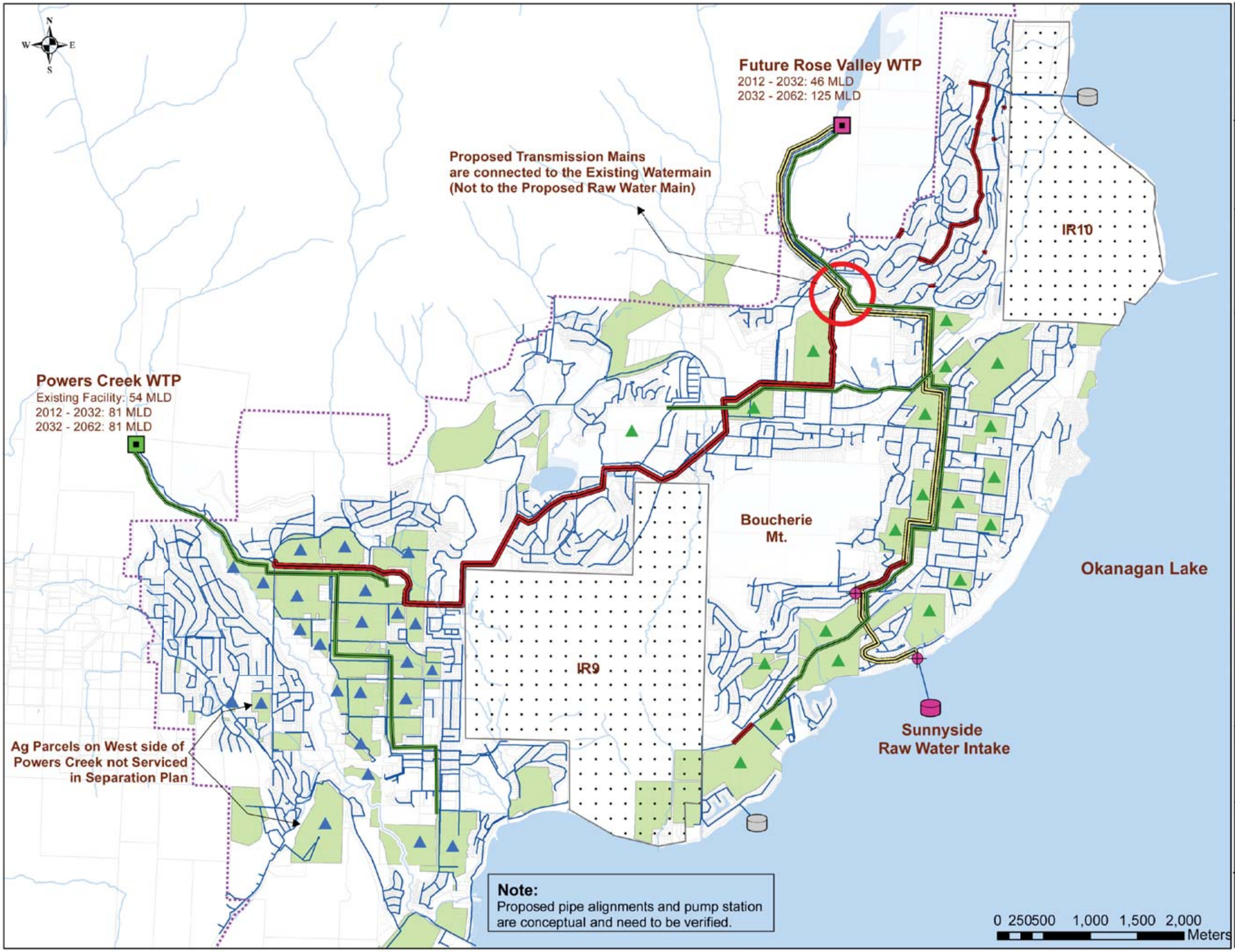

District of West Kelowna

Water Utility Master Plan Supplement

Option 6

Expand WID / Interconnect / Full Agriculture Twinning / Defer Rose Valley

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
- Proposed Ag Transmission Main
- Service Boundary
- Existing Watermain
- Streams
- OCP Agricultural Zoning
- Parcels with Ag Allocation Powers Creek Source
- Parcels with Ag Allocation Rose Valley Source

Figure No: Figure 6

Project No:	Date:
60216671	July, 2013

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In summary the key infrastructure being added for this option is:

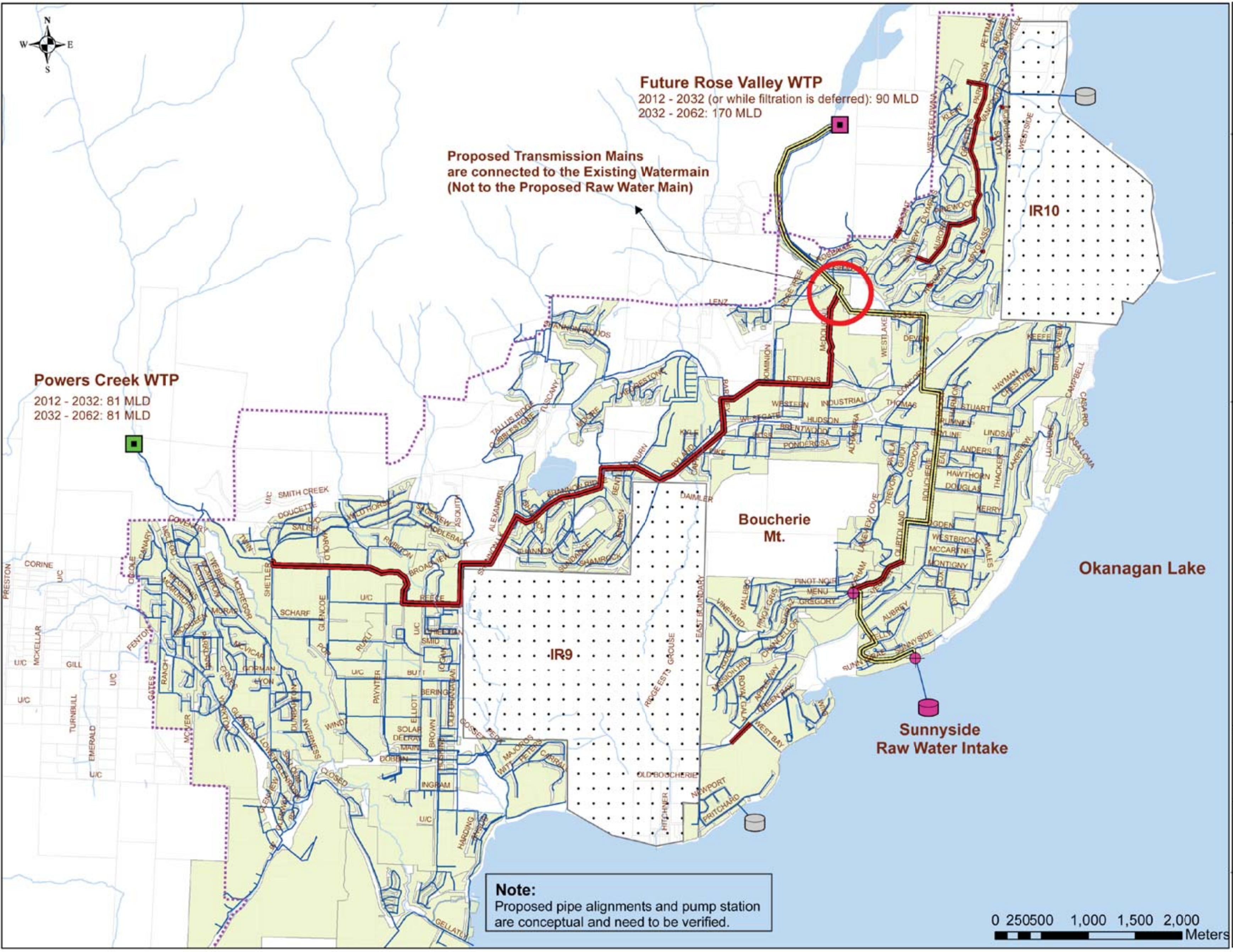
- Immediate Infrastructure Upgrades (Now – 2032):
  - Expand the Powers Creek WTP;
  - Install a low lift pump station in WID to supply treated water from Powers Creek to the rest of the DWK;
  - Install a transmission main to connection WID to Rose Valley. This transmission main is a 600mm pipe 9.2km long. In the short term it will convey water treated at Power Creek and pumped to Rose Valley. In the long term it will provide gravity transmission from Rose Valley to WID;
  - Construct a new conventional water treatment plant and treated water clearwell at the Rose Valley Reservoir site in 2019;
  - Install a transmission main to convey treated water from the new Rose Valley water treatment plant site to WKE. This allows the existing WKE pump station to be abandoned;
  - Install separate agricultural distribution network to convey non-potable water from Okanagan Lake to agricultural lots within Sunnyside.
- 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;
  - Provide a gravity transmission main to improve the transmission capacity of the network from the Rose Valley reservoir to the Sunnyside area.

Option 7 – Rose Valley Filtration Deferral Using Okanagan Lake as Raw Water Source

Option 7 relies on the treatment plant at Powers Creek and a new ultraviolet treatment plant at Rose Valley Reservoir dam site. This option uses Okanagan Lake as the sole water source for Rose Valley to defer filtration. This reduces the initial capital and O&M cost of treatment while increasing pumping costs. Filtration cannot be deferred indefinitely and a filtration plant will be required at some point in the future.

The pipeline to convey raw water from Okanagan Lake in Options 2 is sized to convey 55 ML/d to supplement raw water from the upland watershed. For this option the pipeline must convey 90 ML/d to reach the 2032 horizon when it is assumed that filtration will be constructed a Rose Valley. After filtration is constructed, this pipeline will be used to supplement upland raw water as in Option 2.

Figure 7 shows the conceptual design of the water distribution system for the DWK with deferred filtration.



WEST KELOWNA

District of West Kelowna

Water Utility Master Plan Supplement

Option 7

Current System / Increase Okanagan Lake Water / Defer Rose Valley

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

Figure No:

Figure 7

Project No:	Date:
60216671	July, 2013

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In summary the key infrastructure being added for 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 ultraviolet water treatment plant and treated water clearwell at the Rose Valley Reservoir site;
  - Provide a pipeline sized to convey 90 ML/d to Rose Valley WTP. In addition to the transmission main a pump station is necessary to convey Okanagan Lake water to the Rose Valley water treatment plant;
  - Install a transmission main to convey treated water from the new Rose Valley water treatment plant site to WKE. This allows the existing WKE pump station to be abandoned;
  - Install separate agricultural distribution network to convey non-potable water from Powers Creek to agricultural land within WID;
  - Install separate agricultural distribution network to convey non-potable water from Rose Valley to agricultural land within Lakeview, Sunnyside and Pritchard;
- Future Upgrades (2032 to 2062):
  - Construct a filtration plant a Rose Valley dam site and abandon the ultraviolet water treatment plant;
  - Install an interconnecting gravity transmission main to feed WID 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;

Review of the Non-Cost Considerations

Cost alone should not drive the recommendation so a decision modeling process was conducted to evaluate all the candidate options. The first step in the development of a decision model is to determine the evaluation factors and the associated importance of evaluation factors in the decision making process. The non-cost evaluation factors and the weighting of each factor is presented within **Table 1**.

Is operational ease & flexibility a surrogate for cost? If so, it is double counted.

Table 1 Summary of the Evaluation Factors

Evaluation Factor	Weighting
System Operational Ease & Flexibility – For each option the ease of water delivery will vary. This issue will be considered in this item.	25%
Emergency Preparedness – The ability to respond to emergency conditions, such as the loss of a facility due to earthquake, fire, etc	25%
Average Finished Water Quality – All the options result in the supply of Interior Health compliant acceptable treated water. However, there are some treated water variations between Power Creek, Lambly Creek and Okanagan Lake. This consideration will be reviewed in this valuation item.	5%
Reliability & Availability of Supply – The likelihood that one or more sources will be unable to yield the required volumes of raw water under regular expected operating conditions.	25%
Ease of Implementation – The ability to implement the solution in a timely manner resulting in the customers receiving Interior Health compliant treated water will vary between the options.	5%
Future Expansion – The ability of the system to respond/adjust to changing future needs in a cost effective and operationally efficient manner. Also, the ability option to provide high quality treated water to support economic development and the OCP growth targets.	10%
Environmental Impacts – This factor considers the overall environmental impacts of the various options such as residual production, energy minimization, impact to natural water course, etc. All the	5%
Total Weighting	**100%**

Provided below is a more detailed explanation of the non-cost considerations and how they impact the 7 long term water supply options developed for the District water utility.

1.1.1 System Operational Ease & Flexibility

This evaluation item addresses the non-cost items related to the long term ease, flexibility and resiliency of operating the complete water system. Some of the items considered within this evaluation category are:

1. The integration and operation of several independent water systems into a single system.
2. The number of sources and the challenges associated with each raw water source are considered. The options that rely on more raw water sources and more pumping will provide more operational burden than options that rely on a single gravity source of water.
3. For the system separation options the conveyance of water through a single distribution network versus two completely separate distribution systems. The additional infrastructure necessary to support the implementation of 2 separate water distribution systems will add to the operational burden associated with ensuring the supply of water to all the customers.

Operational burden = cost?

1.1.2 Emergency Preparedness

Vulnerability to failure during an emergency is a key consideration. Under this criterion, higher scores were provided to Options which increased the number of facilities available to the District which would essentially increase flexibility to react to catastrophic loss of a key water supply facility due to unforeseen events, such as earthquake or fire. Furthermore, options that maximize the use of the gravity flow of water complete with interconnects to allow for the delivery of treated during an emergency are rated higher than options that rely on pumping.

Options that rely on the deferral of filtration result in these options being more susceptible to treated water quality compliance issues if there was a catastrophic event in Okanagan Lake such as a fuel spill or some other contaminate.

The water is acceptable, unfiltered, as of the time of this r
But we will need to connect to it in the future when the qua
less certain.

1.1.3 Average Finished Water Quality

All the options result in the supply of treated water that is compliant with the Provincial Drinking Water Objectives being delivered to the District customers; however, given the raw water characteristics of the available sources there will be subtle variations in the treated water characteristics of the water. Given that all the options result in the supply of compliant treated water this criterion is weighted low.

The raw water sources relied on for the long term water supply options and the associated treated water quality considerations are:

1. Okanagan Lake offers the lowest level of natural organic material meaning disinfection by-products will be the lowest with this source. The potential challenge with Okanagan Lake is the long term impact of the numerous discharges and the human activity within the watershed. Currently, these impacts result in acceptable treated water, but the combination of long water residence time in the lake and numerous pollutant source provides the potential for invasive species and other emerging contaminates negatively impacting the drinking water quality from this source.
2. The Powers Creek and Lamby Creek sources offer higher levels of natural organic matter and lower alkalinity. This means that this water source will naturally produce the higher levels of disinfection by-products and offer a water supply that is more corrosive to the distribution network than Okanagan Lake. The impact of the disinfection by-products will vary nominally based on the operation of the water system with each option.

Okanagan Lake offers lower disinfection by-products but a higher potential for exposure to emerging contaminates. Conversely the upland water sources provide high potential levels of disinfection by-products that are known long term health concerns. Options that offer operational flexibility for the raw water source were ranked the higher in this category.

1.1.4 Reliability and Availability of Supply

This criterion refers to the possibility that some or all of the rated capacity of each source used for each option might be lost due to short term unforeseen circumstance, such as drought. Some of the specific items considered during the evaluation of the options are:

1. Options with 2 sources instead of 1 are preferred;
2. The reliability of a water supply during a prolonged drought;
3. The impact of climate change to raw water quality – warmer temperatures will potentially support more frequent and large algae blooms;
4. The ability to interconnect the potable distribution network to different treated water sources will improve the long term ability of the utility to supply treated water;
5. The ability to supply gravity water during an electrical power outage.

Options that include the use of the most raw water sources and maximized the ability to distribute the water within the supply network were ranked the highest in this category.

1.1.5 Ease of Implementation

This item assesses the ease of implementing the supply of treated water to all the domestic customers in a timely manner. For each of the potential long term water supply options, the specific items considered within this item are:

1. Land acquisition can be time consuming and often results in more cost than expected;
2. Disruption to the public from construction;
3. Conflicts and coordination with other utilities and agencies;
4. Transferring of water licenses;
5. Provincial and Federal agency approvals;
6. Changes made to the existing system as the more changes the more challenging the option will be to implementation.

This means options that rely on water treatment plants installed at locations compatible with the existing water system are ranked the highest. Conversely, options that consist of complete system separation, the reliance on alternate raw water sources and the re-configuration of the current water distribution system are ranked lower.

1.1.6 Future Expansion

There is not a discernible difference between the options for future expansion. All the options can be planned to meet the estimated water demands for the next 50 years. Depending on the actual growth rate and the level of water conservation that can be achieved at some point in the vicinity of 50 years in the future an alternate raw water source will need to be developed. This issue is common and comparable to all options. The items considered during the comparison of the options include:

1. Ability to expand domestic supply system;
2. Deferral of capital cost;
3. Ability to change as new technology is developed in the future;
4. Ability to support community growth as stated within the Official Community Plan;
5. Ability to adjust in the future to changing political or economic conditions.

Based on the above points, options that use 2 water treatment plants, multiple water sources and included full system separation were ranked the highest. Options with full system separation offer more flexibility for the use of alternate or new sources of agricultural water in the future.

1.1.7 Environmental Issues

All the options result in the construction of new infrastructure resulting in some level of impact to the environment. The completion of the construction work and the associated ongoing operation will all be completed following local bylaws and the senior government regulations. The cost implications of mitigating the environmental impacts is included within the capital cost estimates so this item should not be further considered during this evaluation. This means environmental protection and proper mitigation during construction is important but for the evaluation of the non-cost review of the options this item was provided a low weighting.

Under this criterion, each of the options were rated against the following key environmental considerations:

1. Annual mass of solids generated by water treatment for each of the Options;
2. Estimated annual power consumption;
3. Chemical usage;
4. Carbon footprint;
5. Amount of space distributed during construction; and
6. Impacts to natural water courses and other undeveloped areas.

Sources that rely on the upland water sources will need more chemical to support effective treatment resulting in the production of more sludge than options that use more water from Okanagan Lake. Conversely, options that rely on the upland water sources will consume less power resulting in the options that use the upland sources being ranked slightly lower. Options that include system separation are ranked lower given the space impacted during construction and the amount of construction activity is higher resulting in more impact to the environment.

Evaluation of the Options

To select a long term water supply option all the options were evaluated and ranked independently by the stakeholder groups represented in the Technical Steering Committee. For each non-cost consideration the options were evaluated and provided a ranking. This evaluation was completed by each stakeholder during or soon after the option review workshop held in July 2013. The results of the option evaluation are provided within **Table 2** below.

The ranking of the options was summarized based on the weighted importance of each non-cost consideration to generate a relative benefit of each option. This relative benefit score was then compared to the calculated total net present value of each long term water supply option. The values used for the net present value of the life cycle cost are a discount rate of 3% and an inflation rate of 2% over a period of 50 years.

Using the benefit ranking and the net present value of each option the benefit-to-cost of each option was determined. This evaluation resulted in Option 2 being the highest ranked option based on the average ranking of all the stakeholders. Furthermore, individually all the stakeholders ranked Option 2 either highest or second highest.

The results of the non-cost evaluation were discussed with the stakeholders and there was consensus that Option 2 offered the appropriate balance of cost versus benefit resulting in Option 2 being the recommended option for the long term supply of water for the DWK.

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Minutes of Meeting

Table 2 – Evaluation Model of the Long Term Water Supply Options

Primary Factor	Option Number						
	Option 1 - Current Water System + Treatment	Option 2 - Centralized Treatment + Use all Three Raw Water Sources	Option 3 - Centralized Treatment + Upland Raw Water Sources Only	Option 4 - Centralized Treatment + Complete System Separation	Option 5 - Centralized Treatment + Sunnyside System Separation Only	Option 6 - Powers Creek + Complete System Separation	Option 7 - Centralized Treatment + Defer Rose Valley WTP by Supplying Okanagan Lake
System Operational Ease & Flexibility	3.6%	25.0%	21.4%	17.9%	14.3%	10.7%	7.1%
Emergency Preparedness	3.6%	25.0%	7.1%	17.9%	14.3%	10.7%	21.4%
Raw Water Quality Impacts on Treated Water	0.7%	4.3%	1.4%	3.6%	2.9%	2.1%	5.0%
Reliability & Availability of Supply	3.6%	17.9%	7.1%	25.0%	21.4%	10.7%	14.3%
Ease of Implementation	5.0%	3.6%	4.3%	0.7%	1.4%	2.1%	2.9%
Future Expansion	1.4%	7.1%	4.3%	10.0%	8.6%	5.7%	2.9%
Environmental Impacts	0.7%	2.1%	1.4%	4.3%	3.6%	2.9%	5.0%
Total Benefits (as Measured by the Decision Model)	**18.6%**	**85.0%**	**47.1%**	**79.3%**	**66.4%**	**45.0%**	**58.6%**
Life Cycle Cost	**$ 219,330,000.00**	**$ 161,670,000.00**	**$ 177,925,000.00**	**$ 175,586,000.00**	**$ 164,102,000.00**	**$ 176,427,000.00**	**$ 173,730,000.00**
Benefit-to-Cost Ratio (with cost measured in millions)	**0.08**	**0.53**	**0.26**	**0.45**	**0.40**	**0.26**	**0.34**

Is the score only 4.3% because in future decades when Okanagan Lake is connected it will be better?

Capital and O&M Cost Model

50 Year Net Present Value (NPV) Summary - 2013 to 2062

Current Year	2013
Interest Rate	[illegible]
Discount Rate	[illegible]

Net Present Value Summary 2062	Total NPV	Capital NPV	O&M NPV	Annual O&M 2013	Annual O&M 2063
Option 1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Option 2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Option 3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Option 4a	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Option 4b	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Option 4c	[illegible]	[illegible]	[illegible]		
Option 5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Option [illegible]	[illegible]	[illegible]	[illegible]		