

TECHNICAL MEMO

To

Shane Fenske,
Regional District of Okanagan-Similkameen

From

Sven Freitag, P.Eng.
McElhanney Ltd

Re

Sage Mesa Pump House – Corrosion Allowance of
Steel Pump Pedestal

Date

March 3, 2022

1. Introduction

The Regional District of Okanagan-Similkameen (RDOS) owns and operates the Sage Mesa pump house located between the west shore of Okanagan Lake and Highway 97 north of Penticton, BC at latitude 49.52215° North and longitude 119.61756° West.



Figure 1: View of pump house looking south with Okanagan Lake on the left and Highway 97 on the right

The pump house has a wet well with three (3) vertical turbine pumps that supply water to the Sage Mesa reservoirs. The wet well is injected with 12% sodium hypochlorite solution to disinfect the lake water. The solution produces chlorine gas, which is very reactive and is a probable contributor to the significant corrosion on the inside of the steel pedestal supporting the vertical turbines. The RDOS retained McElhanney Ltd. (McElhanney) to determine the corrosion allowance of the pump pedestal.

McElhanney

290 Nanaimo Avenue W, Penticton BC Canada V2A 1N5
Tel. 250 492 7399 | Fax. 1-855-407-3895 | www.mcelhanney.com

2. Assessment

Derek Kronebusch, P.Eng. of McElhanney's Penticton office visited the site to take photos and measurements on November 10, 2021.



Figure 2: View of pump pedestal with heaviest vertical turbine (in foreground) removed

The heaviest vertical turbine had been removed prior to our site visit (refer to [Figure 2](#)). Significant corrosion was observed on the inside of the pipe stub supporting the vertical turbine (refer to [Figure 3](#)). The supporting steel work, which consists of two channels facing each other and a cover plate, was also corroded, but to a noticeably smaller amount (refer to [Figure 3](#)).

We assessed the pump pedestal including the pipe stubs in accordance with CAN/CSA-S16-14 *Design of Steel Structures* based on the following:

- The weights of the existing vertical turbines were estimated based on characteristics of current pumps manufactured today using visual based assumptions taken from the field with typical construction materials and we also included a 25% safety factor allowance as follows:
 - Small submersible type turbine (hidden in background in [Figure 2](#)): 700 lbs (318 kg)
 - Medium fabricated discharge head turbine (visible in centre in [Figure 2](#)): 1,600 lbs (726 kg)
 - Large turbine (removed but pipe stub visible in foreground in [Figure 2](#)): 2,700 lbs (1,225 kg)
- We assumed the existing steel to have a yield strength of 30 ksi (210 MPa) and an ultimate strength of 55 ksi (380 MPa) in accordance with Clause 5.2.2 of CAN/CSA-S16-14 in absence of information about the steel.

- We allowed for a horizontal load of 10% of the weight of the turbine applied at mid-height of the motor, which is assumed to be approximately 5'-6" (1.7 m) above the top of the steel pedestal, as an equivalent static force to account for dynamic loads due to earthquakes and imbalance.
- We based the analysis of the pipe stubs on the heaviest turbine, which has pipe stub with an outside diameter of 14" (356 mm). Most commonly steel pipes are standard thickness, which would be 0.375" (9.5 mm) for this diameter.

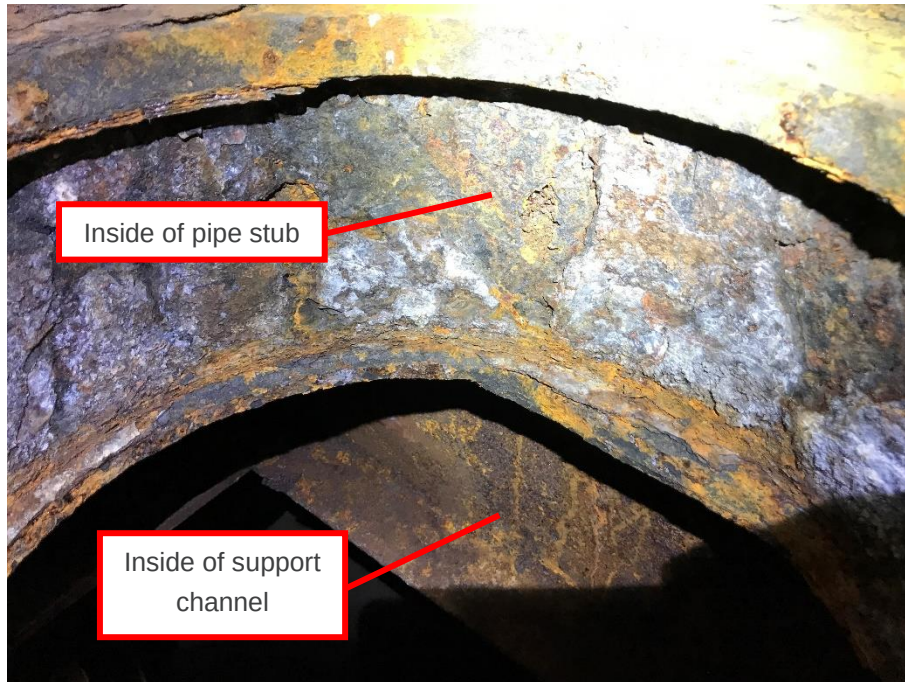


Figure 3: Inside view of pipe stub supporting heaviest turbine

We determined that both the **wall thickness of the pipe stubs** supporting the vertical turbines as well as the **webs of the channels supporting the pipe stubs** only require a minimum thickness of **0.1" (2.5 mm)** to be structurally adequate to support the turbines.

Most likely the pipe stubs had an original wall thickness of 0.375" (9.5 mm), which means they have a significant corrosion allowance. The lightest 8" deep channel has a web thickness of 0.220" (5.6 mm), which also leaves a considerable corrosion allowance.

The thickness can be measured with an ultrasonic thickness (UT) gauge. Non-destructive testing (NDT) companies provide this service, if the RDOS does not have a UT gauge.

We recommend confirming the current steel thickness and monitoring it going forward. The recommended initial monitoring interval is one (1) year. The interval can be increased progressively up to five (5) years to suit the amount of thickness loss between inspections.

The steel pedestal should be replaced if the remaining thickness of the steel pedestal is approaching the limit.

3. Closure

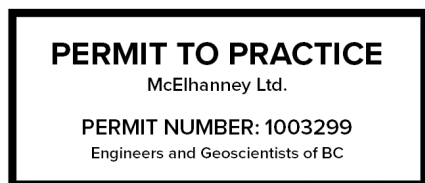
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Sincerely,

McElhanney Ltd.



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Sage Mesa Water System

2019 Annual Water Quality Report

Regional District of Okanagan - Similkameen Public Works

Water System Notifications - 2019

By late April of 2019 the turbidity in Okanagan Lake increased above 1 NTU. At this time the Interior Health Authority upgraded the previous Seasonal *Boil Water Notice* (BWN) for the Lower Zone to a permanent *Boil Water Notice* along with issuing a *Water Quality Advisory* (WQA) for Turbidity > 1NTU (Fair) for the Upper Zone of the system.

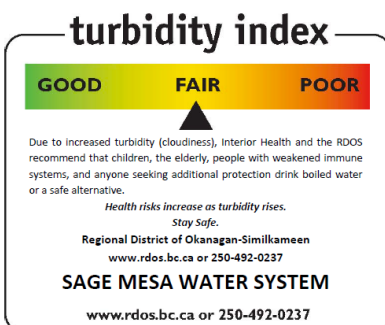
The Interior Health Authority identified insufficient chlorine contact time between the water and the added chlorine before reaching the first customers (the lower portion of the system). With insufficient contact time there is the potential for inadequate pathogen reduction for the water supplied to these properties in the Lower Zone during all times of the year.

This permanent *Boil Water Notice* replaces the previous Seasonal *Boil Water Notice* that was in place for the Lower Zone only during the summer months.

There are three main types of pathogens (micro-organisms) that pose risks to human health in drinking water; viruses, bacteria and protozoa. The Sage Mesa system has only one level of treatment, the addition of chlorine. Chlorine can target viruses and bacteria however with insufficient contact times and increased turbidity these organisms have the potential to remain viable in the water. Protozoa are organisms such as *Giardia* and *Cryptosporidium*. *Giardia* can be partially inactivated by chlorine however, with insufficient contact times and increased turbidity these organisms can also remain viable. *Cryptosporidium* on the other hand cannot be inactivated by chlorine and needs to be removed by filtration or inactivated with additional treatment processes such as ultraviolet light which are currently not in place.

The Upper Zone WQA was rescinded on December 16, 2019 upon turbidity levels in Okanagan Lake consistently reported below 1 NTU (Good).

The permanent BWN for the Lower Zone will remain in effect until the appropriate engineering upgrades are in place to provide the required chlorine contact time between the Lake Pump Station and the first customers of the system (the Lower Zone).



IHA's Role

The Interior Health Authority's team of drinking water officers are responsible for providing the oversight to ensure compliance and drinking water safety. The IHA is responsible for issuing Permits to Operate to drinking water systems. IHA has four levels of water notifications.

WATER QUALITY ADVISORY (WQA)

There is some level of risk associated with consuming the water, but a boil water **NOTICE (BWN)**

There are organisms in the water that can make you sick. To safely consume the water, you must bring it to a rolling boil for at least 60 seconds, or use a safe alternate source of water.

DO NOT CONSUME (DNC)

There are harmful chemicals or other bad things in the water that can make you sick if you consume (swallow) it. You cannot make the water safe by boiling it. You can bath, shower, and water plants and gardens with the water.

DO NOT USE WATER (DNU)

There are known microbial, chemical, or radiological contaminants in the water and that any contact with the water, with the skin, lungs, or eyes can be dangerous. Do not turn on your tap for any reason and do not use your water. You CANNOT make the water safe by boiling it.

Coliform Counts

Total Coliforms and *E.coli* are indicator organisms used to assess bacteriological quality of the water (i.e. the effectiveness of the treatment and safety of the water within the distribution system).



Free Chlorine

Free chlorine residuals in the distribution system add a level of protection to the treated water as it moves through the distribution network. Free chlorine residuals are required to be maintained between 0.2 mg/L and 2.0 mg/L free chlorine.

Water Quality Monitoring in the Distribution System

In 2019 a total of **53** treated water samples were drawn from dedicated sample locations throughout the distribution system on a weekly basis and analyzed by an accredited

laboratory for Total Coliforms and *Escherichia Coli*. All of the samples drawn in 2019 had no detections for Total Coliforms or *E.coli*.

In addition to the weekly bacteriological samples, field tests are conducted for free chlorine residuals, temperature, pH, conductivity and turbidity. The treated water pumped from the Lake Pump station is re-chlorinated at the Booster Station before the water is pumped to the Upper Zone to ensure adequate residuals in the Upper Zone's distribution system.

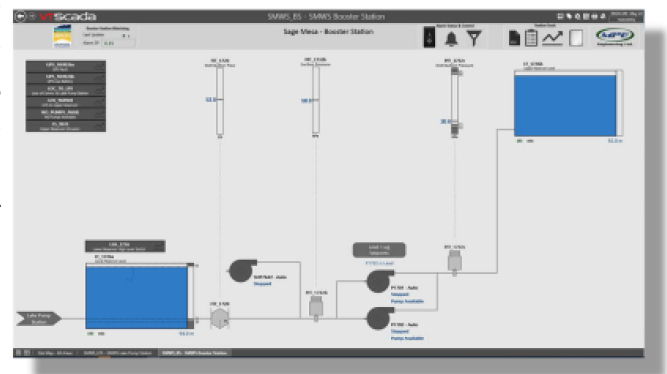


Sampling Location	Unit	Avg.	Min	Max	Number of Results
Booster Station	mg/L	1.07	0.75	1.79	29
Sandstone Dr.	mg/L	0.79	0.31	1.37	48

2019—Distribution Free Chlorine Residuals

Supervisory Control and Data Acquisition (SCADA) Systems

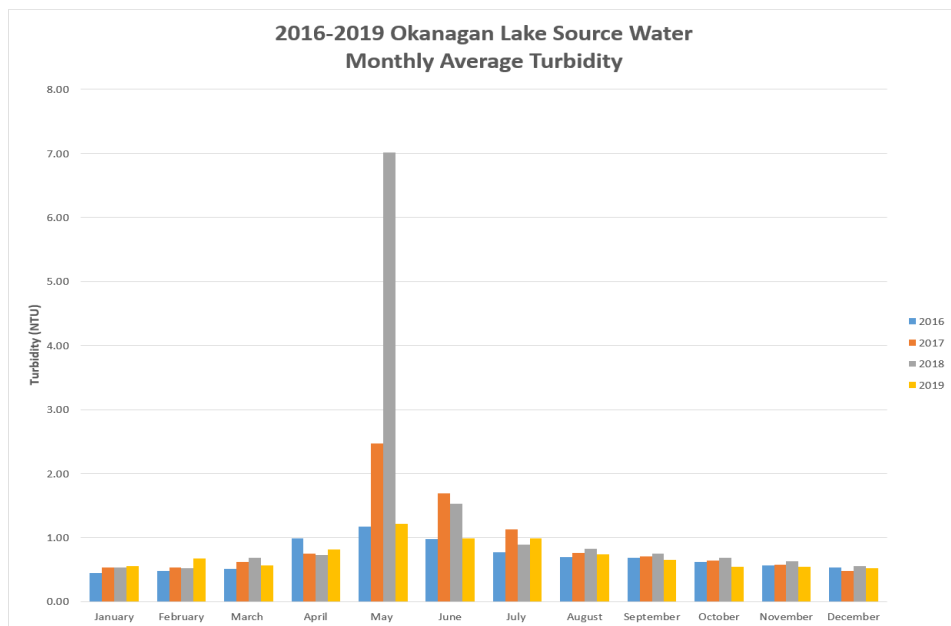
A SCADA system is an integral part of a modern water system. It is comprised of sensors, programmable controllers, communications and network devices installed at pump stations and treatment facilities. The SCADA system controls equipment such as pumps and monitors system operations while storing important data such as intake turbidity levels, pumping flow rates, and storage reservoir levels. The system also provides for efficiencies in operation and the response to system failures. This is achieved by the ability to monitor and view the system remotely through a software package along with the generation of alarms that will notify the system Operators when there is a problem or failure within a system.



A Typical SCADA Screen Display

Okanagan Lake Turbidity

In 2019 turbidity levels in Okanagan Lake exceeded the criteria set in the Interior Health Authority's Turbidity Index which resulted in a *Water Quality Advisory* being issued for the Upper Zone, in addition to the permanent *Boil Water Notice* for the Lower Zone.



Comparison of 2016—2019 Monthly Average Turbidity Levels

Potable Water – Okanagan Lake Source

A variety of testing is carried out in the water system on a daily, weekly, monthly and annual basis. Annually, the RDOS submits an untreated sample from the source, Okanagan Lake, to an accredited lab for full comprehensive potable water testing. The comprehensive test includes physical parameters (e.g. color, turbidity, temperature, UV transmittance), chemical parameters (e.g. total metals and nutrients) and bacteriological quality. Changes in these parameters may result in challenges with the current treatment process, the need for water notifications for customers (i.e. *Boil Water Notice* or *Water Quality Advisory*) or the requirement for additional treatment processes to be implemented. In 2019, all of the tested parameters met the applicable potable water standards with the exception of temperature and turbidity. Temperature exceeded the Aesthetic Objective of 15°C during the months of June to September, with a maximum of 23.8°C recorded from Okanagan Lake. Turbidity exceed the criteria set in the Interior Health Authority's Turbidity Index as discussed previously in this report. These parameters are also trended annually and in 2019 there were no significant changes in any parameters.



What is Turbidity

Turbidity is the measurement of the “cloudiness” of water resulting from the suspension of particles such as clay, silt, organics, etc. and is measured in Nephelometric Turbidity Units (NTU). Bacteria, viruses, and parasites such as *Giardia* and *Cryptosporidium* can attach themselves to the suspended particles in turbid water. These particles then interfere with disinfection by shielding contaminants from the disinfectant (UV or chlorine). Interior Health's Turbidity Index determines the turbidity levels which trigger water system notifications when levels are exceeded. Less than 1 NTU is “Good”, greater than 1NTU and less than 5NTU is “Fair”, with a Water Quality Advisory required and greater than 5 NTU is “Poor”, with a Boil Water Notice required.

Standards for Potable Water

The *British Columbia Drinking Water Protection Act (DWPA)* and supporting Regulation along with the *Federal Guidelines for Canadian Drinking Water Quality (GCDWQ)* define parameters for potable water in BC. These include Aesthetic Objectives (AO) and Maximum Allowable Concentrations (MAC) for numerous water quality parameters.



Certified Water Operators

The British Columbia *Environmental Operators Certification Program (BC EOCP)* is responsible for the classification of water systems in BC. The EOCP is also responsible for certification of all water system Operators.

All RDOS Operators are certified through the *BC EOCP*. Operators may hold certification in the disciplines of Water Distribution and/or Water Treatment with 4 levels of certification achievable within each discipline.

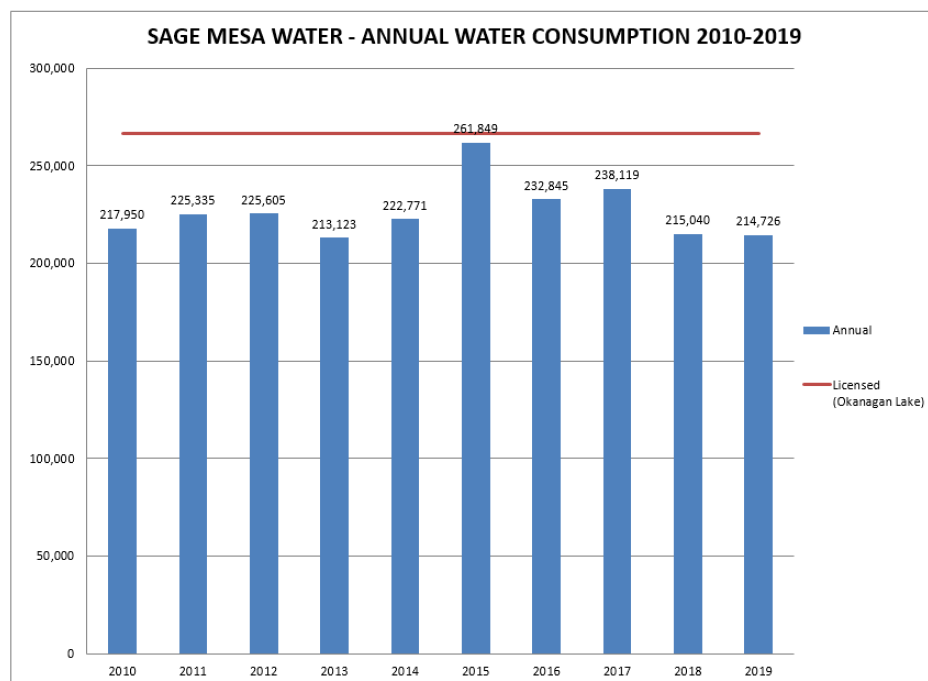
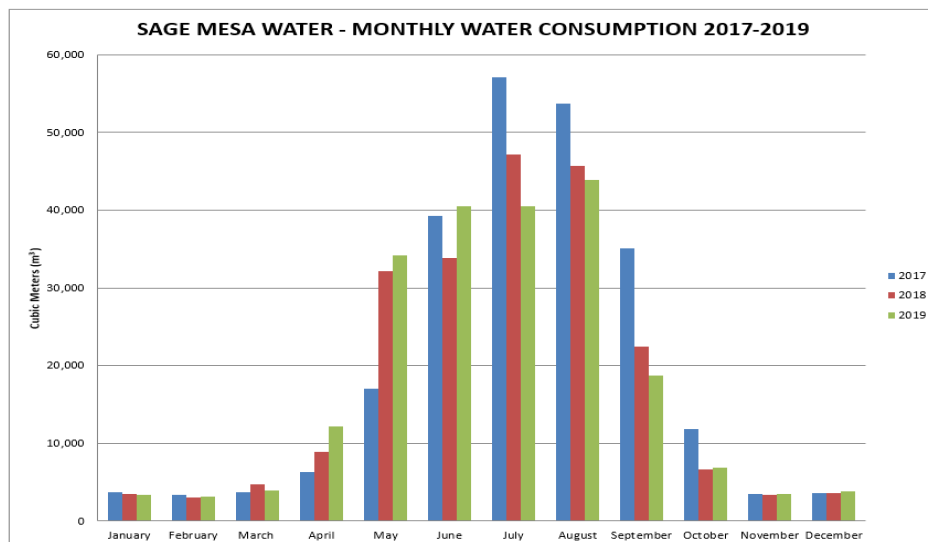
Annually, RDOS Operators attend courses and seminars and complete online training required to maintain and augment their levels of certification.

System Management and Operations Structure

The Sage Mesa system is a privately owned water utility currently under the management of the British Columbia, *Ministry of Forest Lands and Natural Resource Operations and Rural Development (FLNRORD)*. The RDOS provides Operation and Maintenance for the Sage Mesa system under a contract agreement with the *FLNRORD*.

Water Consumption—2019

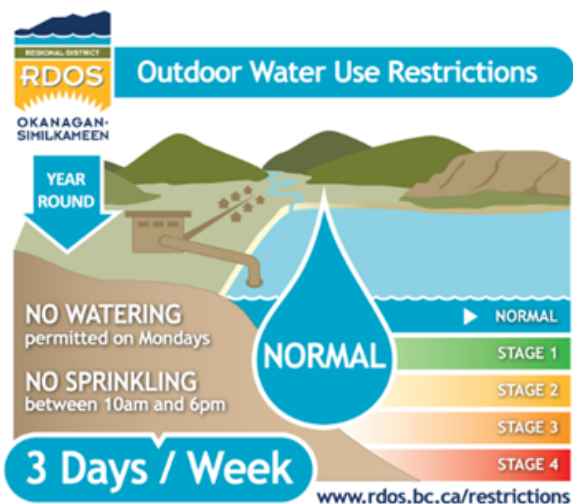
In the Sage Mesa water system, water for domestic and commercial (golf course irrigation) uses is sourced entirely from Okanagan Lake.



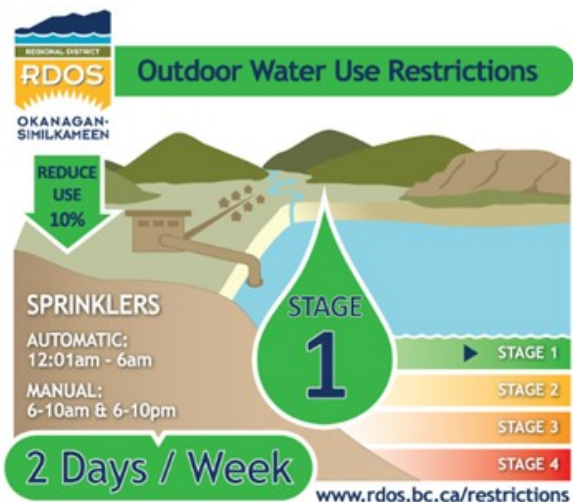
Water Conservation

What's New? RDOS Water Use Restriction Images

These images are designed to illustrate a lake extraction water system, and to graphically display current conditions and allowable uses of water in each Restriction Stage.



Stage Normal - Sprinkling is permitted three days per week, the maximum allowable. The background blue colour which denotes a bountiful water supply. The system is operating efficiently as user demands are conservative, easily met and reservoir levels maintained.



Note: the 'down arrow' is suggesting a 10% reduction. The level of the lake is dropping, more beach is showing and colour of droplet changes from blue to green.

Stage 1— Dry weather conditions coupled with higher water demand by users, can trigger a move to Stage 1 and messaging out to residents. This Stage means the pumping system is working harder to keep up to water demand. Lawn sprinkling is reduced to two days per week to reduce pressure on the system. This stage remains in effect until the weather changes, or the lake (or system issues) rebound. If conditions continue to remain dry and use increases, a move to Stage 2 may be considered.

For the complete Water Use Restriction Stages visit: [Surface Water](#)

If you have specific questions on water use or conservation, contact: Zoe Kirk, RDOS Public Works Projects at zkirk@rdos.bc.ca or call 250-490-4110.

Provincial Drought Levels

It can be confusing when Provincial Drought Levels are circulated in the media and appear to contradict local Water Restriction Stages. They are two different rating systems.

Drought levels are based on 'environmental flow needs' in creeks and rivers. BC River's Forecast Centre monitor volumes of water and water levels in order to insure water levels are adequate to support fish as they move through their life cycle. Fish are indicators of the overall health of the creek ecosystem, especially in times of increasing water scarcity during a drought. The Province developed a system to rate Drought Levels, and the response actions required at each incremental stage.

Regional Water Restrictions

The RDOS owns/operates nine water systems. Each system has its own Water Use Bylaws tailored to the system and user base.

Sprinkling Restrictions relate to the capacity of each water system to provide potable water to users. Restrictions are required in times of heavy use or water scarcity and may not be at the same stage in all systems.

The RDOS underwent a review process to harmonize the restriction stages as much as possible in all nine systems. New regulations will be announced shortly and information distributed to users to assist with implementation of the new restrictions.

Water Quality Complaints

If you have a water quality complaint, concern or would like to request further information regarding any of the RDOS water systems please contact the following:

Public Works Department
RDOS Environmental Technologist
Toll Free: 1-877-610-3737
Phone: 250-490-4106
Email: info@rdos.bc.ca

Water Connections

During regular business hours water related emergencies, questions regarding applications for water service and water service turn on/off requests can be directed to the following:

Public Works Department
Administrative Assistant
Toll Free: 1-877-610-3737
Phone: 250-490-4135
Email: info@rdos.bc.ca

AFTER-HOURS WATER EMERGENCIES

For all after-hours water related emergencies please call:
Regional Dispatch
250-490-4141



Additional Resources

RDOS Water System Home Page
<http://www.rdos.bc.ca/departments/public-works/water-systems/>

Interior Health Authority "Drinking Water for Everyone"
www.drinkingwaterforeveryone.ca/

Interior Health Authority Drinking Water Homepage
www.interiorhealth.ca/YourEnvironment/DrinkingWater/Pages/default.aspx

Federal Guidelines for Drinking Water Quality
www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality.html#tech_doc

Regional District of Okanagan-Similkameen
101 Martin St, Penticton,
BC V2A 5J9

T- 250.493.0237 TF- 1.877.610.3737
Web Site - www.rdos.bc.ca

Sage Mesa Water System

2018 Annual Water Quality Report

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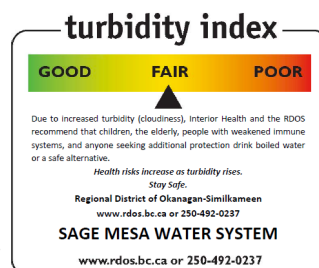
Okanagan Lake Source Water Quality—2018



Lake Pump Station on Hwy 97

For a second year in a row, higher than normal turbidity (suspended particles) and colour were observed in Okanagan Lake as a result of increased flows from the tributary creeks feeding into the Lake. This decrease in water quality resulted in a number of water notifications being issued for the Sage Mesa water system.

On March 23rd, after a heavy rainfall event, a *Water Quality Advisory* was issued for the entire system in response to turbidity levels exceeding 1 NTU at the Lake intake. The Interior Health Authority's (IHA) Turbidity Index requires



a *Water Quality Advisory* to be in place when turbidity exceeds 1 NTU and a *Boil Water Notice* when turbidity exceeds 5 NTU. On April 25th, in response to an increase in water consumption, the "seasonal" *Boil Water Notice* was issued for the Lower Zone, replacing the existing *Water Quality Advisory*. Turbidity levels in Okanagan lake continued to increase into May with the turbidity exceeding 5 NTU. This resulted in a *Boil Water Notice* being issued for the Upper Zone replacing the existing *Water Quality Advisory*.

With Okanagan Lake turbidity levels fluctuating the *Boil Water Notice* for the Upper Zone remained in place until August 31st while the "seasonal" *Boil Water Notice* for the Lower Zone remained in effect until December 11th.

2018 Seasonal Boil Water Notice—Lower Zone

In 2012, the IHA provided direction to the RDOS that a *Boil Water Notice* would be required seasonally during times of high flows for the Lower Zone of the Sage Mesa water system. This decision was based on engineering studies that concluded that there is insufficient contact time between the water and chlorine before reaching the first customers during times of high flows. As a result, there is the potential for inadequate pathogen reduction for the water supplied to these properties.

There are three main types of pathogens (micro-organisms) that pose risks to human health in drinking water; viruses, bacteria and protozoa. The Sage Mesa system has only one level of treatment, the addition of chlorine. Chlorine can target viruses and bacteria however with insufficient contact times and increased turbidity these organisms have the potential to remain viable in the water. Protozoa are organisms such as *Giardia* and *Cryptosporidium*. *Giardia* can be partially inactivated by chlorine however, with insufficient contact times and increased turbidity these organisms can remain viable. *Cryptosporidium* on the other hand cannot be inactivated by chlorine and needs to be removed by filtration or inactivated with additional treatment processes such as ultraviolet light which are currently not in place.

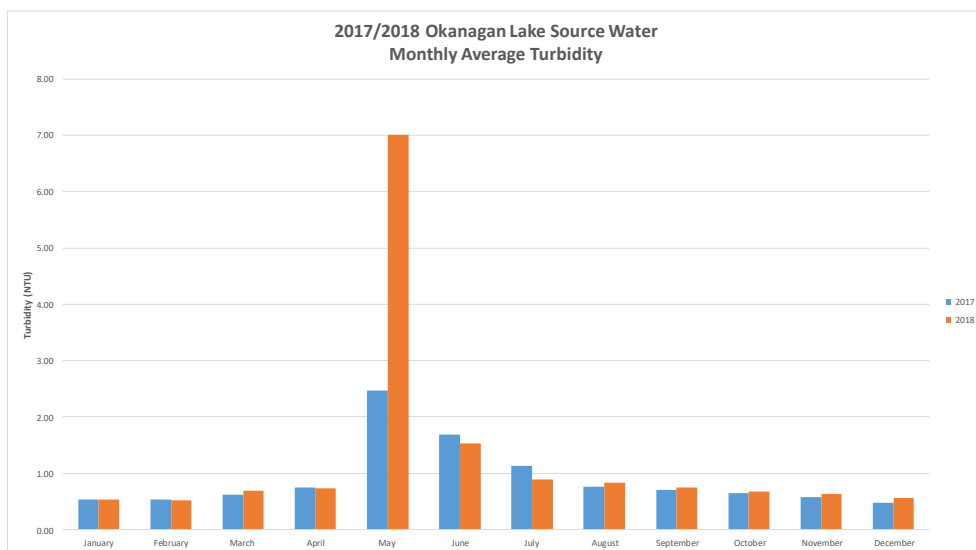
In early 2019, the "seasonal" *Boil Water Notice* was upgraded by the Interior Health Authority to a permanent *Boil Water Notice*.

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Okanagan Lake Turbidity

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Comparison of 2017 and 2018 Monthly Average Turbidity Levels

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IHA's Role

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WATER QUALITY ADVISORY (WQA)

-There is some level of risk associated with consuming the water, but a boil water notice is not needed.

- The risk is elevated for people with weakened immune systems.

BOIL WATER NOTICE (BWN)

- There are organisms in the water that can make you sick.

- To safely consume the water, you must bring it to a rolling boil for at least 60 seconds, or use a safe alternate source of water.

DO NOT CONSUME (DNC)

-There are harmful chemicals or other bad things in the water that can make you sick if you consume (swallow) it.

-You cannot make the water safe by boiling it.

-You can bath, shower, and water plants and gardens with the water.

DO NOT USE WATER (DNU)

- There are known microbial, chemical, or radiological contaminants in the water and that any contact with the water, with the skin, lungs, or eyes can be dangerous.

- Do not turn on your tap for any reason and do not use your water .

- You CANNOT make the water safe by boiling it.



WATER QUALITY
ADVISORY (WQA)



BOIL WATER
NOTICE (BWN)



DO NOT CONSUME
(DNC)



DO NOT
USE (DNU)

Water Quality Monitoring in the Distribution System

In 2018 a total of **57** treated water samples were drawn from dedicated sample locations throughout the distribution system on a weekly basis and analyzed by an accredited laboratory for Total Coliforms and *Escherichia Coli*. All of the samples drawn in 2018 had no detections for Total Coliforms or *E.coli*.



In addition to the weekly bacteriological samples, field tests are conducted for free chlorine residuals, temperature, pH, conductivity and turbidity. The treated water pumped from the Lake Pump station is re-chlorinated at the Booster Station before the water is pumped to the Upper Zone to ensure adequate residuals in the Upper Zone's distribution system.

Sampling Location	Unit	Avg.	Min	Max	Number of Results
Booster Station	mg/L	1.02	0.39	1.92	28
Lower Zone	mg/L	1.13	1.13	1.13	1
Sandstone Dr.	mg/L	0.82	0.08	2.6	53

2018—Distribution Free Chlorine Residuals

Provincial Drought Levels vs Watering Restrictions

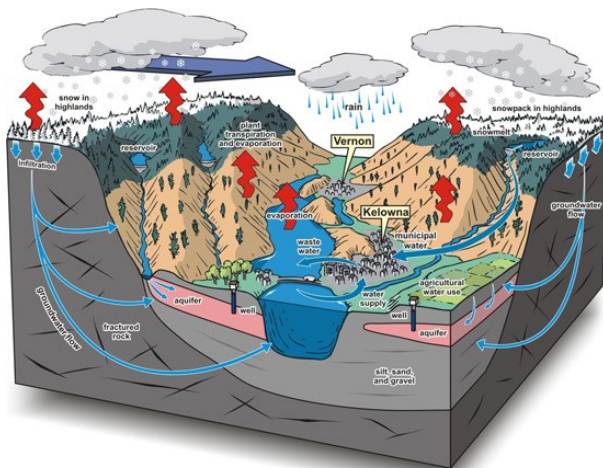
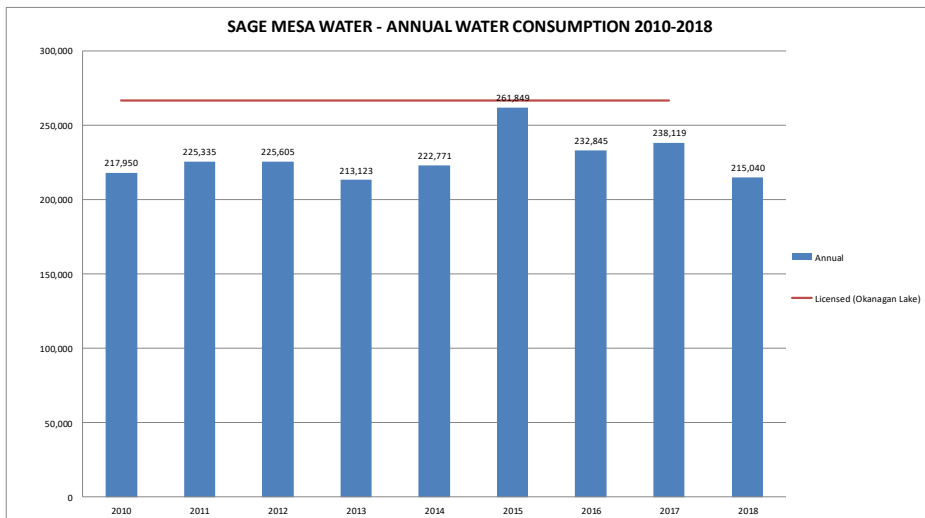
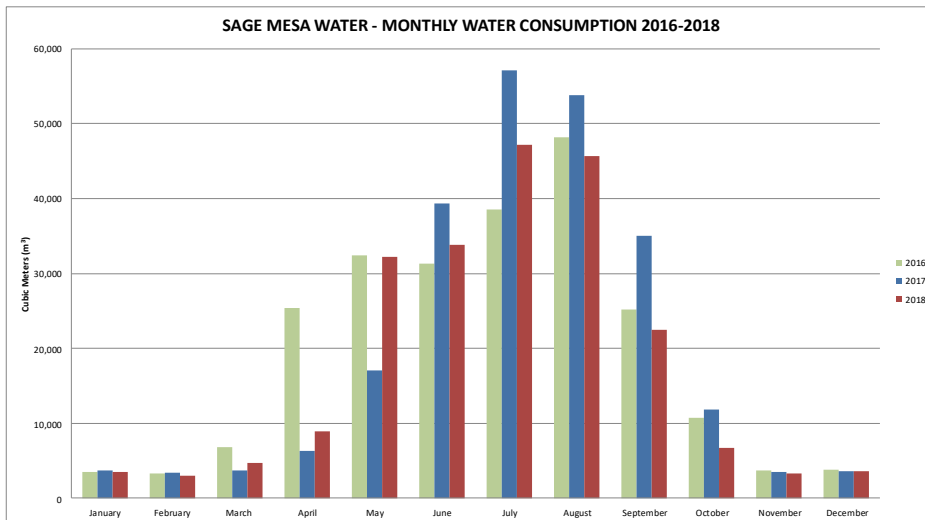
Its confusing when Provincial Drought Levels are circulated in the media and appear to contradict local Watering Restriction Stages. They are two very different rating systems.

Drought levels are based on 'environmental flow needs' in creeks and rivers. BC River's Forecast Centre monitor volumes of water and water levels in order to insure water levels are adequate to support fish as they move through their life cycle. Fish are indicators of the overall health of the creek ecosystem, especially in times of increasing water scarcity during a drought. The Province developed a system to rate Drought Levels, and the response actions required at each incremental stage.

Residential watering restrictions are based on the water system's ability to supply water to all users on the system. Stage 1 begins each April and users are asked to abide by restrictions. The staged use of water allows the RDOS to balance the water demand and reduce stress on the pumping infrastructure.

Water Consumption—2018

In the Sage Mesa water system, water for domestic and commercial (golf course irrigation) uses is sourced entirely from Okanagan Lake.

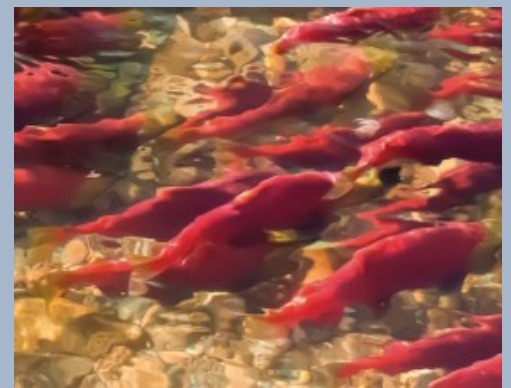


Provincial Drought Levels

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Drought levels are based on 'environmental flow needs' in creeks and rivers. BC River's Forecast Centre monitor volumes of water and water levels in order to insure water volumes are adequate to support fish as they move through their life cycle. Fish are indicators of the overall health of the creek ecosystem, especially in times of increasing water scarcity during a drought.

Flow volumes and levels directly correlate to the temperature of water, as shallow or slow moving water heats up more quickly. Hot water holds less oxygen. Without significant cooling shade from healthy riparian habitat, fish can easily start to suffocate and die of heat stress in hot shallow water.



The Province developed a system to rate Drought Levels, and the response actions required at each incremental stage. These recommendations are advertised through media outlets as Drought Levels change.

Water Quality Complaints

If you have a water quality complaint, concern or would like to request further information regarding any of the RDOS water systems please contact the following:

Public Works Department
RDOS Environmental Technologist
Toll Free: 1-877-610-3737
Phone: 250-490-4106
Email: info@rdos.bc.ca

Water Connections

During regular business hours water related emergencies, questions regarding applications for water service and water service turn on/off requests can be directed to the following:

Public Works Department
Administrative Assistant
Toll Free: 1-877-610-3737
Phone: 250-490-4135
Email: info@rdos.bc.ca

AFTER-HOURS WATER EMERGENCIES

For all after-hours water related emergencies please call:
Regional Dispatch
250-490-4141



Additional Resources

RDOS Water System Home Page
<http://www.rdos.bc.ca/departments/public-works/water-systems/>

Interior Health Authority "Drinking Water for Everyone"
www.drinkingwaterforeveryone.ca/

Interior Health Authority Drinking Water Homepage
www.interiorhealth.ca/YourEnvironment/DrinkingWater/Pages/default.aspx

Federal Guidelines for Drinking Water Quality
www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality.html#tech_doc

Regional District of Okanagan-Similkameen
101 Martin St, Penticton,
BC V2A 5J9

T- 250.493.0237 TF- 1.877.610.3737
Web Site - www.rdos.bc.ca

Sage Mesa Water System

2016 Annual Water Quality Report

Regional District of Okanagan - Similkameen Public Works

2017 Annual Water Consumption



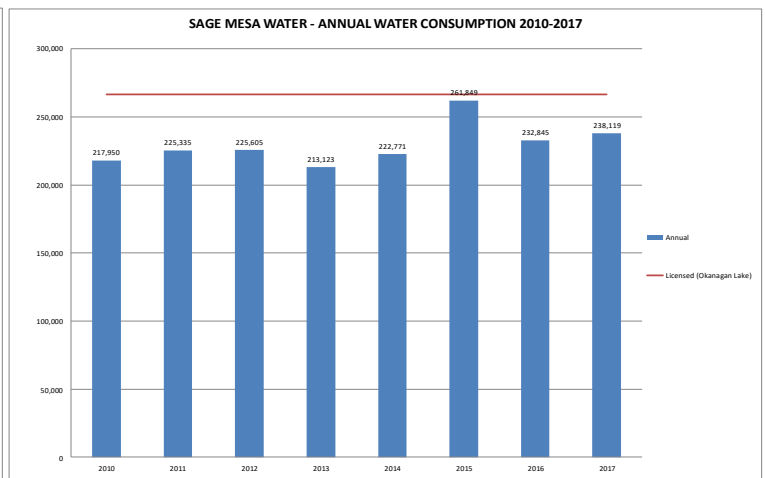
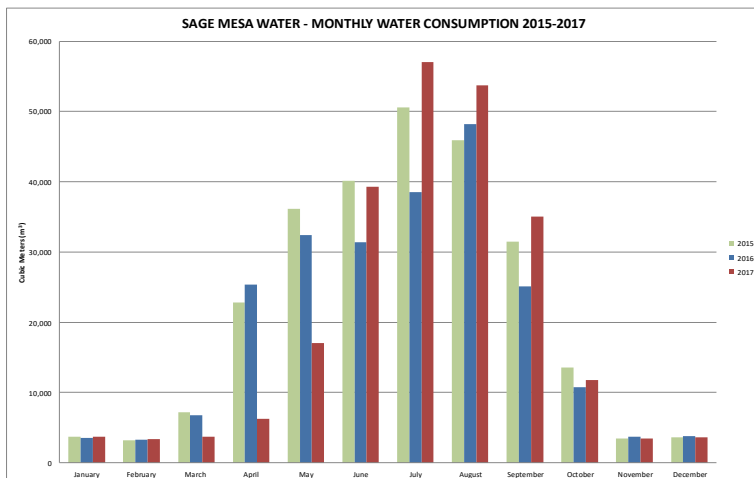
Sandbagging around the Lake Pump Station

2017 was the year of “Floods to Fires”. Above normal precipitation began in April and continued through May and into June resulting in increased water levels in area streams, creeks, rivers, and lakes causing flooding throughout the region. By mid-June, Okanagan Lake had crested and July and August saw record breaking heat and smoky skies along with record low precipitation creating extreme forest fire conditions in the Province. By the beginning of September, the Provincial Government declared a Drought Level 3 for the Okanagan Valley.



Brush fire in Westwood area —July, 2017

In the Sage Mesa water system, water for domestic and commercial (golf course irrigation) uses is sourced entirely from Okanagan Lake. The increased inflow into Okanagan Lake in 2017 caused a number of water quality issues for the Sage Mesa system. These will be discussed in more detail further in this report. Despite the wet start to the year, the total consumption for 2017 was slightly higher than 2016 but less than the drought year of 2015. A total of 238,119 cubic meters was pumped from Okanagan Lake in 2017.



2017 Flooding and Water Quality Events

On top of the above normal precipitation in April, May started out with a heavy rainfall event recorded over the evening of May 4th and into May 5th. This even caused a significant amount of turbid water and debris to enter Okanagan Lake over a short period of time. On May 5th it was decided that the seasonal Boil Water Notice for the Lower Zone of Sage Mesa be issued with the expectation that turbidity levels would be increasing. One day later, on May 6th, a large flow of wooden debris was observed along the south west side of Okanagan Lake. A plume of turbid and murky water was expected to follow. As a precaution a Boil Water Notice was issued to the Upper Zone, providing coverage to the entire Sage Mesa water system. By May 8th, turbidity levels in Okanagan Lake were on the rise above 1 NTU.



By the end of May, the elevated water level in Okanagan Lake started to erode the foreshore around the Sage Mesa pump station on Highway 97. Sandbagging was completed by RDOS and Ministry of Forest crews to provide protection to the foreshore and the Lake Pump Station in response to the forecasts for further increases in the Okanagan Lake level. Fortunately, by mid-June the lake level crested and only limited erosion resulted.



With Okanagan Lake turbidity levels fluctuating along with unseasonal weather the Boil Water Notice for the Upper Zone remained in place until July 25th when it was downgraded to a Water Quality Advisory once turbidity levels started to stabilize.

Both the Lower Zone Boil Water Notice and the Upper Zone Water Quality Advisory remained in effect until October 12th.



System Management and Operations.

The Sage Mesa system is a privately owned water utility currently under the management of the British Columbia, *Ministry of Forest Lands and Natural Resource Operations (FLNRO)*. The RDOS provides Operation and Maintenance under a contract agreement with the *FLNRO*.

The Sage Mesa water system is supplied by Okanagan Lake. Water is pumped from the Lake Pump Station into the distribution system and to an elevated storage reservoir (Lower Reservoir). The only treatment of the raw lake water is chlorination through the addition of sodium hypochlorite (bleach) at the Lake Pump Station. A Booster Station located at the Lower Reservoir provides for re-chlorination of the treated water as it is boosted to the Upper Reservoir at a higher elevation.



Lake Pump Station on Hwy 97

Potable Water – Okanagan Lake Source

A variety of testing is carried out in the water system on a daily, weekly, monthly and annual basis. Annually, the RDOS submits an untreated sample from the source, Okanagan Lake, to an accredited lab for full comprehensive potable water testing. The comprehensive test includes physical parameters (e.g. color, turbidity, temperature, UV transmittance), chemical parameters (e.g. total metals and nutrients) and bacteriological quality. Changes in these parameters may result in challenges with the current treatment process, the need for water notifications for customers (i.e. Boil Water Notice or Water Quality Advisory) or the requirement for additional treatment processes to be implemented. In 2017, all of the tested parameters met the applicable potable water standards with the exception of temperature and turbidity. Temperature exceeded the Aesthetic Objective of 15°C during the months of July to September, with a maximum of 22.7°C recorded from Okanagan Lake. Turbidity will be discussed further in this document. These parameters are also trended annually and in 2017 there were no significant changes in any parameters.

Certified Water Operators

The British Columbia *Environmental Operators Certification Program (BC EOCP)* is responsible for the classification of water systems in BC. The EOCP is also responsible for certification of all water system Operators.

All RDOS Operators are certified through the *BC EOCP*. Operators may hold certification in the disciplines of Water Distribution and/or Water Treatment with 4 levels of certification achievable within each discipline.

Annually, RDOS Operators attend courses and seminars and complete online training required to maintain and progress their levels of certification.



Standards for Potable Water

The *British Columbia Drinking Water Protection Act (DWPA)* and supporting Regulation along with the *Federal Guidelines for Canadian Drinking Water Quality (GCDWQ)* define parameters for potable water in BC. These include Aesthetic Objectives (AO) and Maximum Allowable Concentrations (MAC) for numerous water quality parameters.

What is Turbidity?

Turbidity is the measurement of the “cloudiness” of water resulting from the suspension of particles such as clay, silt, organics, etc. and is measured in Nephelometric Turbidity Units (NTU). Bacteria, viruses, and parasites such as *Giardia* and *Cryptosporidium* can attach themselves to the suspended particles in turbid water. These particles then interfere with disinfection by shielding contaminants from the disinfectant (UV or chlorine). Interior Health’s Turbidity Index determines the turbidity levels which trigger water system notifications when levels are exceeded. Less than 1 NTU is “Good”, greater than 1NTU and less than 5NTU is “Fair”, with a Water Quality Advisory required and greater than 5 NTU is “Poor”, with a Boil Water Notice required.

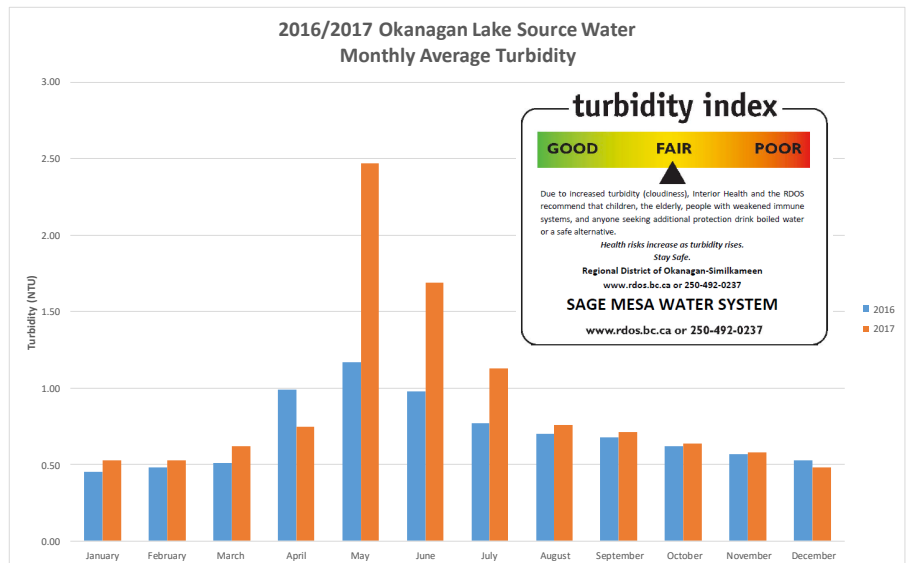
Levels of Water System Notices

Boil Water Notice (BWN): a notification to users of a system indicating that a health risk has been determined in the drinking water. A BWN is targeted to all users of a water system.

Water Quality Advisory (WQA): a level of notification below a Boil Water Notice and is used in situations where the general public health threat is modest. A WQA typically has a specific demographic that it targets.

Do Not Use Notice: is issued when there is an imminent risk to consuming the water or using the water for personal hygiene such as bathing and showering.

Okanagan Lake—Source Turbidity



Comparison of 2016 and 2017 Monthly Average Turbidity Levels

Seasonal Boil Water Notice—Lower Zone

In 2012, the IHA provided direction to the RDOS that a Boil Water Notice would be required to be in place seasonally during times of high flows for the Lower Zone of the Sage Mesa water system. This decision was based on the review of engineering studies that concluded that there is insufficient contact time between the water and the chlorine before reaching the first customers (the lower portion of the system) during times of high flows. As a result, there is the potential for inadequate pathogen reduction for the water supplied to these properties.

There are three main types of pathogens (micro-organisms) that pose risks to human health in drinking water; viruses, bacteria and protozoa. The Sage Mesa system has only one level of treatment, the addition of chlorine. Chlorine can target viruses and bacteria however with insufficient contact times and increased turbidity these organisms have the potential to remain viable in the water. Protozoa are organisms such as *Giardia* and *Cryptosporidium*. *Giardia* can be partially inactivated by chlorine however, with insufficient contact times and increased turbidity these organisms can remain viable. *Cryptosporidium* on the other hand cannot be inactivated by chlorine and needs to be removed by filtration or inactivated with additional treatment processes such as ultraviolet light which are currently not in place.

Water Quality Monitoring in the Distribution System

In 2017 a total of **60** treated water samples were drawn from dedicated sample locations throughout the distribution system on a weekly basis and analyzed by an accredited laboratory for Total Coliforms and *Escherichia Coli*. All of the samples drawn in 2017 had no detections for Total Coliforms or *E.coli*.



In addition to the weekly bacteriological samples, field tests are conducted for free chlorine residuals, temperature, pH, conductivity and turbidity. The treated water pumped from the Lake Pump station is re-chlorinated at the Booster Station before the water is pumped to the Upper Zone to ensure adequate residuals in the Upper Zone’s distribution system.

Sampling Location	Unit	Avg.	Min	Max	Number of Results
Booster Station	mg/L	1.11	0.48	2.8	34
Lower Zone	mg/L	1.66	1.17	3.3	16
Sandstone Dr.	mg/L	0.53	0.53	0.53	1
Upper PRV	mg/L	0.83	0.57	2.06	36

2017—Distribution Free Chlorine Residuals

Provincial Drought Levels vs Watering Restrictions

Its confusing when Provincial Drought Levels are circulated in the media and appear to contradict local Watering Restriction Stages. They are two very different rating systems.

Drought levels are based on ‘environmental flow needs’ in creeks and rivers. BC River’s Forecast Centre monitor volumes of water and water levels in order to insure water levels are adequate to support fish as they move through their life cycle. Fish are indicators of the overall health of the creek ecosystem, especially in times of increasing water scarcity during a drought. The Province developed a system to rate Drought Levels, and the response actions required at each incremental stage.

Residential watering restrictions are based on the water system’s ability to supply water to all users on the system. Stage 1 begins each April and users are asked to abide by restrictions. The staged use of water allows the RDOS to balance the water demand and reduce stress on the pumping infrastructure.

Coliform Counts

Total Coliforms and *E.coli* are indicator organisms used to assess bacteriological quality of the water (i.e. the effectiveness of the treatment and safety of the water within the distribution system).



Free Chlorine

Free chlorine residuals in the distribution system add a level of protection to the treated water as it moves through the distribution network. Free chlorine residuals are required to be maintained between 0.2 mg/L and 2.0 mg/L free chlorine.

Interior Health Authority’s Role

The Interior Health Authority’s team of drinking water officers are responsible for providing oversight to ensure compliance and drinking water safety. IHA is consulted when there is a need for issuing a water notice such as a Boil Water Notice and upon rescinding of notices. IHA is responsible for issuing Permits to Operate to drinking water systems.

The Interior Health Authority has 3 types of water notifications to inform users of negative impacts to water quality.

Water Quality Complaints

If you have a water quality complaint, concern or would like to request further information regarding any of the RDOS water systems please contact the following:

Public Works Department
RDOS Environmental Technologist
Toll Free: 1-877-610-3737
Phone: 250-490-4106
Email: info@rdos.bc.ca

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250-490-4141



Additional Resources

RDOS Water System Home Page
<http://www.rdos.bc.ca/departments/public-works/water-systems/>

Interior Health Authority "Drinking Water for Everyone"
www.drinkingwaterforeveryone.ca/

Interior Health Authority Drinking Water Homepage
www.interiorhealth.ca/YourEnvironment/DrinkingWater/Pages/default.aspx

Federal Guidelines for Drinking Water Quality
www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality.html#tech_doc

Water Conservation Resources

RDOS has online links to water saving tips and tricks, or how to detect leaks.
The Water Talk feature page has videos and info on water stewardship:

Water Conservation: <http://www.rdos.bc.ca/departments/public-works/water-systems/water-conservation/>

Water Talk!: <http://www.rdos.bc.ca/departments/public-works/water-systems/water-conservation/water-talk/>

Regional District of Okanagan-Similkameen
101 Martin St, Penticton,
BC V2A 5J9

T- 250.493.0237 TF- 1.877.610.3737
Web Site - www.rdos.bc.ca

WEST BENCH WATER SYSTEM

WATER CONSERVATION STRATEGY



FEBRUARY 2016



2016-February-25

Regional District of Okanagan-Similkameen,
101 Martin Street,
Penticton, B.C.
V2A 5J9

Attention: Ms. Candace Pilling, Engineering Technologist

**Subject: WEST BENCH WATER SYSTEM
WATER CONSERVATION STRATEGY**

Dear Sir/Madam:

We are pleased to present our final Water Conservation Strategy document. This report outlines where the Regional District should focus their water conservation efforts to achieve objectives of this analysis.

It has been a pleasure working with the staff of the Regional District for preparation of this report. If you require any further input on water conservation efforts for West Bench, please contact us at your convenience.

Yours truly,

A handwritten signature in blue ink, appearing to read "Elise Paré".

Elise Paré, P. Eng.
Project Manager

A handwritten signature in blue ink, appearing to read "Charlie Higgins".

Charlie Higgins, P. Eng.
Senior Review

WSP Canada Inc.
Suite 602, Landmark II
1708 Dolphin Avenue
Kelowna, BC, V1Y 9S4

Tel: 250-980-5500
Fax: 250-980-5511
www.wspgroup.com

EXECUTIVE SUMMARY

The West Bench Water System is located along the southwest side of Okanagan Lake, immediately west of the City of Penticton within the Regional District's Electoral Area 'F', and serves a year-round population of approximately 1050 people. The land use within the West Bench Water System is composed mainly of large semi-rural properties, along with several large acreages, one school, two irrigated parks, and the water utility. The water use has been estimated as 62% residential and 38% agricultural for the water system; however 65% of total annual demand is used for irrigation and agricultural purposes.

The water supply for the West Bench Water System has recently undergone a major upgrade. The Regional District has a bulk water purchase agreement with the City of Penticton for clean filtered water. The water is now supplied to the area through a connection to the City's water system east of the community. Ultimately the origin of the water source, the Okanagan Basin, remains the same.

Since 2003, the West Bench Water Utility has reduced demand by 26% through a series of pipe replacement programs, public outreach and education programs, low flow fixture replacements, and water use regulations. To complement the Regional District's current and upcoming policies and regulations, the West Bench Water Utility has set a target to reduce gross community water consumption by an additional 15 per cent by 2020.

The West Bench Water System's 2013 Maximum Day Demand was 4,600 m³/day. By implementing the activities outlined in this plan, a 15% reduction in demand will result in a Maximum Day Demand of approximately 3,910 m³/day or approximately 252,000,000 litres of water annually by 2020.

In order to achieve this reduction target, the Regional District will focus their water conservation efforts on the objectives outlined below. It is important to note that these objectives have been developed based on the best available data. As the data changes or is refined through enhanced monitoring and analysis or the implementation of improved data gathering technologies, the objectives of this Strategy may also need to be changed or refined accordingly.

- Implementation of universal metering with "user pay" pricing structure;
- Improved Regional Water Use and Conservation Bylaw;
- Continuation of water conservation programs, with potential enforcement, if necessary;
- Continued implementation of water loss management activities.

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1 WATER CONSERVATION OBJECTIVES

1.1 WATER CONSERVATION OBJECTIVES

The Regional District of Okanagan-Similkameen (RDOS) has recently commissioned and completed an upgrade to the West Bench Water System, supported in part by two infrastructure grants administered by the Ministry of Community, Sport and Cultural Development. A complementary step to the upgrades is to complete a West Bench Water Conservation Strategy. A properly created and implemented conservation plan will help to extend the life of the infrastructure and reduce power expenses.

The West Bench Water System is a relatively small user within the Okanagan Basin, but the Regional District recognizes the importance of water conservation to protect and sustain the water levels in Okanagan Lake. The objective of this Strategy is to consider management alternatives for West Bench so it can do its part to protect and sustain water supply levels in Okanagan Lake.

The Regional District's Conservation Strategy for the West Bench Water System strives to meet the goals of several policy and regulatory initiatives including:

- Provincial *Living Water Smart* initiative;
- the OBWB's Okanagan Water Wise goals;
- Regional District's *Strategic Plan*,
- RDOS *Corporate Climate Action Plan*,
- RDOS *South Okanagan Regional Growth Strategy*,
- RDOS *Area 'F' Official Community Plan*;
- Biodiversity strategy for the Okanagan-Similkameen entitled *Keeping Nature in our Future*; and
- The agreement between the City of Penticton and the Regional District for the Purchase of Bulk Water.

Collectively, all work in concert to support water conservation and efficient infrastructure. The provisions in the Regional District's water use bylaws, both current and future, speak directly to reducing water use and will supplement these policies and goals by providing tools to achieve these objectives.

Water reduction targets in this plan are set to be reduced by another 15% to achieve a Maximum Daily Demand of 3,910 m³/day by 2020.

1.2 CONSULTATION

The Water Conservation Strategy will undergo various consultations prior to finalization and implementation. Some suggested parties to review the document and the proposed initiatives are as follows:

- Internal Regional District staff, including the RDOS representatives on the OBWB Water Stewardship committee
- Electoral Area F Director Michael Brydon
- City of Penticton
- Consulting engineering firm WSP Canada Inc (formerly Focus Corporation) whom designed the new booster station and supply watermain from the City
- Regional District Board of Directors

2 COMMUNITY PROFILE

The West Bench Water System is located along the southwest side of Okanagan Lake, immediately west of the City of Penticton within the Regional District's Electoral Area 'F'. The water system is mainly bound in all four directions by the Penticton Indian Reserve No. 1. On the west and north are other rural residential neighbourhoods in the Area 'F' greater West Bench area. To the east of West Bench are Highway 97, Okanagan Lake, and additional smaller parcels of Penticton Indian Reserve Land.

The West Bench is located within a semi-arid grassland ecosystem, and sits on glacio-lacustrine and alluvial terraced deposits adjacent to the southwest end of Okanagan Lake. The elevation is approximately 440 m. Daily mean temperature is 9.20 C. Average yearly precipitation is 333mm with 280 mm falling as rain and 67.2 cm falling as snow.

Figure 2-1 - West Bench location in relation to the City of Penticton and Okanagan Lake



2.1 SERVICE POPULATION AND DEMOGRAPHICS

The West Bench Water System serves a year-round population of approximately 1050 people. The land use within the West Bench Water System is currently composed of semi-rural properties. According to 2013 BC stats data¹, approximately 30% of the population in the Regional District was over 65 with another 34% in the 50-64 age cohorts. As with the remainder of the Regional District, the West Bench demographic follows this trend of an aging population.

2.2 SEASONAL POPULATION VARIABILITY

The West Bench consists primarily of a permanent population with an estimated 20 % of the population ("snowbirds") leaving for a portion of the winter months. There is not a significant increase in population due to tourism during the summer months.

2.3 COMMUNITY GROWTH ESTIMATES

The West Bench land use has undergone transformation to primarily rural residential from orcharding since its development in the early 1950s. The conversion of land use was largely a result of subdivisions being permitted prior to the early 1990's. However, due to the highly erodible silt-laden lacustrine soils, ground water loading is to be avoided to prevent surface and subsurface erosion, and

¹ <http://www.bcstats.gov.bc.ca/StatisticsBySubject/Demography/PopulationEstimates.aspx>

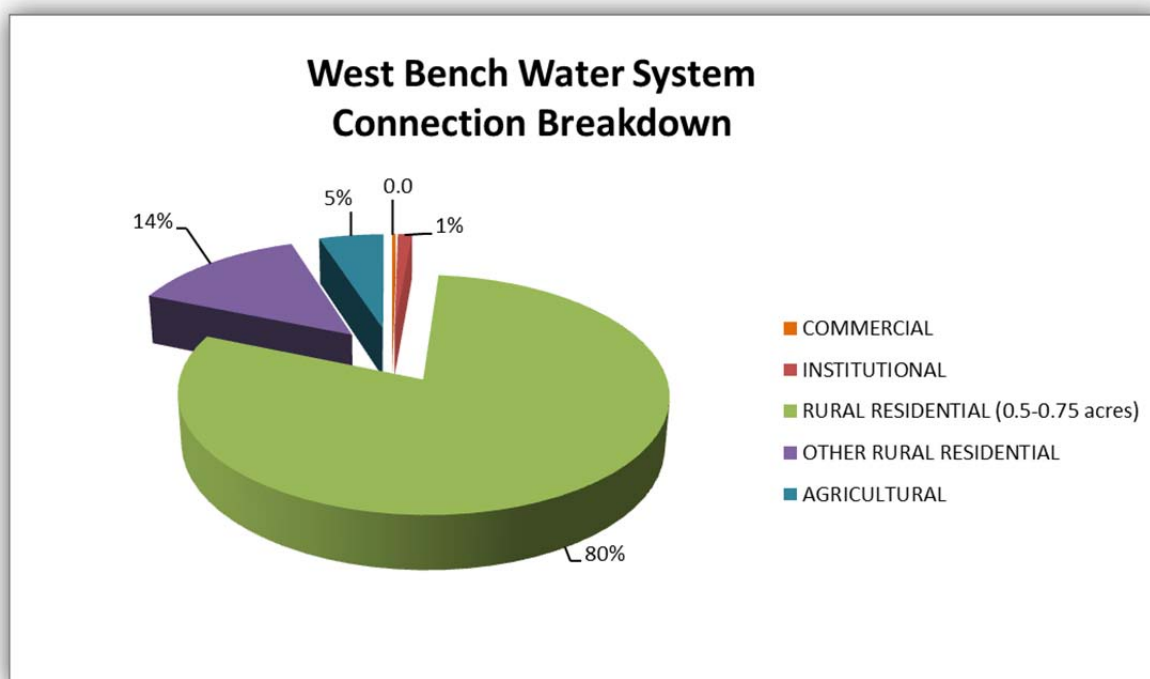
as a result, no additional septic systems are to be installed through further subdivision, secondary suites, or accessory dwellings.

A wastewater collection system that might counteract the effects of ground water loading is extremely costly in an area of such low density. As such, this Water Conservation Strategy will assume the current population for the area will remain relatively stable in the near future. The projected annual population growth rate is very low at 0.001% as the area is built out with minimal opportunity for expansion.

2.4 WATER CONNECTION SUMMARY

In 2013, the West Bench water service supplied approximately 1050 people through 357 connections of which 95% are rural residential, 80% of which are 0.5 to 0.75 acres in size (0.2 to 0.3 ha). The remaining 7% of the properties include 18 large acreages, many of which are commercial orchards, as well as one K-5 elementary school, two irrigated parks, a few small homebased businesses and the water utility.

Figure 2-2 - West Bench Water System Connection Breakdown



2.5 INFRASTRUCTURE SUMMARY

The West Bench Irrigation District (WBID), originating in 1953, established and expanded the West Bench Water System until it dissolved in 2011, passing ownership of the water system to the Regional District of Okanagan-Similkameen.

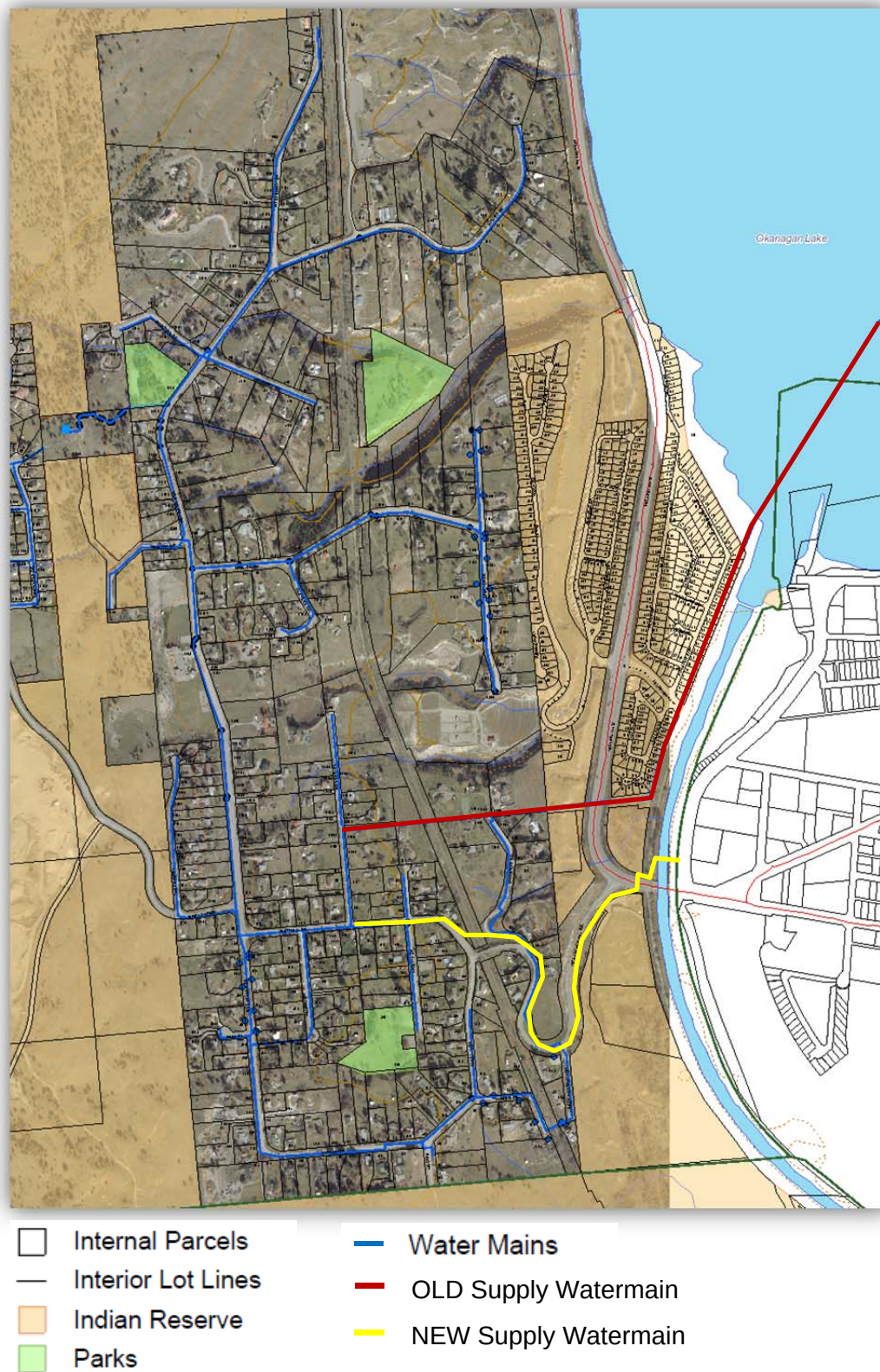
The WBID constructed the original pumphouse for the water system along the Okanagan River Channel and installed an intake extending out into Okanagan Lake. In 2015 the original pumphouse was decommissioned. Figure 2.3 provides an overview of the water system with the original intake location (shown in red). The pumphouse sent water uphill into the distribution system and reservoir requiring an elevation gain of approximately 142m over a horizontal distance of 1.3 km. The pumphouse had been designed to utilize 2x150 HP and 2x75 HP (total 450HP) mono-speed pumps to balance water demand within the water system and reservoir. Chlorination was added in the late 1970's and remained the only form of water treatment.

In 2014, the Regional District completed a comprehensive pipe replacement project in the West Bench distribution system and a new booster station and supply main were constructed. The supply line and booster station connect to approximately 11 kilometers of pipe in the distribution system and a water reservoir with a 1 million liter (270,000 US gal) capacity within one pressure zone. Average system pressures are approximately 85 psi with approximately one third of connections with service pressures exceeding 100 psi.

The previous concerns with water quality are now addressed through the 25 year bulk water purchase agreement with the City of Penticton for filtered treated water. The supply line connects into the City of Penticton's water distribution system at Riverside Drive and travels up West Bench Hill Road to the new booster station located at the midpoint up the hill. Figure 2-3 shows the approximate layout of the new supply system that was completed in April of 2014.

The capacity of the water supply for the West Bench water system has been defined in the Bulk Water Purchase Agreement with the City of Penticton. The maximum annual supply will be 510,000 m³ with a peak hour of 378 m³/hr and a maximum daily supply of 6,048 m³/d.

Figure 2-3 - West Bench Water System – Supply Watermain (OLD and NEW)



2.6 SOURCE RESILIENCY

The water supply for the system originated solely from Okanagan Lake prior to the recent upgrades. The water supplied to the West Bench Water System now comes from the City of Penticton through a bulk water purchase arrangement.

The City of Penticton has a Class IV Water Treatment Plant that obtains water from Penticton Creek and/or Okanagan Lake. The two sources allows the City to have flexibility in choosing which source is the best according to quality, supply capacity, pumping costs, and energy savings. The treatment facility is a multi-barrier system that consists of intake structure, flash/rapid mix, coagulation, flocculation, sedimentation, filtration, and disinfection that meets or exceeds Canadian Drinking Water Standards.²

Concerns surrounding the water quality and quantity in the Okanagan Basin have been a concern for many years and attempts to address them can be traced back 50 years to the origins of the Okanagan Basin Water Board. In 1965, an Okanagan Watershed Pollution Council was established by local government to address concerns about pollution in the Okanagan Watershed. In 1969, this Council was abandoned in favour of the Okanagan Basin Water Board (OBWB).

As a member of the Okanagan Basin Water Board (OBWB), the Regional District is one of three Okanagan Regional Districts that collaborate to provide leadership on water issues spanning the valley. Advised by an innovative cross-disciplinary Council, the Board delivers programs and activities to promote coordinated water management throughout the basin and now includes the Okanagan Nation Alliance and the Water Supply Association of BC.³

2.7 MAJOR WATER USERS

Water demand for the West Bench Water System is estimated at 62% residential and 38% agricultural. Despite this distribution of land use, the residential lots are larger and thus there is a larger percentage of irrigation demand than a typical municipal system. During the peak irrigation month of July 2013, total monthly demand increased approximately 15 times over average winter monthly demand.

Prior to water conservation awareness, the traditional concept of rural residential lots has been one of extensive lawns that require significant irrigation which impacts water use. This is a major factor in this water conservation strategy.

2.8 EXISTING CONSERVATION APPROACH

2.8.1 CURRENT INITIATIVES AND POLICIES

BC Living Water Smart provides the government's vision for sustainable water stewardship, including water source protection, protecting and rehabilitating habitat, modernizing B.C.'s Water Laws, setting strong water efficiency targets, facilitating reduced water consumption and climate change adaptation. The West Bench Water System Upgrade and Water Conservation Strategy address numerous aspects of this overarching initiative.

² <http://www.penticton.ca/EN/main/departments/water.html>

³ <http://www.obwb.ca/>

Okanagan Basin Water Board:

The objectives of the OBWB are to define water resource problems in the valley and to determine priorities and opportunities for solving them. The Board also receives funds and directs them out for water management projects and improving communication and collaboration among levels of government and government agencies.

Immediately after its inception, the OBWB carried out a 5 year comprehensive Okanagan Basin Study, completed in 1974. It took a 50 year perspective in creating recommendations on water quality, supply management and land use. Wastewater treatment has been one of the noteworthy successes in the valley that was identified in the recommendations. Stemming from the 2003 drought, public concerns about the long term sustainability of water played a key role in refreshing the OBWB's mandate of looking at basin-wide concerns with the goal of finding collaborative solutions, and the board is once again taking a more active leadership role for water management in the valley.

In 2006, the OBWB instituted an Okanagan Water Stewardship Council to provide high level technical advice and policy recommendations to the Board. The OBWB has also added members from the Okanagan Nation Alliance and the Water Supply Association of BC. The OBWB is a major partner in the Water Supply and Demand Assessment of the Okanagan Watershed, an update of the original 1974 study, which is assessing patterns of water use, and potential impacts of population growth, climate change, land use and the environment. This innovative, state of the art, water demand model requires informed input from multiple decision-makers and stakeholders and is informing decision making for local governments in the Okanagan Valley on such initiatives as Regional Growth Strategies and land use planning.

In its simplest form, the studies have demonstrated the following. All water that enters the Okanagan Basin comes from precipitation in the form of snow or rain. However, the Okanagan is in the rain shadow of the Coast Mountains, so although the West Bench and the Okanagan Basin are in close proximity to the Pacific Ocean and naturally wet cities like Vancouver and Victoria, the Okanagan Valley gets very little precipitation. Most of the moisture from the Pacific Ocean leaves the air as precipitation before it can reach the Okanagan. As a result the Okanagan has the lowest amount of available fresh water per person than most of Canada, even though the Okanagan has the appearance of a water rich area due to the large lakes. When water is used more than is naturally replenished by rain and snow, a water deficit will result.

Water conservation is of paramount importance in the Okanagan, and systems within the Okanagan Basin Water Board should be managed to achieve four central goals:

1. To bring residents of the Okanagan valley together with the understanding that the water source is connected and that it is a shared resource throughout the valley;
2. To increase awareness among residents about water issues;
3. To support residents in making positive changes in their own water habits that will protect the quality and quantity of the valley's water sources; and
4. To preserve the unique character of the region including fisheries habitat protection.

The West Bench Water Conservation Strategy is created in the context of the Okanagan Basin Water Board's goals.

Biodiversity Strategy “Keeping Nature in Our Future” presents a biodiversity strategy for the region to help protect the Okanagan-Similkameen’s natural assets into the future. As the region’s population continues to grow, this strategy can provide information to factor in environmental considerations in decision making for urban, resource, recreational, and rural development and has been endorsed by the Regional District.

2012-2015 Strategic Plan: Regional District of Okanagan-Similkameen. The upgraded West Bench Water System and its Water Conservation Strategy meet several key goals in the Strategic Plan, including the following: Recognizing the need to meet public need through the development and implementation of key services; to build an economically and environmentally sustainable community and to encourage sustainability through education.

Climate Action Plan. The Regional District’s Climate Action Plan addresses water conservation through energy savings in both the Corporate and Community components, assisting the province in meeting its Climate Action Plan and Green House Gas Reduction targets.

Three quarters of the Regional District’s carbon emissions are estimated to originate from buildings and infrastructure. The water system upgrade and new booster station is anticipated to be more efficient with the power use, thereby reducing carbon emissions and contributing to an overall reduction in the Regional District’s carbon emissions.

The Regional District’s Community portion of its Climate Action Plan also aspires to reduce energy use through education/ outreach programs, policy setting and incentive programs in the community. The reduction in water use through the universal metering, the Water Conservation Programs, and various policies (i.e. water use and distribution bylaw) for reducing water use will contribute to reducing energy use in the community.

South Okanagan Regional Growth Strategy (RGS) includes a goal to coordinate efforts to maximize efficient and effective delivery of infrastructure, reduce environmental impact, and coordinate and collaborate on infrastructure. The RGS also includes goals to reduce Greenhouse Gas Emissions through Climate Action Planning as stated in the provincial mandate. The West Bench Water System upgrade meets both these goals.

Official Community Plan (Area ‘F’ Okanagan Lake West Bench, Bylaw 2460, 2008) includes broad objectives for protecting and enhancing aquatic areas, for maintaining natural ecosystems and environmental quality. Objectives also include planning for adequate delivery of domestic and agricultural irrigation needs. The West Bench Water System upgrade and Water Conservation Strategy assist in meeting these goals.

City of Penticton and the Regional District Agreement for the Purchase of Bulk Water requires a water conservation bylaw, water meters on each connection, a robust water conservation outreach program, and a cross connection control program. The City of Penticton and the Regional District, worked together to increase efficiencies and economies of scale by having the West Bench water supplied from the City of Penticton.

Regional District of Okanagan-Similkameen Bylaw No. 2634, 2013 currently regulates the distribution and use of water and prescribes penalties for non-compliance with the regulations for the community of West Bench. Even / odd day watering and avoidance of daytime watering are key components to water conservation. Odd, even and timed restrictions limit demands on the water system components (i.e. pump run time). Daytime restrictions limit the wasting of water due to evapotranspiration.

The Regional District's future Regional Water Use and Conservation Bylaw, currently being created, will continue to build on the past practices, and address additional water conservation and water quality concerns.

2.8.2 CURRENT AND PAST WATER REDUCTION ACTIVITIES

In order to demonstrate its commitment to water conservation, the Regional District has included a Universal Metering Program on all West Bench water system connections.

Water Use Regulations are detailed in the West Bench Water Distribution and Use Regulation Bylaw No. 2634, 2013. These include:

- Detailing restriction of irrigation, car washing, pool filling and other identified uses during times of short supply.
- Requirement for all new connections to be fitted with a water meter.
- Requirement of flow control valves for irrigation purposes
- Outdoor water use restriction stages are summarized with some details below:

During Stage 1

- Odd numbered street addresses can irrigate on the odd numbered days of the month only and even numbered addresses on the even numbered days only.
- Automatic irrigation systems need to run between the hours of 10:00pm to 4:00am and manual irrigation may be completed between 7:00pm to 10:00pm and 6:00am to 8:00am on the designated day.
- Trigger for Stage 1 restrictions: Always in place between May 1 and August 31 unless otherwise imposed by the District.

During Stage 2

- Odd numbered street addresses may irrigate on Saturdays and Tuesday only and even numbered on Sunday and Wednesday only.
- Automatic irrigation systems need to run between the hours of 10:00pm to 4:00am and manual irrigation may be completed between 7:00pm to 10:00pm and 6:00am to 8:00am on the designated day.
- Golf courses must reduce their total irrigation water by 10%
- Triggers for Stage 2: Projected daily demand for all of the City of Penticton water users is expected to reach 90% of treatment capacity or actual daily use is above the 5 year historical average on the same day; reservoir levels at 60-70% capacity without recovery; and projected drought conditions from the Ministry of Environment.

During Stage 3

- Odd numbered street addresses may irrigate on Tuesday only and even numbered on Wednesday only.
- Automatic irrigation systems need to run between the hours of 10:00pm to 2:00am and manual irrigation may be completed between 8:00pm to 11:00pm on the designated day.

- Golf courses must eliminate the use of automatic irrigation systems and are restricted to hand sprinkling on greens and tees as required to maintain plant material but may not irrigate in the rough play areas, practice ranges and non-essential playing areas
- No filling or refilling of swimming pools, hot tubs or garden ponds.
- Triggers for Stage3: Projected daily demand for all of the City of Penticton water users expected to exceed 90% of treatment capacity or actual daily use is 10% above the 5 year historic average on the same day; reservoir levels are at 60% without recovery, and projected prolonged drought conditions.

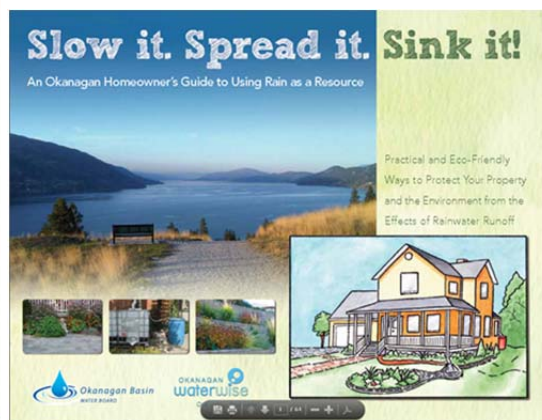
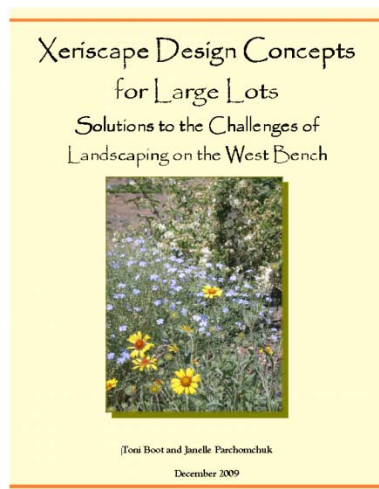
During Stage 4

- No irrigation permitted of residential lawn or gardens
- No irrigation of golf course greens, parks, school yards except where necessary to maintain plant material by the use of a manual shut off hose.
- Golf courses may not irrigate in the rough play areas, practice ranges and non-essential playing areas
- No filling or refilling of swimming pools, hot tubs or garden ponds.
- Triggers for Stage 4: Projected daily demand projected to remain above 95% of treatment capacity; long term failure or malfunction of water system including sustained power outages.

As part of the Okanagan Basin Water Board's educational funding programs, several initiatives have been carried out in the past decade that encouraged water conservation and include the following:

- Limited outreach programs regarding the use of flow control valves and xeriscaping were carried out during the 2003-2006 period.
- A Xeriscape Design Concept manual specifically tailored to the conditions within the West Bench water system area was previously distributed to all residences in 2010 and is available on line at:

http://www.rdosmaps.bc.ca/min_bylaws/ES/public_works/Web_Water/Westbench/XeriscapeManual.pdf



- Water Wise publication coordinated by Interior Health Authority and OBWB, started in 2005, and provided a base publication for water purveyors within the Okanagan Basin to adapt to their specific situations.
- Low flow toilets (6 litre) became a standard requirement under the BC Building Code in 2006. It is anticipated that change-outs due to age during renovations and upgrades to existing residences will result in continued conversion to low flow toilets in the West Bench Water System.
- It is also anticipated that change-outs of other water using appliances, such as washing machines, due to age during renovations and upgrades to existing residences will result in continued conversion to water conscience appliances in the West Bench Water System.
- The Regional District partnered successfully with Fortis BC through its Tap by Tap Low Flow Fixture program (supplied free from Fortis BC) in 2012 and 2013. The low flow fixtures reduce water consumption in each fixture by 50%. The uptake from the program was excellent: West Bench homeowners installed 58 low flow shower heads, 67 bathroom faucet reducers, 76 kitchen faucet aerators, and installed 53 five minute shower timers.
- The RDOS Water Ambassador Program (WA), jointly funded through a grant from the Okanagan Basin Water Board, includes numerous areas of the Regional District within the Okanagan Basin. In 2012, the WA program was extended to include West Bench and adjacent Sage Mesa in Electoral Area F. This included door to door education, information about sprinkling regulations, watering tips, and spot check enforcement of regulations using warning tags and follow up contact. To date approximately 40% of the properties have been visited.
- Rain barrel and hands on water harvesting workshops held in nearby Summerland had West Bench residents make up 20% of attendance at the last three annual events.
http://www.okwaterwise.ca/pdf/HomeDrainageGuide_Okanagan.pdf
- The RDOS" Love My Lawn" project, which gave away compost in the late fall of 2012, had five out of the total 25 recipients from West Bench. The project was to bolster the turf, provide more moisture and substance thereby reducing the need for summer watering. The Love My Lawn pilot project was expanded in 2013 to 50 residences and further expanded in 2014 to 65 residences.

The cumulative success of these programs can be seen in the Table 2-1 and Figure 2-4.

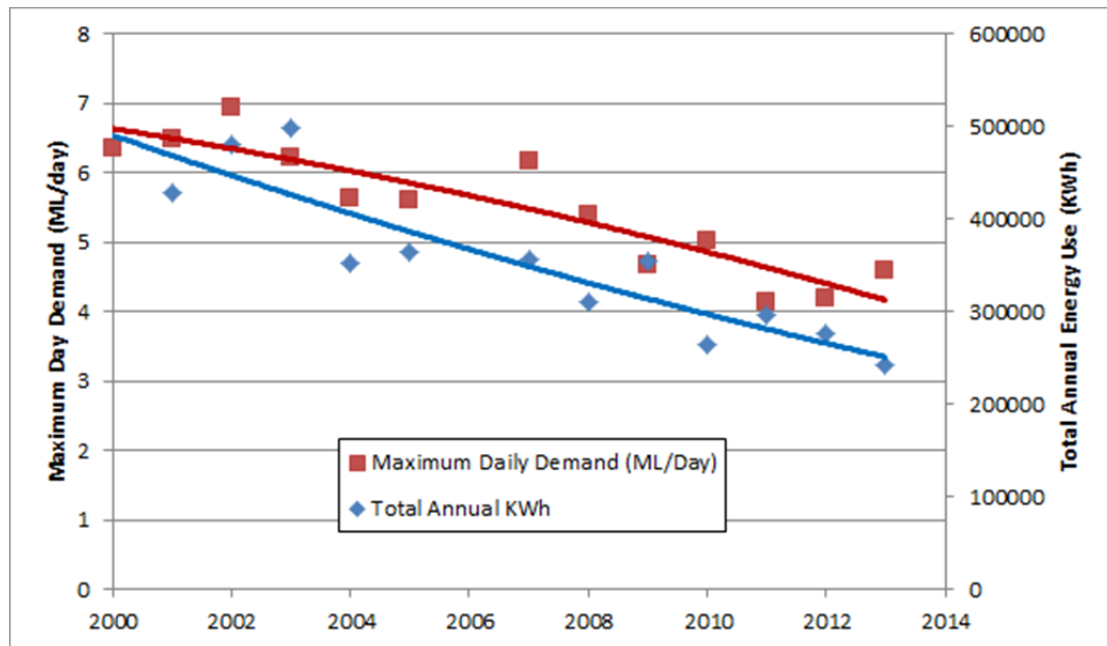
Table 2-1 correlates major water reducing initiatives with annual water consumption, Maximum Daily Demands, and annual energy consumption for the system. The data shows a steady decline in the annual water consumption. Where annual water data is unavailable, the energy use infers water reduction through reduced pumping costs.

Figure 2-4 illustrates this downward trend, illustrating both the maximum daily demand and the total annual energy usage over this time period.

Table 2-1 - Historical Annual Flow, Maximum Daily Demands and Energy Usage

YEAR	ANNUAL FLOW IN M ³	MAXIMUM DAILY DEMANDS IN M ³ /DAY	TOTAL ANNUAL KWH	MAJOR EVENTS THAT COULD HAVE INFLUENCED USAGE
2013	342,797	4600	241,536	Major pipe replacement project (leak reduction)
2012	382,368	4200	276,224	Water Ambassador Program introduced
2011	416,364	4152	296,064	
2010	378,897	5026	264,384	
2009	495,527	4680	354,560	
2008	266,877	5400	309,760	Major pipe replacement project (leak reduction)
2007	478,369	6160	355,840	City of Penticton SCADA data collection initiated
2006	no data	No data	364,800	
2005	no data	5600	364,800	Water restrictions bylaw implemented May 2005
2004	no data	5620	353,280	
2003	no data	6230	497,920	Extreme drought & high prolonged temperatures
2002	no data	6940	481,280	
2001	no data	6500	428,800	
2000	no data	6360	no data	Substantial pipe replacement program w/in dist. system

Figure 2-4 - Maximum Daily Demand and Annual Energy Use for 2000 to 2013



As the data indicates, even without a strategic, coordinated Water Conservation Strategy, a 26% reduction in water use has been achieved since 2003.

Weather patterns will continue to have a dominant effect on summer use. However, staged watering restrictions for drought conditions in the current and future bylaws will cap summer use, and ensure that the West Bench will not experience the high demands seen during past drought events.

3 WATER USE PROFILE

3.1 METERED DATA SUMMARY

The annual, monthly and daily water demands recorded for 2013 for the West Bench water system are provided in the following two tables. The universal metering program had not been fully implement in 2013 and therefore metered data in this plan is limited to total metered supply.

Table 3-1 - Monthly Demand in 2013 for the West Bench Water System

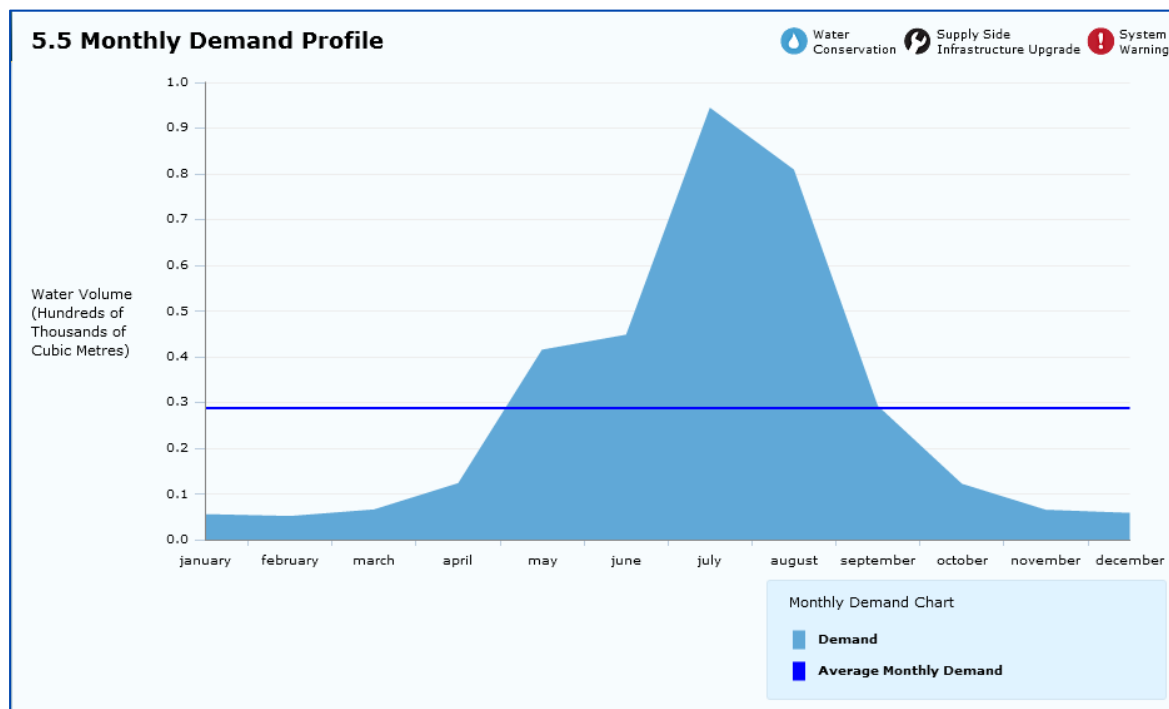
Monthly Demand			OPTIONAL ?		
January	5,631	m ³	May	41,607	m ³
February	5,173	m ³	June	44,835	m ³
March	6,672	m ³	July	94,504	m ³
April	12,426	m ³	August	80,957	m ³
September	29,298	m ³	October	12,271	m ³
November	6,573	m ³	December	5,867	m ³
Total Annual Demand			345,814 m³ ?		
Average Monthly Demand			28,817 m³ ?		

Table 3-2 - Daily Demand in 2013 for the West Bench Water System

Daily Demand		OPTIONAL
Maximum Daily Demand	4,600 m ³	?
Peak Hour Demand	262 m ³	?
Average Daily Demand	947 m³	?
	947,435 L	
Residential Daily Per Capita Consumption	557 L	?
Daily Per Capita Consumption for Entire System	.899 m³	?
Demand as a Percentage of Maximum Daily Supply Capacity		
	<i>Average Daily</i>	<i>Maximum Daily</i>
	15 %	76 %
		?

Graphing monthly demand illustrates that summer use is much higher due to irrigation demands. Outside / irrigation reduction strategies should therefore form the priority for water conservation targets.

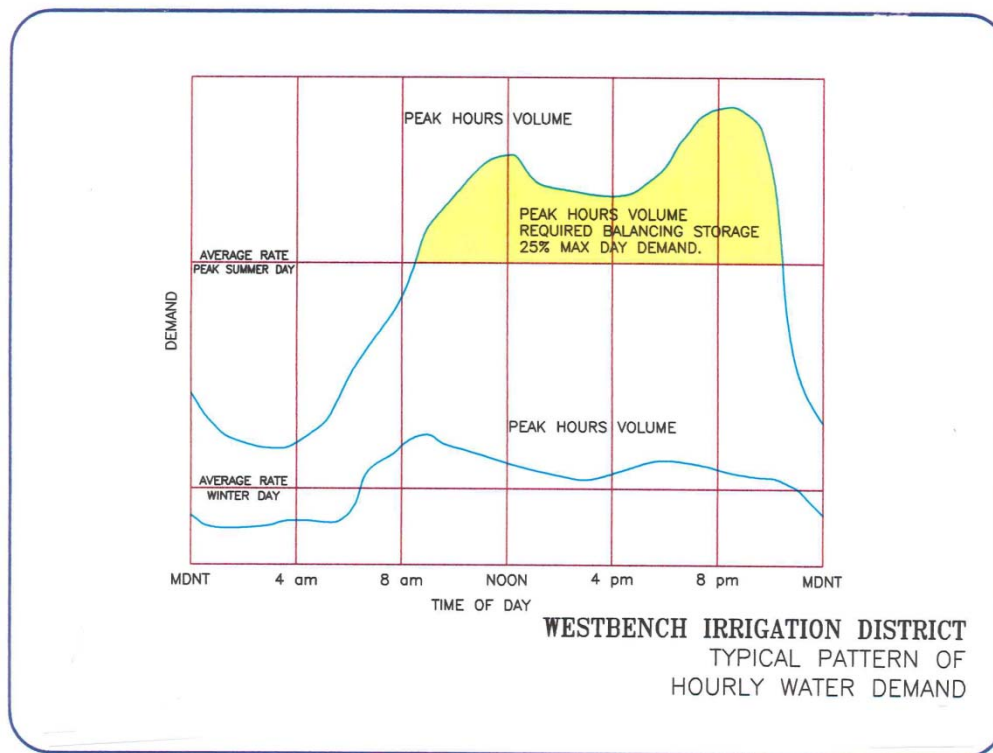
Figure 3-1 - West Bench Water System – Monthly Demand Profile 2013



3.2 PAST WATER CONSUMPTION

Figure 3-2 - West Bench Water System - Hourly Demand from 1990's illustrates the typical summer day demand in the 1990's. In 2005 watering regulations were introduced which prompted the installation of automatic irrigation systems for many homeowners, resulting in programmed night watering. This is preferable in terms of reducing evapotranspiration rates, as temperatures are lower at night. Thus the demand peak has shifted from afternoon / evening as seen in the 1990's to peaks between 4 am to 7 am. Currently the hourly demand is not tracked with the SCADA system but Figure 3-3 shows a representative example of the observed shift in demands throughout the day superimposed on Figure 3-2.

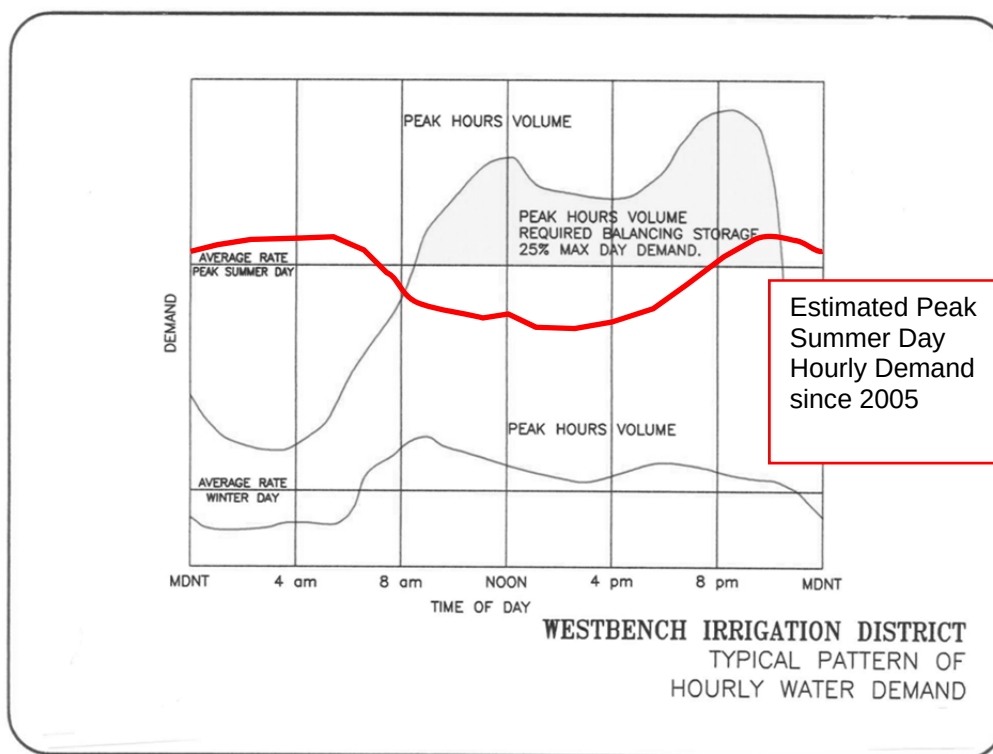
Figure 3-2 - West Bench Water System - Hourly Demand from 1990's



From a system management perspective, consistent water levels with less peaks and valleys are preferable as they reduce wear and tear on water system components, and conserve energy.

Additionally, it provides some separation in tracking domestic demand from irrigation demand which will be helpful in targeting and evaluating irrigation conservation measures.

Figure 3-3 - West Bench Water System – Estimated Hourly Demand since the 2005 introduction of water use regulations, superimposed on graph from 1990's



3.3 WATER USE PROFILE

The Regional District has estimated the balance of single family residential use to agricultural use to be approximately 60% and 38% of total demand respectively. The following water use profile is based on estimates and professional judgment and should only be used for qualitative assessment and they should not be understood as factual. More accurate information will be available with the 2015-2016 universal metering data. Total annual water demand in 2013 was 345.8 ML.

3.3.1 INDOOR RESIDENTIAL

Indoor residential demand was derived from a population of 1050 (20% less from November to March) and an approximated per capita indoor winter demand of 230 liters per person per day (l/p/d). Total indoor residential use is estimated at 81 ML or 23% of total annual water demand. As noted above, this is not based on residential meter data but the estimate provides a starting point for conducting a water balance and developing the water use profile. Seasonal population variations will also affect this estimate. It is noted that the Design Guidelines for Rural Residential Community Water Systems⁴ state that basic domestic indoor use is well established at 230 l/p/d, especially in communities with older homes which may not have been retrofitted with low flow fixtures.

3.3.2 INDUSTRIAL, COMMERCIAL AND INSTITUTIONAL (ICI)

The West Bench Water System has three parks connections, one school and one water utility connection. Professional judgment was used to estimate indoor demand based on connection type and expected seasonal use. Industry-standard water demand rates derived from the reference text Water Supply and Pollution Control (Viessman Jr. and Hammer, 1998, 6th Edition, p. 79. and Mays, Wiley & Sons, 2001, p.346) and the BC MoE Standard Sewerage System Practice Manual, Version 2, were used as a reference for these estimates.

Total indoor ICI use is estimated at 0.95 ML or 0.3 % of total annual demand.

3.3.3 ESTIMATED LEAKAGE

Monitoring flow in the early morning hours between 12 am and 4 am in non-irrigation months, when there is little to no system demand, will provide a baseline flow. If water use is occurring during this time, it can be attributed to system losses through leakage or other non-revenue water. Due to the changeover of the system, it was not possible to download historical night flow records for the West Bench system. Operations staff were able to obtain the minimum night flow in December 2014. Using this data and accounting for a small amount of legitimate night time use (toilets flushing), Current Annual Real Losses were estimated to be approximately 10 m³/day. It is important to note that there are challenges presented by pairing 2014 night flow data with 2013 demand data. If this level of leakage is typical and remained consistent, leakage accounts for 36 ML/year or 11% of total demand.

Due to the existence of joints, fittings, and aging pipes, every water system is subject to unavoidable background leakage. The Unavoidable Real Losses (UARL) calculation takes into account total length of watermain, service connections and average system pressure. The West bench distribution system is comprised of relatively new pipes and leaks tend to surface quickly due to the soil

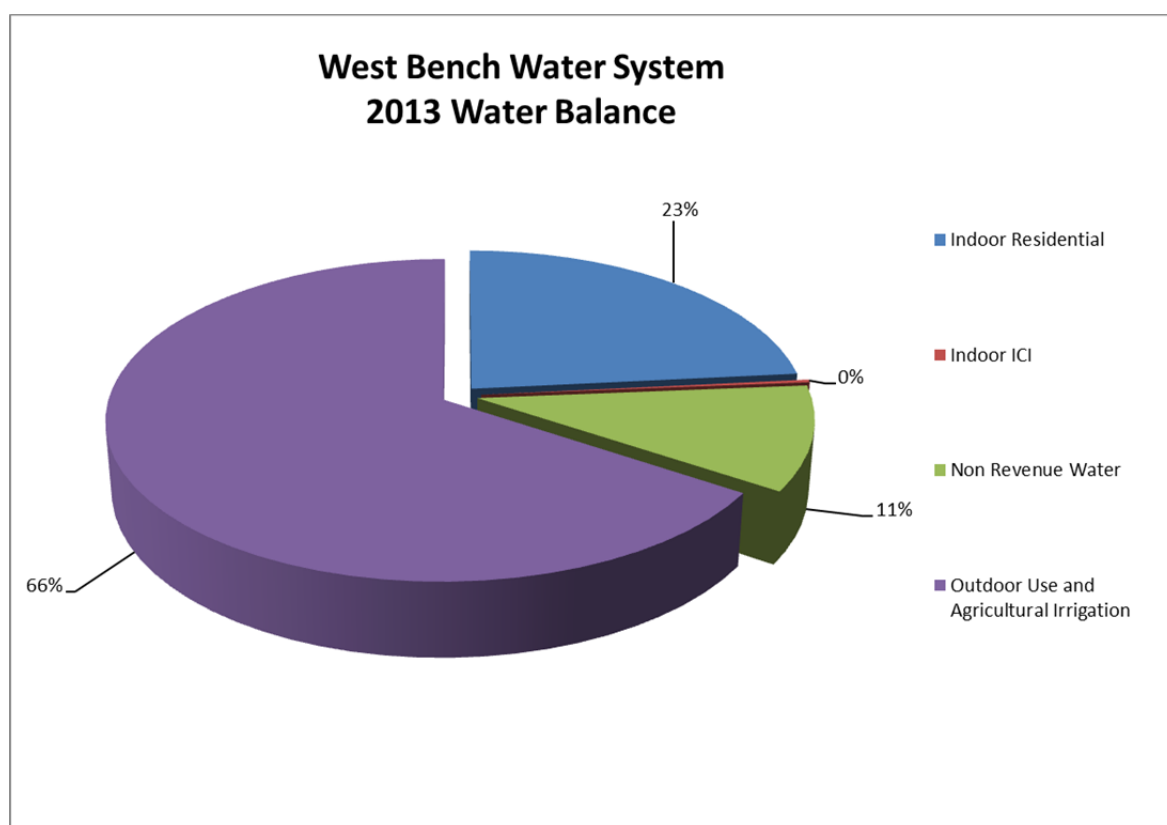
⁴ Design Guidelines for Rural Residential Community Water Systems (Water Stewardship Division of BC MoE, 2007)

composition, however approximately 1/3 of the mains operate at pressures higher than 100 psi. The UARL for the West Bench was calculated to be 12.5 ML/year. An achievable economic goal for leakage in a water distribution system similar to the West Bench system (Infrastructure Leakage Index of ILI = 2 to 3) would typically be in the range of 25 to 38 ML/year.

3.3.4 OUTDOOR DEMAND AND AGRICULTURAL IRRIGATION

Demand spikes significantly from April to October in the West Bench system primarily due to irrigation. Total outdoor use was estimated by subtracting leakage, indoor residential and ICI demand from the total metered supply volume during this period. The remaining water from April to October was assumed to be other agriculture and residential outdoor uses such as lawn watering use (227 ML or 66% of total water produced). Without additional information it is difficult to break this down further.

3.3.5 USER SUMMARY BY SECTOR



4 ENVIRONMENTAL IMPACTS

4.1 CLIMATE CHANGE

The South Okanagan has seen significant growth in the last number of years combined with above average temperatures and below average snow pack and precipitation, which has had the effect of causing Okanagan Lake to drop to historic low levels. Analysis of historic climate and hydrologic data (1976-1996) in the Okanagan Basin indicate significant increase in annual temperature and decreases in precipitation in spring and fall with resultant changes in stream hydrology. As a sub-basin of the Columbia River, the water in the Okanagan Valley is provided mainly by snow melt from adjacent mountains either as runoff or through ground water recharge, with irrigation water being a key component and target for reduction.⁵

Potential responses to global warming are increased temperatures, altered precipitation patterns and changes in the amount of precipitation, all of which will have an impact on the water supply-demand relationship.⁶

Growth is expected to continue and warmer temperatures with less precipitation are predicted to continue. Projected 21st century climate change includes earlier onset of spring peak flows, lower peak flow and increased winter flow for streams with no flow control structures in the Okanagan Basin.⁷

Unfortunately, responses may result in increased demand for water use, in particular irrigation use, extension of the growing season and decreases in water availability. If water requirements for irrigation were to increase unchecked, competition for the resource would have the potential to limit supply.⁸

With water reductions thus far of 26% and the further 15% West Bench Water Conservation Strategy targeted reduction; the West Bench Water System has and will continue to mitigate the effects of climate change in the Okanagan Basin. Lowering the use during peak irrigation season through the Strategy's implementation will contribute to lowering the demand and balancing the demand side of the supply-demand equation.

4.2 CLIMATE ACTION PLANNING

Under its Corporate Climate Action Plan, it is noted that the Regional District's buildings and facilities are estimated to account for 78% of its corporate carbon emissions. The water system upgrade and the Water Conservation Strategy will reduce both energy use and carbon emissions from a Regional District owned and operated facility through significantly more efficiently pumping and reduced pumping requirements.

⁵ Neilsen, D., C.A.S. Smith, G. Frank, W.O. Koch and P. Parchumchuk. 2004. Impact of climate change on crop water demand in the Okanagan Valley, BC, Canada. *Acta-Horticulture* 638: 273-278.

⁶ Ibid.

⁷ Ibid.

⁸ Ibid.

The upgrade of the system and connection to the City of Penticton pressurized water system reduces the amount of pumping required to provide the West Bench with water by replacing the obsolete pump house with a state-of-the-art booster station.

The new booster station, commissioned in April 2014, moves water from the connection with the City of Penticton, through the same distribution system, using 3x60HP high efficiency pumps (total 120HP as a maximum of 2 would be operating with one standby). One of the new pumps is a variable speed pump which further increases efficiency. This replaces the older and inefficient 2x150 and 1x75 HP (total 325 HP) pumps, resulting in a 145 HP reduction to achieve the same pressure and distribution.

In combination with additional water reduction strategies, this contributes to reducing energy use, and is anticipated to provide considerable savings and carbon emissions for the Regional District. Energy costs will accrue to the West Bench residents through operational costs.

The energy consumption for operation of the water system facilities in 2013 was 241,536 kWh/year or 869.5 GJ/year. The volume of water delivered in 2013 was 342,797 m³. Therefore the total energy required to deliver the water in 2013 was 0.7046 kWh/m³.

Estimates are that kWh reduction will be reduced from approximately 276,224 kWh (2012 data) to 104,600 kWh once the full metering program is implemented in conjunction with the new booster station, providing a reduction of 171,624 kWh, or 62% less power. Estimating the cost at \$0.10/kWh, this could result in a cost reduction of approximately \$10,000 per year. The main reason for the reduced energy requirements is the water supply is received pressurized from the City of Penticton's distribution system instead of unpressurized directly from Okanagan Lake. Carbon emissions will be reduced accordingly.

Table 4-1 - Future Energy Consumption Calculations

System Energy Consumption				OPTIONAL
Distribution System	104,600	kWh/year	0	GJ/year ?
Treatment System	0	kWh/year	0	GJ/year ?
Incidental System Use [Electrical] (e.g. heating, lighting, etc.)	0	kWh/year		? ?
Incidental System Use [Natural Gas] (e.g. heating)			0	GJ/year ?
Subtotal Energy Use				
	104,600	kWh/year	0	GJ/year ?
Total Energy Use			376	GJ/year ?

Energy to Deliver Water		
.3024	kWh/m ³	0.0000 GJ/m ³ ?

Comparative values from pre- and post- upgrade and water conservation strategy are calculated as follows:

Table 4-2 - Consumption Comparison in 2012 and after upgrades in 2015

YEAR	ENERGY USED (kWh)	ENERGY COST	ENERGY TO DELIVER WATER (kWh/m ³)
2012	276,224	\$20,792	0.7987
2015 - 2030	104,600	\$10,460	0.3024

Although there are several variables, it is anticipated that the energy use for the new booster station will be less than half of the energy used by the old pumphouse.

4.3 HABITAT CONSERVATION

The Okanagan Basin waterways supply domestic, commercial and irrigation water and have minimum flow requirements to protect fish habitat and recreational values.⁹

As a water system that draws water from Okanagan Lake and Penticton Creek (through the City of Penticton's system), conservation measures implemented through this Strategy will help to preserve fisheries habitat and spawning. Areas where shore spawning takes place could be impacted by low water levels potentially as a result of droughts; reduced demands on water supply will help maintain higher lake levels.

4.4 CROSS CONNECTION CONTROL

Cross connection control is the potential connection between any part of a potable water system and another environment that contains substances that may enter the potable system. The substances can be chemicals, waste products, non-potable water from another source, etc. Backflow preventers would be required on any connection suspected of having the potential for cross connection issues to eliminate the risk of this hazard. The West Bench water system currently has a Cross Connection Control bylaw in place that was developed by the WBID.

Additionally, a Cross Connection Control (CCC) bylaw is currently being drafted. CCC is a requirement of the Purchase of Bulk Water Agreement with the City of Penticton.

⁹ Neilsen, D., C.A.S. Smith, G. Frank, W.O. Koch and P. Parchumchuk. 2004. Impact of climate change on crop water demand in the Okanagan Valley, BC, Canada. *Acta-Horticulturae* 638: 273-278.

5 SUMMARY OF PRIMARY COMMUNITY DRIVERS

As noted, there are a several reasons for reducing water use in the West Bench Water System:

- Reduced operations and maintenance costs;
- Reduced variable costs resulting in cost savings in the overall system operating expenditures;
- Achieving targets for the OBWB vision for maintaining the water basin's integrity; and
- Achieving the RDOS Corporate Climate Action Planning goals.

6 PLANNED WATER REDUCTION STRATEGIES

As the data indicates, even without a strategic, coordinated Water Conservation Strategy, a 26% reduction in water use has been achieved since 2003. Weather patterns will continue to have a dominant effect on summer use. However, staged watering restrictions for drought conditions in the current and future bylaws will cap summer use, and ensure that the West Bench will not experience the high demands seen during past drought events.

To achieve an additional 15% demand reduction by 2020, the water conservation strategy includes the following activities:

- Implementation of universal metering with “user pay” pricing structure;
- Improved Regional Water Use and Conservation Bylaw;
- Continuation of Water Conservation Programs, with potential enforcement, if necessary; and
- Continued implementation of water loss management activities.

6.1 CONSERVATION BASED VOLUMETRIC RATE SETTING

Meters were installed for all 356 parcels connected to the water system with a total of 363 water connections and meters.

After several months of data collection, including irrigation season and winter months, water rates will be developed for the different types of water connections, which include: residential/domestic, combined residential/domestic and agricultural and agriculture use. Implementation of the rate structure based on water use rates is planned to be in effect by 2016.

With the installation of meters PLUS a conservation based volumetric rate, a total reduction in annual demand to be approximately 15% is expected, which would equate to an annual water savings of approximately 49,000 m³/year.

6.2 OUTREACH PROGRAMS

Implementation of metered water rates will be accompanied by continuation of a Water Conservation Program that will target both indoor and outdoor water use. Budget allotted to the program will range between \$5,000 - \$7,500 per year and will vary depending on which activities are priority for the year. It is anticipated that the first three to five years of the Water Conservation Strategy will require the most intensive outreach and education efforts.

6.2.1 OUTDOOR INITIATIVES

Due to the seasonal variation in irrigation water use, a main priority of the West Bench Water Conservation Strategy will be targeted at outdoor watering. This will include behaviour modification, irrigation system efficiencies, and xeriscape concepts on both agricultural and non-agricultural properties.

Additionally, efforts can be directed to include water reduction programs for orchards; provide support and / or education around setting of automatic irrigation systems, and reducing water used for lawns; and continuation of the “Love Your Lawn” program. Reductions in consumption are expected to be quantifiable once the change in rate structure has been implemented.

6.2.2 INDOOR INITIATIVES

Household water reductions will be achieved through behaviour modification and appropriate appliance selection and replacing water fixtures with low flow models.

6.2.3 LEADING BY EXAMPLE

The Regional District also has an initiative to “lead by example”. The new West Bench booster station is visible as it is located immediately adjacent to the main access off the highway into the neighbourhood. The ground disturbance due to 2012-2013 booster station construction was restored with native plantings to serve as an educational model for a xeriscape garden and will also increase habitat value for wildlife.

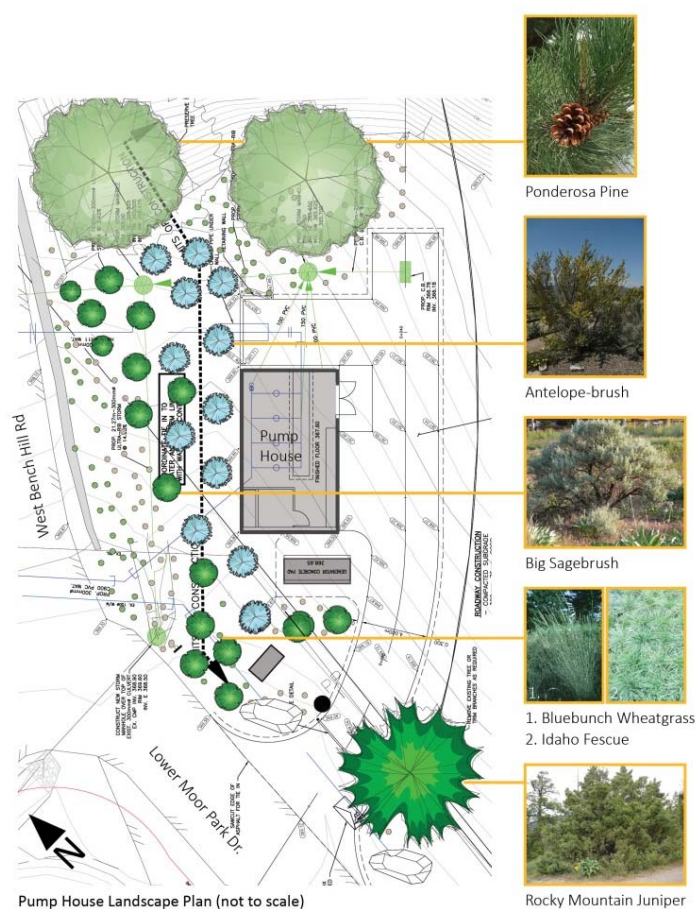


Figure 6-1 Landscaping Plan for the new West Bench Water Booster Station

The Regional District is also initiating water reduction strategies in the West Bench parks owned and managed by the Regional District. These include Selby Park on West Bench Drive and Mariposa Park on Vedette Drive. Irrigation installations have been assessed and updated to more efficient apparatus. Trees have been strategically trimmed or planted for optimum shade and cooling effects. Future Regional District park and pathway plantings will take xeriscape and water conservation principles into consideration.

6.2.4 REGIONAL WATER USE REGULATION AND CONSERVATION BYLAW

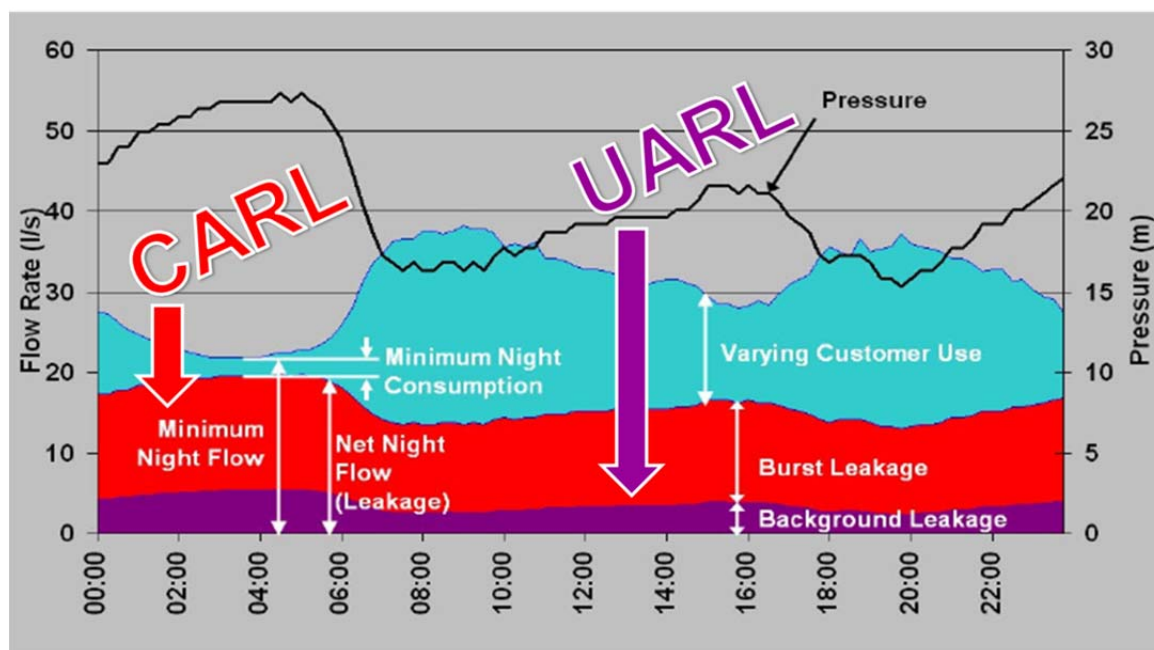
While an existing water use bylaw is in place specifically for the West Bench Water system, a Region-Wide Water Use Regulation and Conservation Bylaw will ultimately replace the existing bylaw for this water system and all Regional District owned and operated water systems. It will unify the water use standards, including consistent messaging for water conservation and water use planning, integration of drought management recommendations, Cross Connection Control (CCC) requirements and consistent interpretation of the regulations. This is a two year project, starting in early 2015 with the first step seeing the completion of the draft Regional Bylaw. Finalization of the Bylaw and implementation is estimated for 2016.

6.2.5 WATER LOSS MANAGEMENT

Water Loss Management was initially addressed by the replacement of pipes under the water system upgrade projects. Starting in 1991, all pipes have been replaced with 25% of the system replaced after 2011. Ongoing leakage monitoring will be enabled through quarterly review of the data from the meters on each service connection and other system meters installed during the system upgrade.

The Regional District will monitor night time flows between 12am and 4am to track baseline flows within the system and calculate Current Annual Real Losses (CARL). The Unavoidable Real Loss (UARL) in the system is a function of pipe length, number of services and operational pressure. With these two values, the Regional District will be able to track the Infrastructure Leakage Index (ILI), a practical performance indicator method used to assess water distribution system efficiency from a bottom up approach.

Figure 6-2 Typical Diurnal Chart for a Municipal Water System



Leakage control is a key component of the West Bench Water System operations due to its location within an area of silt-laden soils, which are subject to erosion and piping from ground water movement. Leakage control to avoid erosion is paramount for public health and safety considerations, and is complementary to water conservation initiatives.

Using 2014 data, the Regional District will be completing the AWWA Water Audit¹⁰ following the practices of the AWWA Standard Practice Manual M36, "Water Audits and Loss Control Programs".

¹⁰ <http://www.awwa.org/home/awwa-news-details/articleid/2641/awwa-free-water-audit-software-version-5-0-now-available.aspx>

This top down assessment of water use allows the utility to identify areas for improved efficiency and cost recovery using the data from the universal metering program.

7 IMPLEMENTATION STRATEGY

Implementation of the Water Conservation Strategy will be carried out in the community over the next several years. Various water conserving initiatives already underway will continue and a water rate structure based on water usage will be developed. The strategy will be made available on the RDOS website.

7.1 SCHEDULE

It is anticipated that the various water reduction initiatives will continue into the future. The biggest program will be the metering program that will include collecting data from the meters to determine usage for the residential and agricultural uses. Rates will be proposed and taken to the community for feedback before being finalized. Once the rates are in place the property owners will receive bills based on their water used. It is expected that rates will be in place by the end of 2016.

Other items on the schedule for implementation include a Regional Water Use and Conservation Bylaw for all of the Regional District owned and operated water systems, the Water Conservation Program and associated initiatives as well as leading by example with Xeriscaping gardens.

Table 7-1 provides a summary of the different conservation activities planned for 2016 and into the future. The shaded areas indicate when the project will be initiated and/or implemented in the community.

Table 7-1 - Conservation Activity and Proposed Timeline for Implementation

Conservation Activity	Timeline							
	2014	2015	2016	2017	2018	2019	2020	2021-2030
Conversion to new pump house / booster station								
Universal Metering Program								
Data Collection Phase								
Rate Setting								
Usage Statements								
Implementation of "user pay" rates								
Enforcement								
Regional Water Use and Conservation Bylaw								
Bylaw Drafting								
Consultation								
Implementation								
"Water Conservation Program" Outreach & Education								
Outdoor								
Outreach on Water Use Regulations (even / odd, no daytime use)								
Outreach on behaviour modification (water saving tips)-ongoing								
Xeriscaping								
Rain Barrel / Rain Garden								
Love Your Lawn compost program								
Indoor								
Outreach on low flow fixtures/appliances								
Outreach on behaviour modification								
Lead By Example								
Xeriscape Demonstration Garden at Pumphouse								

7.2 WATER SAVINGS

The water reductions implemented since 2003 have resulted in a 26% water reduction, and the Water Conservation Strategy is intended reduce water use approximately another 15% by 2020, for a total water reduction on the West Bench Water System of approximately 40% from 2003.

Estimated savings from each type of activity over a five year period are listed below:

PEAK DEMAND REDUCTION:

- Universal metering **with conservation based volumetric rate:** Approximately 15% savings could be achieved through the combination of metering and a conservation based volumetric rate for residential demand;
- Agricultural volumetric water use rate: The South East Kelowna Irrigation District implemented volumetric based pricing resulting in water reductions of 40% compared to metering and education alone.¹¹;
- Water Conservation Program – active education and outreach program: The USEPA suggests that water use reduction communications programs should yield between 2% and 5% reductions. West Bench may have already achieved this reduction through past years of program implementation, but a sustained outreach program will support other initiatives.

OVERALL DEMAND REDUCTION

- Indoor low flow fixture replacement: Savings are estimated at 5% of total demand over five years;
- Water Conservation Program – active education and outreach program on behaviour modification: (see above)
- Water Loss Management (No savings at this time but essential for system performance tracking)

7.3 BUDGET FOR WATER CONSERVATION PROGRAM

The Regional District has budgeted \$5,000 to \$7,500 per year for the Water Conservation Program.

7.4 COST SAVINGS

As previously noted pumping costs are estimated to reduce costs by approximately \$10,000 / yr, which includes a calculation for reduced water use through metering and outreach programs.

Operating and Maintenance costs are split at approximately 18% fixed costs (employees/ testing) and 82% variable costs (electricity and charges / m³). Water conservation strategies reduce the variable costs, resulting in cost savings in overall system operating expenditures. This provides another motivation for employing water conservation strategies.

¹¹ http://www.obwb.ca/fileadmin/docs/sekid_pricing_impacts.pdf

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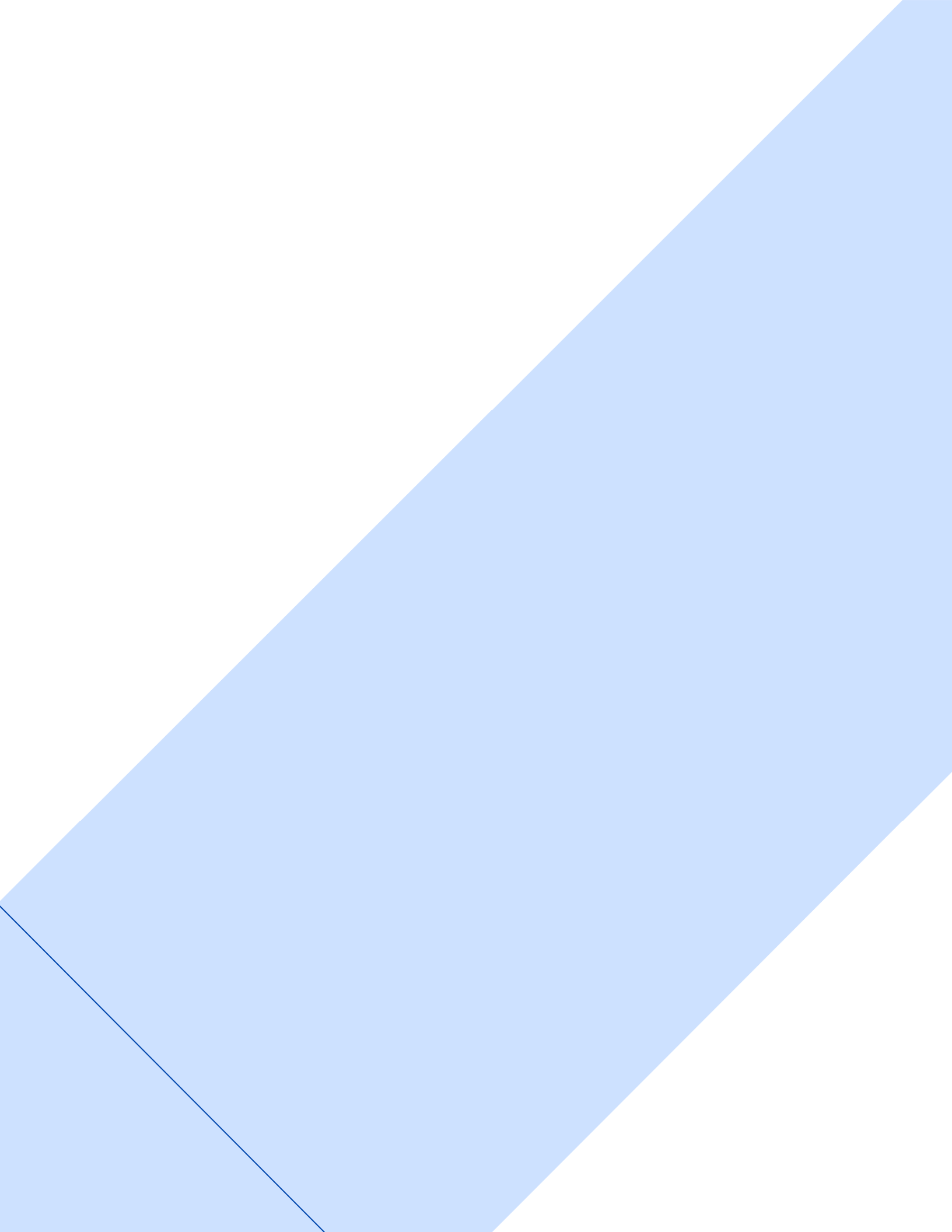
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REGIONAL DISTRICT OF OKANAGAN SIMILKAMEEN SAGE MESA WATER SUPPLY STUDY

January 2015



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FOCUS

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1.0 INTRODUCTION

The Sage Mesa/Hisula Highlands (SM) area is serviced by a water system that draws water from an intake in Okanagan Lake. Water is chlorinated and then pumped to a reservoir in Sage Mesa. Water is then distributed to the residents of Sage Mesa. From the Sage Mesa Reservoir, water is pumped to an upper reservoir in the Hisula Highlands area. This reservoir supplies the residents of Hisula Highlands. **Figure 1** provides a layout of the existing Sage Mesa/Hisula Highlands water supply system.

As noted, the only water treatment that the SM water system receives is disinfection with chlorine. In order to meet Interior Health Authority's Drinking Water Objective, upgrades would be required to the Sage Mesa supply system. In 2012, Focus completed a study for the Regional District of Okanagan Similkameen (RDOS). This study reviewed standalone options for upgrading Sage Mesa's water supply and treatment system to meet the IHA objectives.

Since completion of the study, the community of West Bench, located directly adjacent to Sage Mesa, has been connected to the City of Penticton's water supply system. This upgrade has now provided West Bench with a water supply that meets all of the IHA Drinking Water Objectives. RDOS wishes to review the potential for extending the Penticton supply system through West Bench to Sage Mesa. The following study examines how the West Bench system can be extended to service Sage Mesa.

1.1 Scope of Work

The scope of work for this project was defined in our proposal dated December 15, 2014. The scope includes the following tasks:

Task 1 – Water Demands: We will obtain RDOS records of water demands for West Bench, Sage Mesa, and the golf courses. We understand each golf course may have its own flow meter (Pine Hills supply is pumped separately from the Upper Zone). We will determine Maximum Day Demands (MDD) from the available flow records and our previous work. A discussion of possible demand reductions in West Bench with the implementation of metering will be held with RDOS.

Task 2 – West Bench Connection: The options for connection of the West Bench system are limited. We will review various alternatives that may be available and provide a recommendation for how the West Bench supply can be extended to Sage Mesa and how the system would be controlled.

Task 3 – Golf Course Separation: We will review options for separation of the golf course water supply systems from the domestic system.

Task 4 – Sage Mesa Upgrades: A study we completed in 2012 reviewed the existing Sage Mesa system and identified a number of upgrades that were required to meet current standards. We will review these recommendations, upgrade them as necessary, and provide opinions of probable costs.

Task 5 – Technical Memo and Cost Estimates: We will prepare a technical memo complete with suitable illustrations and an opinion of probable cost for the recommended upgrades. The memo will be forwarded to the District for review. Comments received will be incorporated into a final memo.

2.0 WATER SYSTEM DESIGN CRITERIA

In order to evaluate the water system, design criteria must be established for each system component. These criteria are then used to evaluate the capacity of the water system. In previous studies, the criteria were established based on typical engineering standards for water districts of this size and existing bylaws. The following section outlines the recommended design standards.

2.1 Source

The source of supply is the Penticton water system. The capacity of this system is beyond the scope of this study. The Penticton source is, however, considered to be adequate for supply to Sage Mesa. Further comments on the Penticton supply system are noted in Section 4 of this report.

2.2 Water Demands

Water demands from the RDOS Subdivision Servicing Bylaw are as follows. Sage Mesa does not have any specific bylaws for water demands.

Maximum Daily Domestic Flow (MDD)	8,000 l/single family unit/day
Peak Hour Demand (PHD)	13,600 l/single family unit/day

An analysis of water demands and calculation of Maximum Day Demands are completed in a later section of this report. The demands noted above are reasonable for a water system of this size. They are higher than the City of Penticton bylaw demands which are 1,750 l/c/d for MDD. At 3 persons per unit, the MDD for a single family unit would be 5,250 l/d. West Bench demands were previously estimated to be 10,900 l/single family unit/d. The West Bench demands have, however, seen significant reductions in recent years.

2.3 Water Treatment

The City of Penticton's water system meets all treatment objectives of IHA. Water treatment is, therefore, not party of this study. It is assumed that the City has adequate capacity in their treatment plant to supply Sage Mesa.

2.4 Pumping Systems

Typical standards for surface water sources state supply pumps must be capable of meeting maximum day demands with the largest pump out of service and balancing storage on line. If no balancing storage is available, pumps must meet peak hour demand with the largest pump out of service. Standby power must be available, as well as additional pumps sized to provide fire flows.

2.5 Distribution System and Pressure Zones

The distribution system must be capable of conveying the maximum day demand, plus fire flow or peak hour demand, whichever is greater, and still maintain the system pressures above specified minimums. Velocities of the water in pipelines should be kept to less than 2.0 meters per second except near a fire. Velocities near fires should be less than 4.0 meters per second. Mains should be looped wherever possible.

The service pressures in each zone should normally be maintained between 275 kpa (40 psi) and 690 kpa (100 psi), although they may drop as low as 135 kpa (20 psi) at a fire site during a maximum day. Areas of pressures greater than 100 psi may be acceptable but must be less than 150 psi.

2.6 Reservoir Capacity

There must be sufficient reservoir capacity to store the peak hour demands, plus the total fire flow requirements. A volume of 25 percent of the domestic maximum day demand has been used for peak hour storage. Irrigation flows for golf courses are relatively constant and, therefore, not included in the storage calculation. Fire storage requirements are typically defined by Fire Underwriter Survey Guidelines as noted in the following section. In some municipalities, emergency storage equal to 25% of the sum of the peak hour storage and fire storage is also required. For the purpose of this study, we have not included the 25% emergency storage.

2.7 Fire Flows/Storage

In addition to meeting normal system demands, reservoir storage facilities and distribution mains must be capable of meeting possible fire demands. In the past, there was a wide variation in standards set by various agencies and municipalities for duration and volume of the fire flows. The Fire Underwriters Survey (FUS) prepared by the Insurance Advisory Organization is now used by most municipalities and is noted in the RDOS Subdivision Bylaw. A summary of minimum standards listed in the RDOS Subdivision Bylaw 2000 are provided in Table 2.1.

DEVELOPMENT TYPE	FIRE FLOW (l/s)	DURATION (hrs)
Single Family Residential	60 l/s (min)	1.5
Apartments/Townhouses	150 l/s (min)	2.0
Commercial/Industrial	230 l/s – 260 l/s	3.5
Institutional	85 l/s	1.75

Table 2.1 - Fire Flows from RDOS Bylaw #2000

The fire flows noted are minimum standards. For the purpose of this report, we have used 75 l/s as a fire flow for the residential development in SM. There is no multifamily, apartment, commercial or institutional development in SM.

3.0 POPULATION AND DEMANDS

Population data and water demands are used to evaluate the water supply system capacities and to determine sizing of facilities needed to convey water from West Bench to Sage Mesa. The following sections outline existing populations and an analysis of water demands.

3.1 Populations

There is no specific population data available for Sage Mesa from Census Canada. We completed a count of the legal lots and came up with a total of 257 lots and 2 golf courses. There were 183 in the upper zone (Hisula Highlands) and 74 in the lower zone (Sage Mesa). Previous studies identified a total of 265 lots with 175 in the upper zone and 90 in the lower zone. The upper zone lots are stated to be metered with the lower zone not metered. For the purpose of this study, we will use a total of 260 lots with 185 in the upper and 75 in the lower.

An estimate of population in SM using 3 persons per lot would be approximately 780. There is some growth potential for the area through development of adjacent lands; however, for the purpose of this study, we have evaluated system capacities based on the current population/development.

3.2 Water Demands

The demand for water within a utility varies hourly, daily, weekly, monthly and seasonally. It is dependent upon the type of properties serviced and the water requirements for each type of use. The primary water use within Sage Mesa is for domestic purposes. Domestic use includes water utilized within the home for day-to-day needs, as well as lawn sprinkling. Typically, domestic demand remains relatively constant in non-irrigation seasons, then peaks during summer months as the amount of water use increases dramatically due to watering of lawns and gardens. The other primary users of water within Sage Mesa are the two golf courses. These two customers are significant water users in the community. Irrigation demands for the golf courses are typically relatively constant throughout the irrigation season (May to end of September). The golf courses irrigation system normally come on in late evening and water through the night.

As noted in the previous section, the number of connections is estimated to be a total of 260 with 185 in the upper zone and 75 in the lower. Both golf courses are serviced from the lower zone. Using the number of connections and RDOS subdivision bylaw standards, the Maximum Day Demand (MDD) for the residential use would be $2,080 \text{ m}^3$ ($8,000 \times 260 \div 1,000$). Golf course irrigation would be in addition to this amount. In previous studies, residential MDD was predicted to be $2,250 \text{ m}^3/\text{day}$ (Associated Engineering and True Consulting). Golf course irrigation was estimated to be $550 \text{ m}^3/\text{day}$. The total MDD was estimated to be $2,800 \text{ m}^3/\text{day}$ ($2,250 + 550$). The Associated Engineering report (September 2007) used $2,500 \text{ m}^3/\text{day}$ and $500 \text{ m}^3/\text{day}$ as a design demand for their study.

Our 2012 study reviewed flow records provided by RDOS for 2009 to 2011. These results indicated MDD's in the order of $2,100$ to $2,300 \text{ m}^3/\text{day}$, including the golf courses. More recent flow records provided by RDOS indicated a MDD of $2,276 \text{ m}^3/\text{day}$ (July 26, 2013) and $2,100 \text{ m}^3/\text{day}$ on July 28, 2014.

These records are total flows, including the golf courses (are total flow from the lake pump house). Available flow records from the golf courses for 2008 to 2013 indicated peak monthly total flows in the order of 3,100,000 imperial gallons. Converting this to cubic meters per day, the flows are approximately 450 m³/day. It is anticipated that golf course demands are relatively constant through peak summer months.

Deducting the golf course flow of 450 m³/day from the total measured flows (using the July 2013 flow of 2,276 m³/day, the largest recent MDD), the maximum day domestic demand would be 1,826 m³/day (2,276 – 450). This flow is somewhat less than previously predicted MDD's of 2,080 to 2,250 m³/day. For the purpose of this study, we would recommend using a somewhat conservative estimate of MDD until further flow records are available and the accuracy of the flow meters can be confirmed. We would recommend the following MDD's:

MDD Domestic	2,000 m ³ /day
MDD Golf Courses	<u>450 m³/day</u>
TOTAL MDD	<u>2,450 m³/day</u> (28.3 l/s)

At 2,000 m³/day, the MDD per residential connection is 7,690 l/day. It is expected that universal metering of Sage Mesa and implementation of higher water rates would reduce MDD somewhat.

As the supply system that will provide water to Sage Mesa also supplies West Bench, it will be important to have flow records for West Bench. West Bench has seen a significant reduction in water demands in the last fifteen years. Previously MDD exceeded 6,000 m³/day. In recent years, the demands have been between 4,000 and 5,000 m³/day. MDD over the last 6 years are as follows:

2009	4,680 m ³ /day	2012	4,200 m ³ /day
2010	5,026 m ³ /day	2013	4,570 m ³ /day
2011	4,152 m ³ /day	2014	4,100 m ³ /day

MDD in 2014 is the first year with supply from the City of Penticton. Meters have been installed on all connections in West Bench. Billing according to water use has not yet commenced. It is expected that some further reduction in demands would be realized once the metered use is billed to customers. For the purpose of this study, we will use the average of the last 6 years demands in West Bench for MDD as a conservative estimate. Further reductions should occur when billings are based on metered use. Therefore, the supply system from Penticton would be sized for the following MDD:

West Bench	4,450 m ³ /day
Sage Mesa	2,000 m ³ /day
MDD Golf Courses	<u>450 m³/day</u>
TOTAL MDD	<u>6,900 m³/day</u> (79.9 l/s)

If the golf courses are supplied from a different source (i.e. the existing Sage Mesa system), the West Bench/Sage Mesa MDD would be reduced to 6,450 m³/day (74.7 l/s). If we utilize the 2014 MDD for West Bench of 4,100 m³/day, the combined MDD would be 6,100 m³/day (70.6 l/s).

4.0 WATER SYSTEM ANALYSIS AND UPGRADING REQUIREMENTS

The following section analyzes the capacity of each system component based on the design criteria established in Section 2 and water demands in Section 3. A schematic of the existing water system is provided in **Figure 2**. An overall plan of the District and the water distribution system is provided in **Figure 1**.

4.1 Supply Source

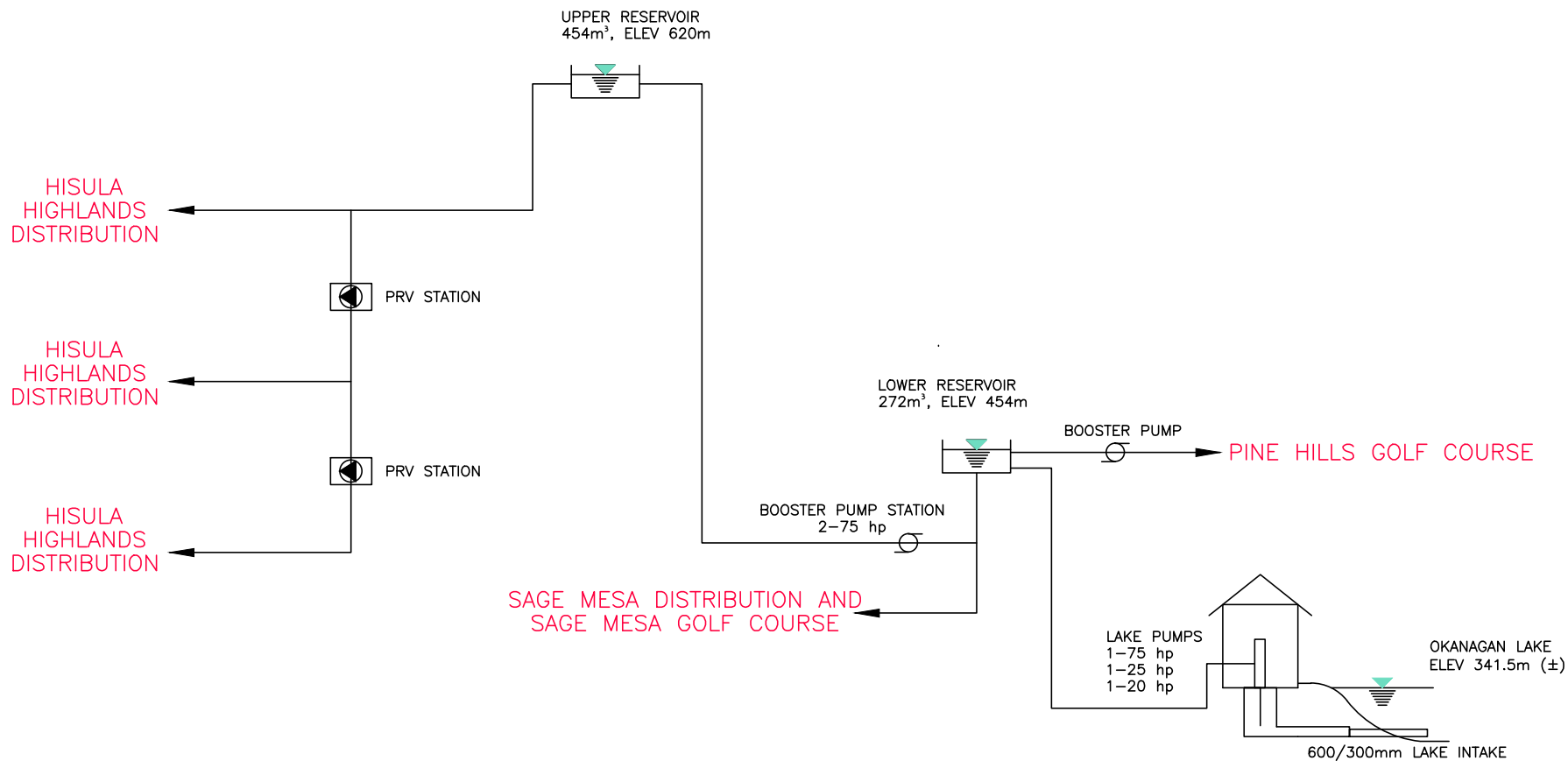
The current supply system pumps water from Okanagan Lake. The new supply system will be from the City of Penticton. For the purpose of this study, we have assumed that the City of Penticton's water supply system is capable of meeting MDD for Sage Mesa (in combination with West Bench). It should be noted that when the West Bench pump station was commissioned, there were higher than expected pressure drops in the City's distribution system when the West Bench pumps were running. The City has been reviewing their water distribution system to determine what pipelines may need to be upgraded to resolve this. Previous water modeling completed on the City's system indicated that pressure losses with a supply of 70 l/s and 100 l/s to West Bench only caused minor deficiencies in Penticton's system, even during MDD and a fire of 150 l/s in the area of the West Bench tie in. There may, therefore, be upgrades required in the City's distribution system to resolve the reduced pressures being experienced. Determining what upgrades may be required are beyond the scope of this study. It is, however, important to note this issue, as the City may be looking to recover costs for upgrading their distribution system to supply communities outside their boundaries.

The other cost issue that is not included as part of this study is the cost for water treatment. The City of Penticton recently upgraded their water treatment plant. Supplying Sage Mesa will utilize a percentage of the City's spare capacity at the plant. The City will be looking at a cost recovery for the treatment plant for the capacity that will be assigned to Sage Mesa. These costs, or the costs for any distribution upgrading, are not included in this study.

4.2 West Bench Pump Station

West Bench and Sage Mesa will be supplied by the new booster station constructed on Moor Park Drive. The new station is equipped with 3 – 60 hp vertical inline pumps. Each pump has a capacity of approximately 46 l/s depending upon suction pressure variation in the Penticton supply system. With two pumps running, the station capacity is approximately 70 l/s, also depending upon suction pressures from the City's distribution system. Therefore, the supply capacity of the existing system is:

Single Pump Running	3,974 m ³ /day (46 l/s)
Two Pumps Running	6,048 m ³ /day (70 l/s)



The third pump acts as a standby. Based on current demands in West Bench (maximum in 2014 was 4,100 m³/day), a single pump can almost meet MDD. Based on flow records provided by RDOS, there were only two days in 2014 when two pumps operated. The following Table 4.1 provides a list of demands and pump capacity.

West Bench Demand (m ³ /day)	Sage Mesa Demand (m ³ /day)	Golf Course Demand (m ³ /day)	Total Demand (m ³ /day)	West Bench Capacity 1 Pump (m ³ /day)	West Bench Capacity 2 Pumps (m ³ /day)	West Bench Capacity 3 Pumps* (m ³ /day)
4,100	2,000	0	6,100 (70 l/s)	3,970	6,050	7,700
4,450	2,000	0	6,450 (75 l/s)	3,970	6,050	7,700
4,100	2,000	450	6,550 (76 l/s)	3,970	6,050	7,700
4,450	2,000	450	6,900 (80 l/s)	3,970	6,050	7,700

Table 4.1 – Pump Capacity vs Demands

* Estimated capacity – subject to Pentiction supply

Based on the above table, in order to meet projected demands, a fourth pump will need to be added to the West Bench booster station (3 operating, one standby). There is, however, the potential that the three existing pumps (2 operating, one standby) can meet maximum day demands if the golf courses are separated from the domestic system and supplied by the existing Sage Mesa water system, and demands are reduced in West Bench and Sage Mesa.

The 2014 MDD in West Bench was 4,100 m³/day. This is less than the previous years averages of 4,450 m³/day. With the implementation of billing based on metered use, we would expect some further reducing in MDD. The Sage Mesa prediction of 2,000 m³/day may also be somewhat conservative as flow records indicate it may be closer to 1,850 m³/day. Implementation of universal metering in Sage Mesa may also reduce demands. As such, if combined MDD's can be reduced to less than 6,000 m³/day, the existing supply pumps may be adequate. Any improvements to the Pentiction distribution system that reduce the pressure drop at the tie in point will help to increase the supply pump capacity.

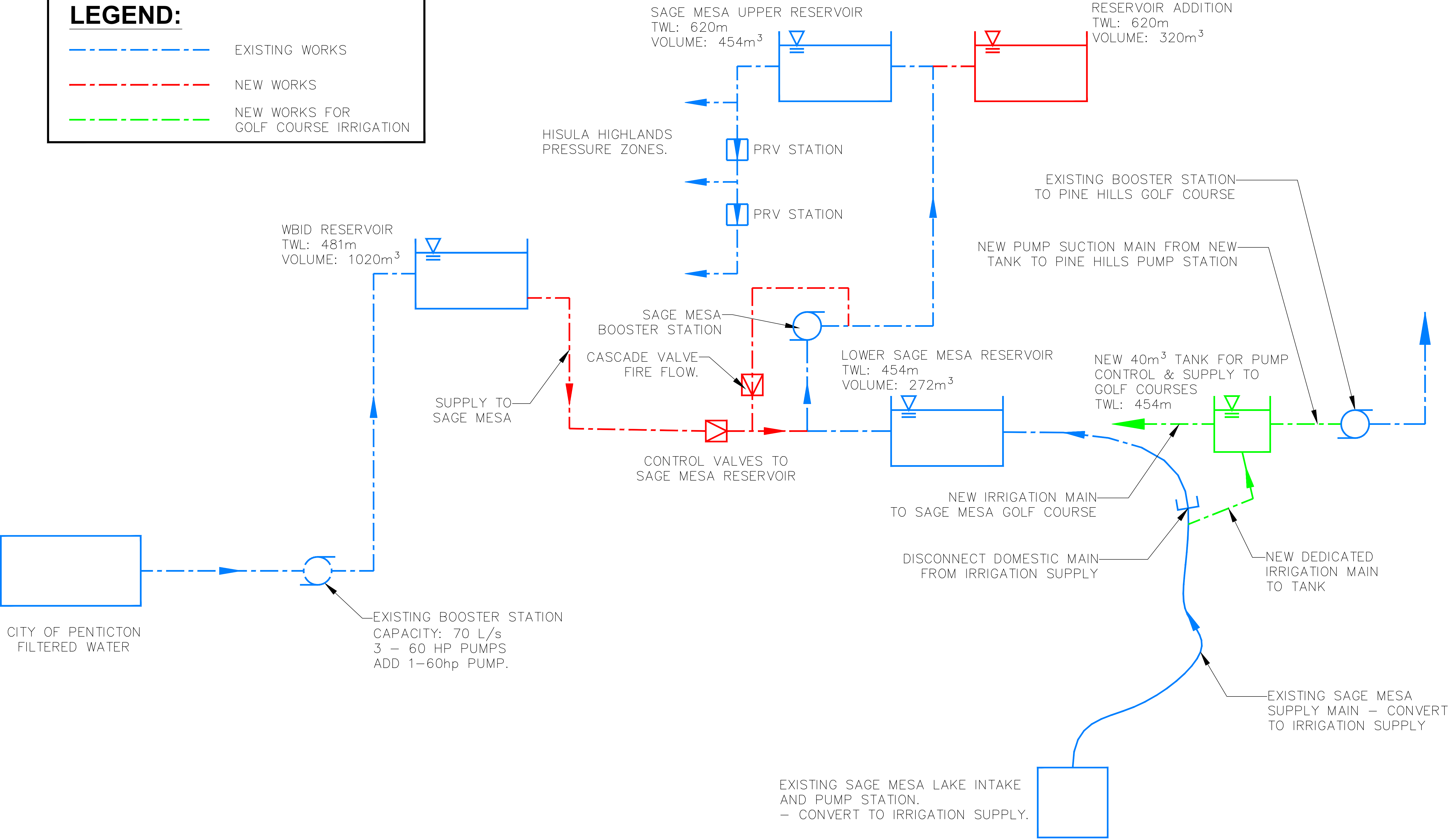
Cost estimates provided in a later section of this report includes the cost of adding a fourth pump to the station. The impact on Pentiction's distribution system of running 3 pumps would need to be investigated further.

4.3 Sage Mesa Supply

In order to convey water from the West Bench distribution system to Sage Mesa, an extension of a supply main is required. A 200 mm main would be extended along Pine Hills Drive from Hyslop Drive to the existing Sage Mesa lower reservoir/booster pump station (see **Figures 3 and 4**). A tie in/looping would be installed to the main on MacIntosh (West Bench) Drive.

LEGEND:

- EXISTING WORKS
- NEW WORKS
- NEW WORKS FOR GOLF COURSE IRRIGATION



J:\Engineering\Projects\061500256 - Sage Mesa water study\03 Drawing\061500005 Base.dwg Plotted: 31 December 2014

DATE	REV	DESCRIPTION	BY	APPR.	DATE	REV	DESCRIPTION	BY	APPR.
					07-JUL-11	1	REPORT ISSUE	SM	CH
					5-JAN-2015	2	STUDY UPDATE	SCD	CWH

SCALES
DATE
APPROVED
DESIGN BY
DRAWN BY
CHECKED BY

NTS
JAN 2015
CH
SM

SEAL

**WSP**
REGIONAL DISTRICT OKANAGAN SIMILKAMEEN
WATER SUPPLY TO SAGE MESA
UPGRADED WATER SYSTEM SCHEMATIC

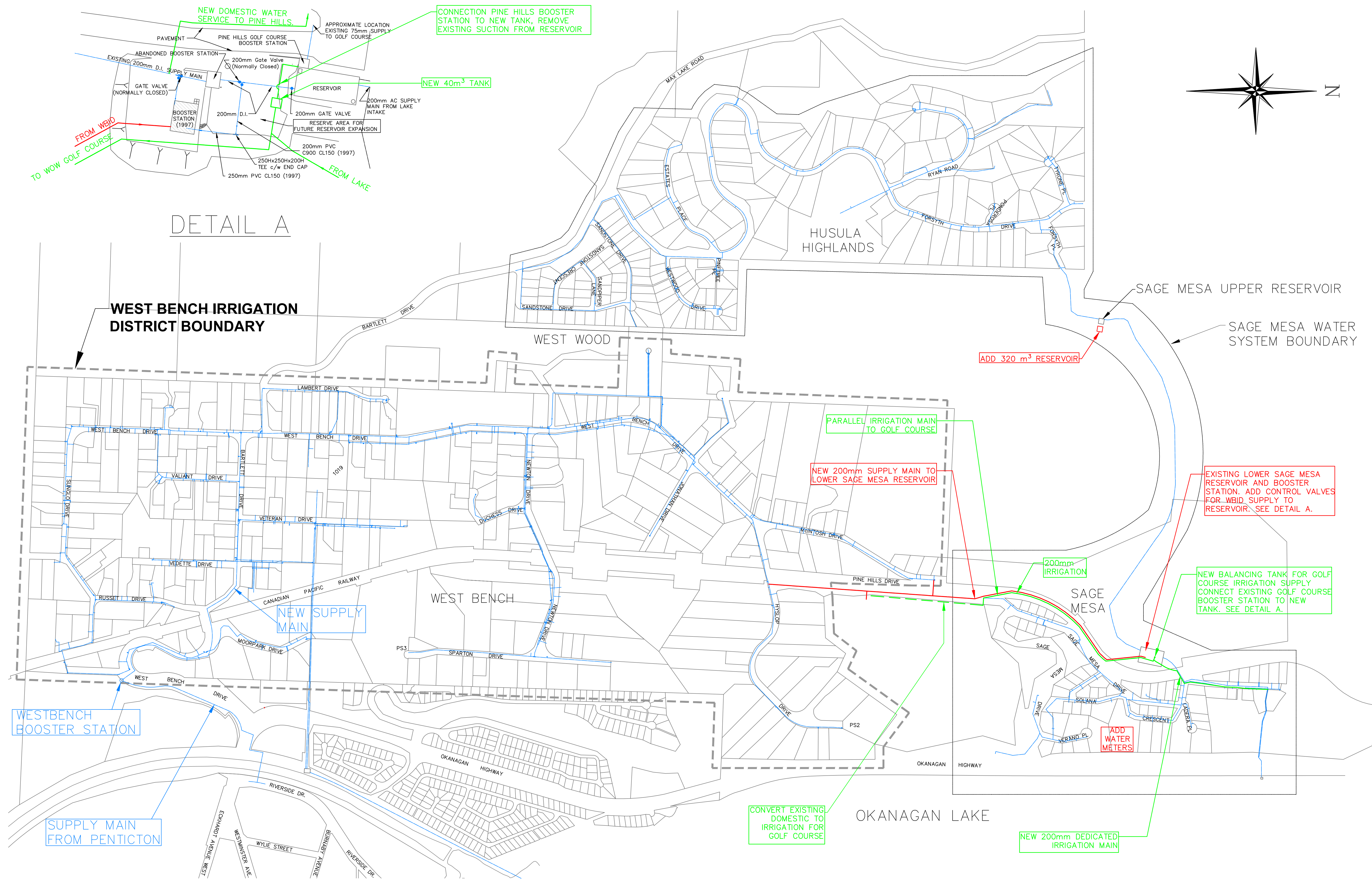
ENGINEERING • GEOMATICS • PLANNING
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KELOWNA, B.C. V1Y 9S4
PHONE (250) 980-5500 FAX (250) 980-5511
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REV. No.
1

OFFICE No.

DRAWING No.
3

J:\Engineering\Projects\061500256 - Sage Mesa water study\03 Drawing\061500005 Bar.dwg Plotted: 30 December 2014



DATE	REV	DESCRIPTION	BY	APPR.	DATE	REV	DESCRIPTION	BY	APPR.
07-JUL-11	1	REPORT ISSUE	SM	CH	07-JUL-11	1	REPORT ISSUE	SM	CH
5-JAN-2015	2	2015 STUDY	SCD	CWH	5-JAN-2015	2	2015 STUDY	SCD	CWH

SCALES NTS
DATE JAN 2015
APPROVED
DESIGN BY CH
DRAWN BY SM
CHECKED BY



REGIONAL DISTRICT OKANAGAN SIMILKAMEEN
WATER SUPPLY TO SAGE MESA
UPGRADED WATER SYSTEM LAYOUT

ENGINEERING • GEOMATICS • PLANNING
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REV. No. 1
OFFICE No.
DRAWING No. 4

This supply main has a hydraulic grade line (HGL) of approximately 480 m which is above the lower Sage Mesa reservoir elevation of 454 m, but below the upper Sage Mesa reservoir elevation of 620 m. As the HGL of the two systems do not match, a control valve will be required to tie the new main to the lower reservoir. The control valve would operate based on water level in the lower Sage Mesa reservoir – as the reservoir level drops, the valve would open to refill the reservoir. The valve would contain a pressure reduction flow control feature to compensate for the pressure differential between the West Bench/Sage Mesa system.

The operation of the Sage Mesa distribution system would remain unchanged. The lower zone would be supplied from the lower reservoir. The upper zone would be supplied from the existing booster station/upper reservoir. As there is approximately 26 m (37 psi) pressure drop from the West Bench to Sage Mesa lower zone, there is the potential to tie the supply main directly to the suction of the Sage Mesa Upper Zone booster pumps (as well as the lower reservoir through the control valve). The direct connection to the booster pumps would increase the suction pressure on the pumps to increase their capacity if the new operating point is suitable for their curves. It appears that the new operating point from the increased suction pressure would be well within the efficient operating range of the existing pump. A more detailed analysis of the energy savings versus the cost of this option would need to be done at the predesign stage to determine if it is cost effective.

4.4 Golf Course Separation

As it is unlikely the City of Penticton will want to supply treated water to the golf courses, and the golf courses may not be able to afford the metered cost of treated water supply, they may wish to maintain their current water supply from Okanagan Lake. This will require the ongoing use of the existing Sage Mesa lake intake and pump house, and separation of the supply to each golf course from the existing domestic system.

The estimated MDD of the two golf courses is 450 m³/day (5.2 l/s). A review of the supply system capacity and how the supply to the golf courses can be separated from the domestic system is noted below. **Figures 3 and 4** provide schematics of the various upgrades required.

a) Lake Intake:

Lake intake consists of 120 m of 300 mm pipe and 32 m of 600 mm CMP. No changes to the lake intake are necessary.

b) Pumping Station:

The pump station at the lake currently consists of three pumps – 75 hp 28 l/s, 25 hp 10.5 l/s and a 20 hp 10.5 l/s. As MDD is expected to be approximately 5.2 l/s, the two 10.5 l/s pumps will be adequate for supply. The 75 hp pump could be removed. There is a chlorine disinfection system at the pump house. This could be maintained if the golf courses want chlorinated water for their irrigation. If not, it could be removed.

c) Supply Main:

The supply main from the pump house to the lower zone reservoir is tied to the domestic distribution system on Sage Mesa Drive north. As such, it will be necessary to disconnect the supply line from the domestic system. A new dedicated supply main would be required from Sage Mesa Drive north to the current reservoir/booster station location.

d) Golf Course Supply

The WOW golf course currently receives water supply from the lower zone reservoir via a gravity connection. The Pine Hills golf course has a separate pump system that draws from the lower reservoir. In order to control the lake pumps and provide a supply source for the Pine Hills booster pump and gravity supply for WOW, a small storage tank/reservoir is recommended. The tank would be approximately 40 cubic meters in size and would be located between the existing reservoir and the upper zone booster pump house. The suction piping for the Pine Hills booster pump would be rerouted to this new tank. A new domestic service would be required for the Pine Hills club house. This would be extended from the upper zone booster station. A new supply main from the tank to the WOW golf course would be required. The supply line would parallel the new domestic supply main from West Bench (in same trench if permitted by IHA) to a point south of the last service on Sage Mesa Drive. It would then tie to the existing water supply to the golf course. A new domestic supply for the golf course club house would be provided from the new domestic supply main.

As presented in the following section, the cost of separating the golf courses from the domestic system is significant. A cost benefit analysis should be completed to confirm that the capital cost of separating the system, together with the ongoing operating cost for the separate system, outweighs the cost of water supply from Penticton (assuming they will permit the use of treated water for the golf course).

It should be noted that a portion of the new water lines identified Sections 4.3 and 4.4 (see **Figure 4**) are to be installed along the Kettle Valley rail right-of-way. The current ownership/status of this right-of-way is not known. In order to install mains in this right-of-way, permission would be required from the Penticton Indian Band, as well as the railway company.

If permission cannot be obtained for use of this land, alternate routes following existing road right-of-ways would be required. This could increase the cost of the installation as additional road rehabilitation would be required and pipe installation costs will increase.

Land tenure at the lower reservoir/booster station site should also be confirmed prior to any construction work being undertaken.

4.5 Pumping Capacities

The capacity of the West Bench booster station is noted in Section 4.2. There are two other pumping stations in Sage Mesa, the Upper Zone booster station and the Pine Hills Golf Course booster pump noted above. The capacity of the Upper Zone booster station is 2 - 75 hp vertical turbines 22 l/s (350 USgpm).

The water use in the upper zone is not metered at the pump station. We understand there are meters on the water connections but do not believe there is any data available on water use. Using the bylaw demand of 8,000 l/lot/day which is very close to the estimated value of 7,690 l/lot/day (2,000 m³/day MDD), the MDD for the upper zone would be 17 l/s ($185 \times 8,000 \div 86,400$). Based on this calculation and the design criteria, the booster pumps have adequate capacity.

The pump that supplies the Pine View Golf Course and club house is a single pump, size and capacity not available. Its capacity must be suitable for current demands; however, there is no standby pumping available. For the purpose of this report, we have assumed this pump is not the responsibility of the District to maintain.

4.6 Reservoir Capacity

There are two reservoirs in Sage Mesa. Their volumes and elevations are as follows:

Sage Mesa (lower) – Elevation 454 m, Volume 272 m³
 Hisula Highlands (upper) – Elevation 620 m, Volume 454 m³

The new West Best supply will feed the Sage Mesa (lower) reservoir, the booster station draws water from the Sage Mesa reservoir and pumps it to the Hisula Highlands (upper) reservoir. There is currently no connection available to allow water from the upper reservoir to cascade to the lower reservoir.

Reservoirs are sized for two criteria – peak hour storage and fire storage. Peak hour storage is based on the demand in each zone and is estimated as follows. Peak hour storage is based on domestic demand only (no storage for golf course demand).

Lower Zone

MDD domestic $75 \times 8,000 \div 86,400 = 6.9$ l/s

Storage is 25% of MDD

Storage equals $0.25 \times 6.9 \times 86,400 \div 1,000 = 149$ m³

Upper Zone

MDD domestic $185 \times 8,000 \div 86,400 = 17.1$ l/s

Storage is 25% of MDD

Storage equals $0.25 \times 17.1 \times 86,400 \div 1,000 = 369$ m³

Fire storage is to be provided in accordance with the FUS. The fire flow we would recommend for this area would be a minimum of 75 l/s (1200 USgpm). Fire storage required for a flow of 75 l/s is:

$$75 \times 3,600 \times 1.5 \div 1,000 = 405 \text{ m}^3$$

As there is no interconnection between reservoirs to allow water to cascade from the upper reservoir to the lower, fire storage is required in each zone. Therefore, the required storage volumes for each zone are:

Lower Zone

Peak Hour Storage	149
Fire Storage	<u>405</u>
TOTAL	<u>554</u> m³

Upper Zone

Peak Hour Storage	369
Fire Storage	<u>405</u>
TOTAL	<u>774</u> m³

Based on the design criteria, there are significant shortfalls in each reservoir; 282 m³ in the lower reservoir, 320 m³ in the upper reservoir. There is the potential to reduce the required storage for Sage Mesa by providing a Cascade Valve to allow water from the upper reservoir to flow to the lower reservoir during a fire. This would remove the requirement for providing fire storage in each reservoir. Required storage volumes for each reservoir would, therefore, be:

Lower Zone

Peak Hour Storage only	149 m ³
------------------------	--------------------

Upper Zone

Peak Hour Storage	369
Fire Storage	<u>405</u>
TOTAL	<u>774</u> m³

Using this calculation, there is only a shortfall of 320 m³ in the upper reservoir. This would, however, require the installation of a control valve to allow water to flow from the upper reservoir to the lower zone in case of an emergency. The piping system is in place in the booster station to install a control valve either in parallel with the existing pressure relief valve or by upgrading the valve by adding a solenoid control. This value will require special design to handle the high pressure drop between the upper and lower zone. Velocities in the piping system would need to be reviewed. Installing the cascade valve and adding to the reservoir storage in the upper zone would be the most cost effective way to upgrade Sage Mesa's reservoir capacity to meet the design criteria.

Another option to consider for reservoir storage is to combine the volumes of West Bench and Sage Mesa reservoirs. Currently, West Bench has a shortfall of reservoir storage according to design criteria. The West Bench storage volumes requirements are as follows:

Peak Hour Storage -	$25\% \times 4,100 = 1,025 \text{ m}^3$
Fire Storage (Institution) -	$85 \times 3,600 \times 1.75 \div 1,000 = 535 \text{ m}^3$
Total -	$1,025 + 535 = 1,560 \text{ m}^3$
Existing Storage -	$1,020 \text{ m}^3$
Shortfall -	558 m^3

If all fire storage is located in the highest reservoir (Sage Mesa Upper), the storage requirements for the three reservoirs are provided in the following Table 4.2:

Reservoir	Balancing	Fire	Total	Existing	Shortfall
Sage Mesa Upper	369	535	904	454	450
West Bench	1,025	-	1,025	1,020	5
Sage Mesa Lower	149	-	149	272	-

Table 4.2: Reservoir Volumes

Therefore, by combining storage volumes between Sage Mesa and West Bench, a reservoir addition of 450 m³ would be required at the Sage Mesa upper reservoir. This would be the most economical method of sharing reservoir storage between the two water systems if there was the ability to cascade water from the highest reservoir to lower reservoirs.

The ability to cascade water from the upper Sage Mesa reservoir to the West Bench and Sage Mesa lower system could come from an extension of the emergency supply line previously installed to connect the West Bench and Sage Mesa. The volume (rate) of flow that can be supplied to the reservoir through the Sage Mesa upper distribution system will need to be analyzed prior to proceeding with the reservoir addition as there are a number of lengths of small diameter main (150 mm) and two PRV's to pass through. When this system was used in the past, there appeared to be limited supplies available. The rate of flow that can be routed to the West Bench reservoir will need to be hydraulically modeled to confirm this is the best option for cascading flows. Other options could be considered but involve high pressure drops across control valves as previously noted and similar small diameter supply mains (Sage Mesa upper reservoir directly to the West Bench zone through the Sage Mesa booster). Fire flows are higher for this option (85 l/s vs 75 l/s).

4.7 Distribution System

A general review of the pipe sizes and looping was completed in previous studies and it appears that the distribution system would be capable of providing peak hour flows with only a few of the homes at the upper elevations possibly seeing pressures close to criteria minimums. Similarly, there may be areas within Sage Mesa that will receive marginal fire flows on peak days. There are some sections of 150 mm pipes that are not looped, some areas with 100 mm pipelines, and Verano Place appears to be serviced with a 50 mm service. Previous studies had recommended a new supply main be installed along Highway 97 from the

pump house to Sage Mesa Drive, and then from Sage Mesa Drive to Solana Crescent and up to the reservoir site. This would, however, no longer be applicable with a supply from West Bench.

Prior to implementing any system improvements for Sage Mesa, we recommend a hydraulic model be prepared for the distribution system. An analysis should be done on the ability of the distribution system to meet peak hour and maximum day plus fire demands. Any upgrading requirements would be identified. The current 50 mm supply main to Verona Place must be upgraded to provide fire flows to this area.

Another project proposed for the piping system was to install an overflow pipeline for the lower reservoir. There have been some problems with reservoir overflowing and causing damage to downstream properties. This project was previously analyzed by McElhaney Engineering. The cost of this project is included in Section 5.

Water meters will need to be installed on all water connections in Sage Mesa. The existing water meters in Hisula Highlands will need to be checked and possibly updated to current standards (a cost is included in Section 5 for updating these meters).

4.8 Summary of Water System Upgrades

A summary of the upgrades required to extend water from the City of Penticton's system to Sage Mesa are outlined in Table 4.3.

COMPONENT	UPGRADE
City of Penticton Distribution System	- Possible upgrade of distribution piping to reduce impacts of West Bench pumps.
West Bench Pump Station	- Install 4 th 60 hp pump in booster station.
Sage Mesa Supply	- Extend 200 mm waterline Hyslop Drive to lower reservoir. Loop main to West Bench Drive. - Install control valves/piping in booster station.
Golf Course Separation	- Remove 75 hp pump from lake pump house. - Extend dedicated supply main from Sage Mesa Drive north to reservoir site. - Construct 40 m ³ storage tank. - Connect Pine Hills booster pump to new tank. - Extend supply main to WOW golf course. - Provide domestic water service to both golf course club houses.
Reservoir Capacity	- Add 320 m ³ reservoir at upper zone site. - Install cascade valve in booster pump house.
Distribution System	- Install water meters in lower zone. Replace water meters in upper zone. - Replace 50 mm supply to Verona Place. - Provide overflow pipeline from lower reservoir.

Table 4.3 – Water System Upgrades

Note: The recommendation for reservoir upgrades is based on a stand-alone option for Sage Mesa. If Sage Mesa/West Bench were combined, we would recommend the 450 m³ upgrade noted in Section 4.6.

5.0 UPGRADING COSTS

The following section outlines our opinion of probable cost for the various improvements identified. Actual cost will only be known once the design is complete and projects tendered. We have provided a capital cost estimate which includes a 35% allowance for contingencies and engineering. We have not included allowances for land costs for right-of-ways required for pipelines or other facilities, financing costs or GST. Costs for upgrading Penticton's distribution system or for water treatment are also not included. A detailed breakdown of the costs is provided in Appendix A. A summary of the costs is provided in Table 5.1.

Item	Cost Estimate
1. Add 4 th pump at West Bench Road station.	\$ 86,400
2. Install water supply main West Bench to Sage Mesa c/w control valve.	633,700
3. Separate golf course water supplies from domestic supply.	564,600
4. Add 320 m3 reservoir at upper reservoir. Install cascade valve.	410,700
5. Install water meters in lower zone, revise meters upper zones as necessary.	341,500
6. Replace 50 mm supply to Verona Place.	123,400
7. Provide overflow pipeline for lower reservoir.	121,500
TOTAL CAPITAL COST (excl. GST)	\$2,281,800

Table 5.1 – Estimated Capital Costs

6.0 RECOMMENDATIONS

Based on the findings of this study, we offer the following comments/recommendations:

- The maximum day demand (MDD) for both the West Bench and Sage Mesa systems should be further studied to determine the impacts of universal metering. It is expected that MDD should be reduced once water billing is based on actual metered use.
- The new West Bench pump station can be upgraded to meet the demands of West Bench, Sage Mesa, and the two golf courses in Sage Mesa.
- There is potential to avoid the upgrading if demands can be reduced and the golf course irrigation separated from the domestic system.
- The capacity of the West Bench pump station is impacted by the HGL in the Penticton distribution system. The City of Penticton may be in the process of upgrading the distribution mains in the area of the West Bench tie in. Further discussions should be held with the City in this regard to determine planned upgrades and any applicable cost sharing.
- Discussions should be held with the City of Penticton to confirm the costs for water treatment that would be applicable to Sage Mesa.
- The capital cost to connect Sage Mesa to West Bench and obtain fully treated City of Penticton water, including water meters, is estimated to be \$1,061,600, plus GST.
- The capital cost to separate the two Sage Mesa golf courses from the domestic water supply is estimated at \$564,600. As this cost is significant and requires the ongoing operation and maintenance of the existing lake intake pump station, a cost benefit analysis should be completed to determine if it is cost effective to separate the water supply. Discussions will need to be held with the City of Penticton to obtain their input on domestic supply to the golf courses.
- There are various system upgrades recommended for the Sage Mesa water system. These include a reservoir expansion, cascade valve, and replacement of some distribution mains. Further study needs to be conducted on the existing distribution system to determine if other upgrades are required. The capital cost for upgrades noted in this report is \$655,500, plus GST.
- Cost estimates in this report do not include any costs associated with obtaining right-of-ways or easements for installation of mains or other facilities on private properties, rail right-of-ways, or other land tenures. Prior to implementing any upgrades, land ownership/tenure must be confirmed and approvals obtained where necessary.

APPENDIX A

Opinion of Probable Costs

APPENDIX A
REGIONAL DISTRICT OF OKANAGAN SIMILKAMEEN
SAGE MESA WATER SUPPLY STUDY
OPINION OF PROBABLE COST

The following estimates outline conceptual level estimates for the projects identified in the report. More detailed engineering would be required to confirm the scope of work for each project and associated costs. A 35% allowance has been added for contingencies and engineering. GST is not included.

Watermain projects have separate sheets for each project. Other project costs are outlined in the following pages. Table 5.1 provides a summary of the costs.

1. West Bench Pump Station – Install 4th 60 hp pump

Pump supply	\$ 15,000	
Valves	8,000	
Piping	6,000	
Installation	10,000	
Electrical	<u>25,000</u>	
Sub-Total	64,000	
35% Contingencies/Engineering	<u>22,400</u>	
TOTAL (excl. GST)	<u>\$ 86,400</u>	\$86,400

- | | |
|--|-----------|
| 2. Water supply main from West Bench to Sage Mesa, including tie-in to booster station and control valve (see attached sheet). Note: This estimate assumes watermain can be installed outside of the roadway structure along Pine Hills Drive and in the rail right-of-way to the booster station site.) | \$633,700 |
| 3. Separate golf course water supply from domestic system (see attached sheet). | \$564,600 |
| 4. Add 320 m3 reservoir at upper reservoir site. Install cascade valve in upper zone booster station (see attached sheet). | \$410,700 |
| 5. Install water meters in lower zone, replace meters in upper zone (see attached Sheet). Note: Contingency and engineering for water meters set at 15%. | \$341,500 |
| 6. Replace 50 mm supply main to Verona Place (see attached sheet). | \$123,400 |
| 7. Provide overflow pipeline for lower reservoir (see attached sheet). | \$121,500 |

SAGE MESA WATER SUPPLY UPGRADE SUPPLY MAIN WEST BENCH TO SAGE MESA December 2014 OPINION OF PROBABLE COST					
	DESCRIPTION	UNIT OF MEAS	QTY	UNIT PRICE	CONTRACT AMOUNT
<u>WATER SUPPLY MAIN FROM WB TO SM -- HYSLOP DRIVE TO BOOSTER STATION</u>					
<u>A. General Conditions</u>					
1	Mobilization and demobilization	LS	1	\$5,000.00	\$5,000.00
2	Bonding and Insurance	LS	1	\$10,000.00	\$10,000.00
3	Surveys and Layout	LS	1	\$4,000.00	\$4,000.00
4	Traffic Management	LS	1	\$5,000.00	\$5,000.00
5	General Requirements	LS	1	\$3,000.00	\$3,000.00
6	Erosion and Sediment Control	LS	1	\$2,000.00	\$2,000.00
7	Clear and Grub	LS	1	\$4,000.00	\$4,000.00
SUBTOTAL GENERAL REQUIREMENTS					\$33,000.00
<u>Section 02224- Roadworks,Excavation,Embankment, Compaction</u>					
02224.1	Gravel shoulder restoration	l.m	700	\$6.00	\$4,200.00
02224.2	Sawcut Asphalt	l.m	100	\$10.00	\$1,000.00
02224.3	Asphalt Removal and disposal	sq.m	200	\$5.00	\$1,000.00
02224.4	Subgrade Preparation	sq.m	200	\$2.00	\$400.00
02224.5	Replace unsuitable subgrade with 150mm minus, compaction in place, disposal- as directed	cu.m	100	\$35.00	\$3,500.00
<u>Section 02233 - Granular Base</u>					
02233.1	Granular base - 25 mm minus crushed gravel - 150 mm thick, removal, disposal of existing	sq.m	200	\$10.00	\$2,000.00
<u>Section 02234 - Granular Sub Base</u>					
02234.1	Granular sub-base,75mm minus pit run gravel (300mm thick),removal, disposal of existing	sq.m	200	\$12.00	\$2,400.00
<u>Section 02235 - Unsuitable Trench Material- only as directed/authorised by Contract Administrator</u>					
02235.1	Removal, disposal, replacement with pitrun gravel (150mm minus)	cu.m	100	\$35.00	\$3,500.00
<u>Section 02512 - Hot Mix Asphalt Paving</u>					
02512.1	Asphalt (Roadway) - 50 mm thick - patching	sq.m	200	\$35.00	\$7,000.00
SUBTOTAL ROADS					\$25,000.00
<u>Section 02666 - Waterworks including tie in to Booster Station</u>					
02666.1	Watermains-All depths , Native backfill				
	200mm CL 150 C900 PVC	lin.m	1150	\$220.00	\$253,000.00
	200mm CI 150 PVC on Hillside	lin.m	100	\$400.00	\$40,000.00
02666.2	200 mm Gate Valves	each	3	\$1,500.00	\$4,500.00
02666.3	Tees c/w TB	each	1	\$1,200.00	\$1,200.00
02666.4	Bends c/w TB	each	10	\$700.00	\$7,000.00
02666.5	Air Release Valves	each	2	\$4,000.00	\$8,000.00
02666.6	Tie to Existing	each	1	\$5,000.00	\$5,000.00
<u>Tie to Booster Station</u>					
02666.7	Building Tie in	LS	1	\$5,000.00	\$8,000.00
02666.9	Control Valve, including electrical	LS	1	\$25,000.00	\$25,000.00
02666.10	Flow meter	each	1	\$5,000.00	\$5,000.00
02666.11	Butterfly Valves	each	5	\$1,200.00	\$6,000.00
02666.12	Piping	lin.m	20	\$1,000.00	\$20,000.00
02666.13	Tie to Existing Pump Header	each	1	\$5,000.00	\$5,000.00
<u>Water main looping to West Bench Drive</u>					
02666.7	150 mm PVC Pipe	lin.m	60	\$150.00	\$9,000.00
02666.8	150 mm Valves	each	3	\$1,000.00	\$3,000.00
02666.9	150 mm fittings	each	4	\$800.00	\$3,200.00
02666.10	Tie to Existing	LS	1	\$3,000.00	\$3,000.00
SUBTOTAL WATER					\$405,900.00
<u>Section 02921, 02934 - topsoil, hydroseeding</u>					
02921.1	Hydroseeding - Highways mix as directed by Engineer	sq.m.	7000	\$0.50	\$3,500.00
02921.2	Sod Replacement of disturbed areas as directed by Engineer	sq.m.	100	\$20.00	\$2,000.00
SUBTOTAL LANDSCAPING					\$5,500.00
SUB TOTAL WATER SUPPLY MAIN TO SAGE MESA					\$469,400.00
35% CONTINGENCIES AND ENGINEERING					\$164,290.00
TOTAL WATER SUPPLY MAIN TO SAGE MESA					\$633,690.00



SAGE MESA WATER SUPPLY UPGRADE SEPARATION OF GOLF COURSE WATER SUPPLY December 2014 OPINION OF PROBABLE COST					
	DESCRIPTION	UNIT OF MEAS	QTY	UNIT PRICE	CONTRACT AMOUNT
UPGRADES REQUIRED TO SUPPLY IRRIGATION WATER TO GOLF COURSES					
<u>A. General Conditions</u>					
1	Mobilization and demobilization	LS	1	\$5,000.00	\$5,000.00
2	Bonding and Insurance	LS	1	\$9,000.00	\$9,000.00
3	Surveys and Layout	LS	1	\$4,000.00	\$4,000.00
4	Traffic Management	LS	1	\$5,000.00	\$5,000.00
5	General Requirements	LS	1	\$4,000.00	\$4,000.00
6	Erosion and Sediment Control	LS	1	\$1,000.00	\$1,000.00
	SUBTOTAL GENERAL REQUIREMENTS				\$28,000.00
<u>Section 02224- Roadworks,Excavation,Embankment, Compaction</u>					
02224.1	Sawcut Asphalt	l.m	250	\$10.00	\$2,500.00
02224.2	Asphalt Removal and disposal	sq.m	800	\$5.00	\$4,000.00
02224.3	Subgrade Preparation	sq.m	800	\$2.00	\$1,600.00
02224.4	Replace unsuitable subgrade with 150mm minus, compaction in place, disposal	cu.m	100	\$35.00	\$3,500.00
<u>Section 02233 - Granular Base</u>					
02233.1	Granular base - 25 mm minus crushed gravel - 150 mm thick, removal, disposal of existing	sq.m	800	\$10.00	\$8,000.00
02233.2	Granular shoulders	lin.m	250	\$6.00	\$1,500.00
<u>Section 02234 - Granular Sub Base</u>					
02234.1	Granular sub-base, 75mm minus pit run gravel (300mm thick), removal, disposal of existing	sq.m	800	\$12.00	\$9,600.00
<u>Section 02235 - Unsuitable Trench Material- only as directed/authorised by Contract Administrator</u>					
02235.1	Removal, disposal, replacement with pitrun gravel (150mm minus)	cu.m	100	\$35.00	\$3,500.00
<u>Section 02512 - Hot Mix Asphalt Paving</u>					
02512.1	Asphalt (Roadway) - 50mm thick	sq.m	800	\$25.00	\$20,000.00
	SUBTOTAL ROADS				\$54,200.00
<u>Section 02666 - Waterworks</u>					
02666.1	Watermains-All depths , Native backfill				
	200mm CL 150 C900 PVC	lin.m	350	\$220.00	\$77,000.00
	200mm CL 150 C900 PVC Common Trench	lin.m	550	\$120.00	\$66,000.00
02666.2	200mm CL 150 C900 PVC Hillside	lin.m	200	\$400.00	\$80,000.00
02666.3	200 mm Gate Valves	each	2	\$1,500.00	\$3,000.00
02666.4	Bends c/w TB	each	10	\$1,000.00	\$10,000.00
02666.5	Air Release Valves	each	1	\$4,000.00	\$4,000.00
02666.6	Tie to existing				
	a) Connect to existing 200mm watermain at Sage Mesa Drive North,	each	1	\$7,000.00	\$7,000.00
	b) Connect to existing 150mm watermain at Sage Mesa Drive South,	each	1	\$4,000.00	\$4,000.00
02666.7	Service Conversion at Tie in, Sage Mesa Drive North	each	4	\$1,000.00	\$4,000.00
02666.8	150 mm Pump Suction Line for Pine Hills Pump Station	LS	1	\$8,000.00	\$8,000.00
02666.9	Domestic Water Service to WOW Golf Course	LS	1	\$6,000.00	\$6,000.00
02666.10	Domestic Water Service to Pine Hills Golf Course	LS	1	\$10,000.00	\$10,000.00
02666.11	Remove 75 HP pump from Lake Pump Station	LS	1	\$2,000.00	\$2,000.00
	SUBTOTAL WATER				\$279,000.00
<u>Section 02921, 02934 - Landscaping</u>					
02921.1	Landscaping Rehab and hydroseeding	LS	1	\$7,000.00	\$7,000.00
	SUBTOTAL LANDSCAPING				\$7,000.00
<u>Section 5000 to 9000 - 40 cm Balancing Tank</u>					
1	Excavation/Backfill	LS	1	\$5,000.00	\$5,000.00
2	Concrete Tank	LS	1	\$20,000.00	\$20,000.00
3	Process Mechanical	LS	1	\$15,000.00	\$15,000.00
4	Level Control	LS	1	\$10,000.00	\$10,000.00
	SUBTOTAL BALANCING TANK				\$50,000.00
	SUB - TOTAL IRRIGATION SEPARATION UPGRADES				\$418,200.00
	35% CONTINGENCIES AND ENGINEERING				\$146,370.00
	TOTAL IRRIGATION SEPARATION UPGRADES				\$564,570.00



SAGE MESA WATER SUPPLY UPGRADE DISTRIBUTION UPGRADES December 2014 OPINION OF PROBABLE COST					
	DESCRIPTION	UNIT OF MEAS	QTY	UNIT PRICE	CONTRACT AMOUNT
<u>NEW WATER MAIN TO SUPPLY VERANO PLACE</u>					
<u>A. General Conditions</u>					
1	Mobilization and demobilization	LS	1	\$2,000.00	\$2,000.00
2	Bonding and Insurance	LS	1	\$6,000.00	\$6,000.00
3	Surveys and Layout	LS	1	\$1,500.00	\$1,500.00
4	Traffic Management	LS	1	\$3,000.00	\$3,000.00
5	General Requirements	LS	1	\$4,000.00	\$4,000.00
6	Erosion and Sediment Control	LS	1	\$500.00	\$500.00
	SUBTOTAL GENERAL REQUIREMENTS				\$17,000.00
<u>Section 02224- Roadworks,Excavation,Embankment, Compaction</u>					
02224.1	Sawcut Asphalt	l.m	30	\$10.00	\$300.00
02224.2	Asphalt Removal and disposal	sq.m	100	\$5.00	\$500.00
02224.3	Subgrade Preparation	sq.m	100	\$3.00	\$300.00
02224.4	Replace unsuitable subgrade with 150mm minus, compaction in place, disposal	cu.m	20	\$35.00	\$700.00
<u>Section 02233 - Granular Base</u>					
02233.1	Granular base - 25 mm minus crushed gravel - 150 mm thick, removal, disposal of existing	sq.m	100	\$10.00	\$1,000.00
02233.2	Granular shoulders	lin.m	20	\$10.00	\$200.00
<u>Section 02234 - Granular Sub Base</u>					
02234.1	Granular sub-base, 75mm minus pit run gravel (300mm thick), removal, disposal of existing	sq.m	100	\$12.00	\$1,200.00
<u>Section 02235 - Unsuitable Trench Material- only as directed/authorised by Contract Administrator</u>					
02235.1	Removal, disposal, replacement with pitrun gravel (150mm minus)	cu.m	20	\$35.00	\$700.00
<u>Section 02512 - Hot Mix Asphalt Paving</u>					
02512.1	Asphalt (Roadway) - 50mm thick	sq.m	100	\$35.00	\$3,500.00
	SUBTOTAL ROADS				\$8,400.00
<u>Section 02666 - Waterworks</u>					
02666.1	Watermains-All depths , Native backfill 200mm CL 150 C900 PVC Hillside	lin.m	100	\$400.00	\$40,000.00
02666.2	200 mm Gate Valves	each	2	\$1,500.00	\$3,000.00
02666.3	Bends c/w TB	each	10	\$800.00	\$8,000.00
02666.4	Air Release Valves	each	1	\$4,000.00	\$4,000.00
02666.5	Tie to existing				
	a) Connect to existing 150mm Solana Cres.,	each	1	\$3,500.00	\$3,500.00
	b) Connect to existing 250mm watermain at Sage Mesa Drive South,	each	1	\$2,500.00	\$2,500.00
	SUBTOTAL WATER				\$61,000.00
<u>Section 02921, 02934 - Landscaping</u>					
02921.1	Landscaping Rehab	LS	1	\$5,000.00	\$5,000.00
	SUBTOTAL WATERMAIN REPLACEMENT TO SOLANA				\$91,400.00
	35% CONTINGENCIES AND ENGINEERING				\$31,990.00
	TOTAL WATERMAIN REPLACEMENT TO SOLANA				\$123,390.00
<u>OVERFLOW PIPING FOR LOWER RESERVOIR</u>					
<u>From McElhanney report</u>					
1	Estimated cost	LS	1	\$90,000.00	\$90,000.00
	SUBTOTAL OVERFLOW PIPE				\$90,000.00
	35% CONTINGENCIES AND ENGINEERING				\$31,500.00
	TOTAL OVERFLOW PIPE				\$121,500.00
<u>WATER METER INSTALLATION</u>					
1	Install water meters on Lower Zone Connections	each	65	\$2,800.00	\$182,000.00
2	Replace existing water meters registers	each	27	\$455.00	\$12,285.00
3	Replace existing water meters	each	163	\$630.00	\$102,690.00
	SUBTOTAL WATER METERS				\$296,975.00
	15% CONTINGENCIES				\$44,546.25
	TOTAL WATER METERS				\$341,521.25

**SAGE MESA WATER SUPPLY
UPPER ZONE RESERVOIR and CASCADE VALVE UPGRADES
December 2014
OPINION OF PROBABLE COST**

	DESCRIPTION	UNIT OF MEAS	QTY	UNIT PRICE	CONTRACT AMOUNT
<u>RESERVOIR UPGRADES 320 cm at UPPER RESERVOIR SITE</u>					
<u>A. General Conditions</u>					
1	Mobilization and demobilization	LS	1	\$3,000.00	\$3,000.00
2	Bonding and Insurance	LS	1	\$8,000.00	\$8,000.00
3	Surveys and Layout	LS	1	\$1,000.00	\$1,000.00
4	Traffic Management	LS	1	\$0.00	\$0.00
5	General Requirements	LS	1	\$8,000.00	\$8,000.00
6	Clear and Grub	LS	1	\$1,000.00	\$1,000.00
	SUBTOTAL GENERAL REQUIREMENTS				\$21,000.00
<u>Section 02224- Roadworks,Excavation,Embankment, Compaction</u>					
02224.1	Subgrade Preparation	sq.m	50	\$2.00	\$100.00
02224.2	Replace unsuitable subgrade with 150mm minus	cu.m		\$30.00	\$0.00
<u>Section 02233 - Granular Base</u>					
02233.1	Granular driveways - 25 mm minus crushed gravel - 100 mm thick, removal , disposal of existing	sq.m	50	\$10.00	\$500.00
<u>Section 02234 - Granular Sub Base</u>					
02234.1	Granular sub-base,150mm minus pit run gravel (300mm thick),removal, disposal of existing	sq.m	50	\$10.00	\$500.00
<u>Section 02235 - Unsuitable Trench Material- only as directed/authorised by Contract Administrator</u>					
02235.1	Removal, disposal, replacement with pitrun gravel (150mm minus)	cu.m	20	\$30.00	\$600.00
	SUBTOTAL ROADS				\$1,700.00
<u>Section 02666 - Buried Waterworks</u>					
02666.1	Watermains-All depths , Native backfill				
	200mm CL 150 C900 PVC	lin.m	20	\$300.00	\$6,000.00
02666.8	Tie to existing				
	a) Connect to existing 200mm watermain.	each	1	\$3,000.00	\$3,000.00
	b) Connect to existing 150mm	each	1	\$3,000.00	\$3,000.00
	SUBTOTAL BURIED WATERWORKS				\$12,000.00
<u>Section 02921, 02934 - topsoil, hydroseeding</u>					
02921.1	Hydroseeding - Highways mix as directed by Engineer	sq.m.	500	\$0.50	\$250.00
	SUBTOTAL LANDSCAPING				\$250.00
<u>Section 0300 to 01100 - Reservoir Construction and Cascade Valve in Booster Station</u>					
1	Excavation / Backfill	LS	1	\$15,000.00	\$15,000.00
2	Concrete Walls	m³	45	\$900.00	\$40,500.00
3	Concrete Floor	m³	35	\$700.00	\$24,500.00
4	Concrete Roof Slab	m³	40	\$1,200.00	\$48,000.00
5	Concrete Valve Chamber	m³	25	\$1,000.00	\$25,000.00
6	Mechanical	LS	1	\$60,000.00	\$60,000.00
7	Electrical / Controls Reservoir	LS	1	\$10,000.00	\$10,000.00
8	Electrical Supply	LS	1	\$2,500.00	\$2,500.00
9	Cascade Control Valves	each	2	\$8,000.00	\$16,000.00
10	Butterfly Valves	each	4	\$1,200.00	\$4,800.00
11	Piping Cascade Valve	lin.m	10	\$1,000.00	\$10,000.00
12	Electrical / Controls Cascade Valve	LS	1	\$5,000.00	\$5,000.00
13	Tie ins - Cascade Valve	each	2	\$4,000.00	\$8,000.00
	SUBTOTAL RESERVOIR CASCADE VALVE CONSTRUCTION				\$269,300.00
	SUB TOTAL RESERVOIR and CASCADE VALVE UPGRADES				\$304,250.00
	35% CONTINGENCIES AND ENGINEERING				\$106,487.50
	TOTAL RESERVOIR CASCADE VALVE UPGRADES				\$410,737.50