Drought Management Plan

Town of Oliver

Oliver
CANADA'S WINE CAPITAL

May 2024

Project No. 306-1701

TRUE CONSULTING

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2089 Falcon Rd | Kamloops BC | V2C 4J2 | www.true.bc.ca | tel 250.828.0881 | fax 250.828.0717

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Revision Log

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Report Submission

Report Prepared By:

<DRAFT>

Sean Curry, P. Eng.
Project Engineer

Report Reviewed By:

<REFER TO ORIGINAL 2017 REPORT>

Steve Underwood, P. Eng.
Senior Engineer

<REFER TO ORIGINAL 2017 REPORT>

Douglas Geller, M.Sc., P.Geo. (Western Water Associates Ltd.)

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List of Acronyms

ADD	Average Day Demand
BGS	Below Ground Surface
GSC	Geological Survey of Canada
MFLNRO	Ministry of Forests, Lands, and Natural Resource Operations
MDD	Maximum Day Demand
MOE	Ministry of Environment
MWLRS	Ministry of Water, Land and Resource Stewardship
OBWB	Okanagan Basin Water Board
OIB	Osoyoos Indian Band
OLRS	Okanagan Lake Regulation System
OW	Observation Well
RDOS	Regional District of Okanagan-Similkameen
RFC	River Forecast Centre
SOLID	South Okanagan Lands and Irrigation District
SOLP	South Okanagan Lands Project
TRUE	TRUE Consulting Ltd.
WSA	Water Sustainability Act

Units of Measure

cfs	cubic feet per second
ft	feet
km	kilometre
L/d	Litres per day
L/s	Litres per second
lpcd	Litres per capita per day

m^3/sec	cubic metres per second
m	metre
m bgs	metres below ground surface (refer to the following Figure 0-1 for illustration)
ML	megalitre
USgpm	US gallons per minute

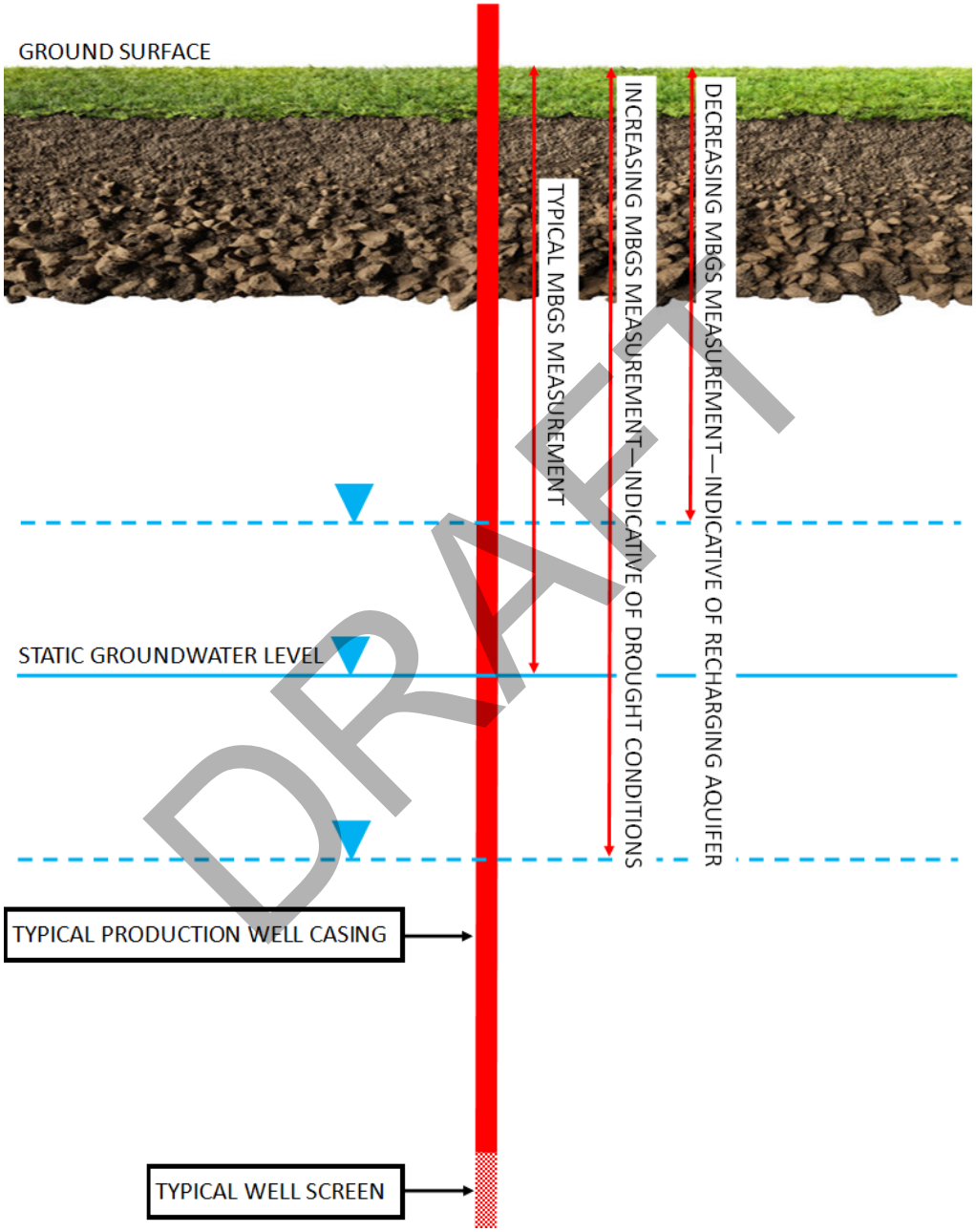

FIGURE 0-1: MBGS ILLUSTRATION

Executive Summary

2024 Update

Since the original Drought Management Plan was initially prepared in early 2017, the Town of Oliver has experienced varying drought conditions on a regular basis. The following provides a summary of drought conditions declared by the Town within the past five years.

2019 (reached Drought Stage 1)

- Stage 1 drought declared: June 26, 2019 (all restrictions lifted in October 2019)

2021 (reached Drought Stage 3)

- Stage 1 drought declared: April 29, 2021
- Stage 2 drought declared: July 14, 2021
- Stage 3 drought declared: July 30, 2021 (all restrictions lifted on October 25, 2021)

2022 (reached Drought Stage 2)

- Stage 2 drought declared: July 25, 2022 (bypassed Stage 1 drought level)
- Stage 1 drought declared: August 22, 2022 (all restrictions lifted on August 26, 2022)

2023 (reached Drought Stage 2)

- Stage 1 drought declared: June 15, 2023
- Stage 2 drought declared: July 12, 2023 (all restrictions lifted on October 4, 2023)

2024 (currently at Drought Stage 1)

- Stage 1 drought declared: April 23, 2024

Drought Management Plans should be updated regularly to reflect lessons learned by Town staff, the effectiveness of drought level triggers, and whether new triggers should be recommended. Recognizing that the Town has been regularly impacted by drought conditions within the past five years and that drought conditions are projected to worsen due to climate change impacts, this 2024 update was deemed necessary by Town staff.

This 2024 Drought Management Plan update has been prepared with the following considerations:

- To provide updated irrigation and domestic water demand projections
- To provide an update for surface water triggers for various drought stages based on latest Okanagan Basin Water Board recommendations.
- To include a discussion of how the Town of Oliver's drought stages relate to Provincial drought levels.

It is important to note that a review of groundwater triggers was not included in the scope of this update. As such, this update does not include a signature from the project hydrogeologist. Please refer to the final 2017 report for further details relating to the hydrogeological drought triggers.

2017 (Original)

With climate change consistently becoming a greater concern in the Southern Okanagan Region, drought forecasting and planning is emerging as a requirement for water purveyors such as the Town of Oliver. In August 2015, the Province of British Columbia declared a Level 4 drought in the Okanagan Basin. A complicating factor relating to this drought declaration was that water purveyors in the South Okanagan manage each licensed system independently and drought management planning is not widely considered. Following the 2015 drought, the Okanagan Basin Water Board recognized that a Valley-wide forecasting and response plan was likely the most effective method of drought mitigation in the future. This document has therefore been prepared at the behest of the Okanagan Basin Water Board as a means to address drought management planning deficiencies relating to water sources utilized by the Town of Oliver.

The Town of Oliver withdraws domestic and irrigation water from groundwater and surface water sources. For perspective, the Town's annual irrigation demand is approximately five to six times greater than its domestic demand. Ensuring long-term sustainability of these water sources is of utmost importance to the Town of Oliver. The following subsections summarize the proposed methods for forecasting and responding to drought conditions.

Drought Forecasting for Surface Water

Drought forecasting for the Town's surface water surfaces has been proposed to be based on Okanagan Lake levels measured at Kelowna. Monitoring data for this station can be found by visiting: http://wateroffice.ec.gc.ca/report/real_time_e.html?stn=08NM083. The following Okanagan Lake water levels have been proposed as indicators for each stage of drought.

Month	Normal (Stage 0)	Stage 1	Stage 2	Stage 3	Stage 4
July	>342.44	342.44 - 342.227	342.227 - 342.046	342.046 - 341.981	<341.981
August	>342.24	342.24 - 342.097	342.097 - 341.929	341.929 - 341.869	<341.869
September	>342.04	342.04 - 341.950	341.950 - 341.802	341.802 - 341.667	<341.667
October	>341.89	341.89 - 341.796	341.796 - 341.655	341.655 - 341.511	<341.511
November	>341.84	341.84 - 341.681	341.681 - 341.575	341.575 - 341.421	<341.421

Drought Forecasting for Groundwater

Drought forecasting for the Town's groundwater surfaces has been proposed to be based on Provincial groundwater observation well data. Monitoring data for these wells can be found by visiting: http://www.env.gov.bc.ca/wsd/data_searches/obswell/map/. The following observation well water levels measured below ground surface have been proposed as indicators for each stage of drought.

- Normal (Stage 0): Groundwater supply is at or above normal levels.

- Stage 1: OW 405 ≥ 18.7 m bgs, OW 407 ≥ 11.7 m bgs, OW 332 ≥ 18.0 m bgs – remains at or below this level for one week or more
- Stage 2: OW 405 ≥ 18.7 m bgs, OW 407 ≥ 11.7 m bgs, OW 332 ≥ 18.0 m bgs – remains at or below this level for four weeks or more
- Stage 3: OW 405 ≥ 20.5 m bgs, OW 407 ≥ 12.35 m bgs, OW 332 ≥ 19.1 m bgs – remains at or below this level for two weeks or more
- Stage 4: OW 405 ≥ 20.5 m bgs, OW 407 ≥ 12.35 m bgs, OW 332 ≥ 19.1 m bgs – remains at or below this level for four weeks or more

Corresponding Water Restrictions

Domestic system restrictions associated with each drought level have been proposed as follows:

- Stage 1: Outdoor watering (not associated with agricultural irrigation) is allowed 3 days per week.
- Stage 2: Outdoor watering (not associated with agricultural irrigation) is allowed 2 days per week.
- Stage 3: Outdoor watering (not associated with agricultural irrigation) is allowed 1 day per week.
- Stage 4: Moratorium on outdoor water use (not associated with agricultural irrigation).

During severe water restrictions, Town personnel will also shift domestic production to other parts of the system to even out the demand across systems in order to maintain adequate water levels.

For the irrigation system, the Town will not mandate or enforce reduced irrigation water supply to agricultural customers unless absolutely necessary. In the event of a severe water shortage, Town personnel will institute a rolling shut down of irrigation system pumphouses where water is sequentially shut off and then turned back on for each irrigation system within the Town's boundaries.

1.0 Introduction and Objectives

Drought is defined as a water shortage resulting from a prolonged period of abnormally low precipitation. The other common contributing factors to drought in British Columbia include insufficient snowpack and hot and dry weather. These factors can result in reduced flow conditions in streams and insufficient recharge rates for lakes and aquifers, thereby potentially depleting sources of water commonly utilized for domestic and irrigation purposes.

The Town of Oliver (the Town) utilizes both groundwater and surface water sources to satisfy domestic and irrigation demand. The Town's domestic water system is entirely supplied by the Town's groundwater sources while the irrigation system is supplied by a combination of groundwater sources and a surface water source which originates from the Okanagan River. For perspective, the Town's annual irrigation demand is approximately five to six times greater than its domestic demand.

Surface water for irrigation provides service to agricultural land (i.e. orchards, wineries, etc.). This water provides livelihood for these users. Limiting the water supply to these users could result in crop loss and loss of actual trees or vines. Therefore, the Town's position is that they will not mandate or enforce reduced irrigation to their agricultural customers unless absolutely necessary.

Oliver's groundwater sources comprise a series of relatively shallow wells completed in valley-bottom aquifers. These aquifers are thought to be recharged in the north by Vaseux Lake, Vaseux Creek and Okanagan River and discharge to wetlands and the Okanagan River north of Osoyoos Lake. Generally speaking, groundwater availability is less susceptible to the effects of drought, although severe droughts spanning more than a year have the potential to impact groundwater supplies.

Drought can affect the availability of groundwater supplies in two primary ways: 1) increased demand can lead to higher-than-normal pumping rates and greater drawdown in aquifer water levels and 2) reduced river levels (and flow) and lower than normal runoff and precipitation combine to lower the water table, which in turn could affect pumping rates in wells. However, because the Okanagan River system is regulated to the extent that there is always at least 5 m^3/sec of flow (and historically flows rarely fall below 8 m^3/sec), the drought risk associated with groundwater availability is believed to be low.

Ensuring that source water for the domestic and irrigation water systems is maintained is of utmost importance to the Town. This Drought Management Plan has been prepared to assist Town staff with recognizing drought conditions by way of easily monitored target thresholds and connecting these targets to usage reductions for the Town's water system. These objectives are recommended as a method to reduce the effects of drought conditions, thereby ensuring that the Town has access to water during periods of extended drought.

1.1 Background

In August 2015, the Province of British Columbia declared a Level 4 drought in the Okanagan Basin. This Level 4 classification resulted from extremely dry weather conditions which put stream, lake and aquifer levels at risk. Provincial drought levels are declared on a regional basis by the Province of British Columbia. These drought levels are based on stream flows to ensure that adequate water is available to support fish viability. A complication resulting from the Province's Level 4 declaration was that water purveyors in the Okanagan region manage each licensed system independently. Therefore, at the time of the Level 4 drought declaration there was widespread uncertainty about which level of response would satisfy the requested water usage reductions that the Province was mandating. Another complicating factor was that water purveyors in the Okanagan Valley who rely on source water obtained via mainstem lake intakes or groundwater sources typically do not have drought triggers and corresponding reactionary guidelines in place to manage water demand during extended periods of drought.

The Okanagan Basin Water Board (OBWB) was instituted in 1970 as a collaboration of the three Okanagan regional districts to provide leadership on water issues spanning the Okanagan Valley. A key mandate of the OBWB is to work with Valley water users to protect water resources in the Okanagan Valley. Based on the 2015 Level 4 drought declaration and the resulting varied responses by Okanagan Valley water users, the OBWB commissioned a technical team of experts in the field of drought management with the goal of proposing consistent Valley-wide drought triggers based on mainstem lake levels. The subsequent goal of the OBWB is for each water purveyor in the Okanagan Valley to adopt these drought triggers by way of a council endorsed Drought Management Plan, thereby ensuring that water users in the Okanagan Valley act in sync during drought conditions.

1.2 Drought Plan and Purpose

Drought response plans provide water purveyors with guidelines to plan for and reduce the impact of drought conditions. The risk of drought impacts communities by:

- Reducing source water availability for domestic, irrigation and fire fighting purposes;
- Impacting water quality; and
- Increasing risk to aquatic species.

The purpose of this report is to provide the Town with a response plan meant to minimize the effects of drought conditions. Being prepared for drought conditions will help to protect source water availability. The response plan should also be comparable to other Okanagan Valley water users to ensure drought responses are consistent on a Valley-wide basis and effects of extended drought are minimized.

1.3 Components of the Drought Response Plan

This report includes the following sections:

- The Town's water supply and demand profile – drought response restrictions are typically based on reductions in water usage. Therefore, reviewing past water demand and future projections are an important component of a drought response plan.
- Factors influencing the likelihood of drought for the Town's water sources – identifying specific factors that have the greatest likelihood of affecting the Town's water sources are an important aspect of this report. Identifying these factors will provide Town staff with an understanding of the reasons why specific targets have been recommended to trigger the drought response plan.
- Drought forecast approach methods – As with the factors influencing the likelihood of drought, this section provides the Town with background for recommended drought targets. This section identifies quantifiable methods that are available to Town staff to aid in forecasting the stages of a drought. Ideally, this section will coordinate forecasting methods with other water purveyors in the Okanagan Valley.
- Stages of Drought – this section defines each stage of a drought and identifies the forecast methods which are proposed to be utilized by Town staff when declaring a drought stage.
- Drought Plan Implementation – This section identifies Town resources that will be utilized during a drought event.

The final objective of this report is to ensure that the Town has a series of guidelines that will assist Town staff in responding to each stage of a drought. Of vital importance to the Town will be to ensure that source water is maintained for both the domestic and irrigation systems. Therefore, the drought response guidelines have been proposed to maintain these services in the event of an extended drought.

2.0 Water Supply and Demand Profile

2.1 Background

In 1918, the Provincial Government, led by “Honest John Oliver” the Premier of the time, purchased over 22,000 acres of land in the South Okanagan to develop an Irrigation Canal system to convert 8,000 acres of desert land on each side of the Okanagan River into viable agricultural land. This land would then be for sale, at a reasonable cost, designated to the soldiers returning from World War I. This land arrangement was known as the “The Soldiers’ Land Act.” This project then became the South Okanagan Lands Project (SOLP).

Construction of the irrigation system, including the intake dam at the base of McIntyre Bluff, began in 1919 and was not completed until 1927. The resulting canal, known as “The Ditch”, had an overall length of approximately 40 km measuring 5.6m across the top, and 1.5m deep, delivering 230 cubic feet of water per second or approximately 10 inches of water on every acre, every month during the irrigation period. Relevant historical phots of “The Ditch” are shown in the following Figure 2-1.

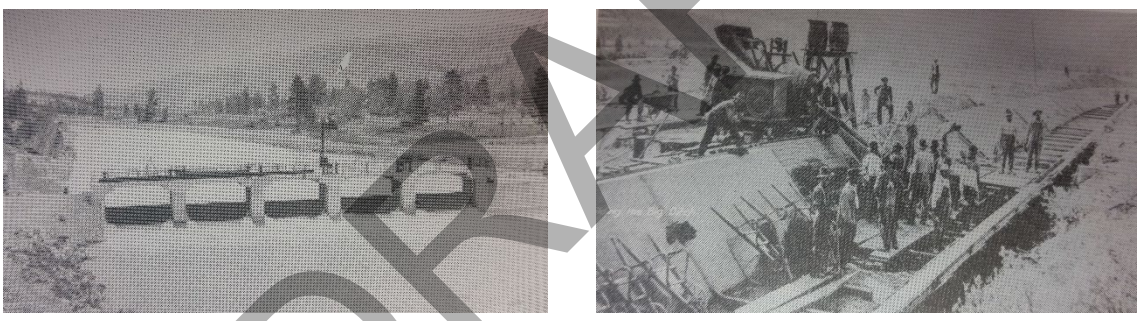

FIGURE 2-1 THE DAM NORTH OF OLIVER BELOW MCINTYRE BLUFF IN THE 1950'S (LEFT) AND CONSTRUCTION OF THE DITCH (RIGHT) (SOURCE: CANCELA. 1986).

Overall, the canal was composed of a diversion dam, 32 km of concrete-lined ditches, 27 flumes, 7 spillways and a woodstave siphon. The flumes were mainly constructed of half round galvanized steel on timber trestles or timber boxes lined with zinc. The SOLP designed the canal to transport irrigation water from one side of the Valley to the other. To accomplish this, a 7-foot diameter siphon made out of wood stave pipe had to be built underground, which ran approximately 590m long directly beneath the center of the Town, connecting the North and South parts of the canal.

Over the next forty years the canal was maintained and run by the provincial government employees (SOLP), until the spring of 1964, as the province decided it was removing itself from the irrigation business. Premiere W.A.C. Bennet passed the canal to the Oliver and Osoyoos Fruit Growers’ Association which volunteered itself to become the cornerstone of the South Okanagan Lands and Irrigation District (SOLID). During these years, SOLID installed the first of several

groundwater wells to supplement the canal system (e.g. the Fairview and Tuc-El-Nuit wells). The district operated and maintained the canal system until 1989 when it was divided into two municipal governments: The Town of Oliver and the Town of Osoyoos. At that time, the Town was given the responsibility to maintain and operate the canal, which continues to be a major contributor to the water that Oliver and Osoyoos delivers annually to the parched desert area of the Valley.

Today, the Town provides domestic water to approximately 2,393 residential connections (including rural users), and 174 commercial and industrial connections. Irrigation water is also provided to about 601 connections which is irrigating approximately 5,200 acres of agricultural land with 1,025 acres of that pumping their own water from the Town's Irrigation Canal. Approximately, 455 acres of non-agricultural land is also irrigated from this system.

2.2 Water System Description

The Town owns and operates water systems servicing lands adjacent to the Okanagan River over a length of about 20 km from the Highway 97 Bridge at the north to the north end of Osoyoos Lake at the south. An overall plan of the water systems owned and operated by the Town is presented in *Appendix A*. Areas within the Town's municipal boundaries are serviced by the Town's domestic water system which also provides domestic water service to rural areas via a twinned domestic / irrigation water system. This domestic system is described in Section 2.2.1. Rural areas in Regional District of Okanagan-Similkameen Electoral Area C, both north and south of the Town, are provided water for irrigation purposes by the irrigation system. This system is described in Section 2.2.2.

Municipal wastewater is also treated and stored for reuse by irrigation in the Fairview Area. In 2004, the Town completed extensions of its reclaimed water supply system thereby making reclaimed water available for irrigation purposes to areas adjacent to or near the Fairview Road and Co-Op Avenue corridors within the municipal boundaries. The reclaimed water supply system is described in Section 2.2.3.

The Town's overall water system is broken down into seven (7) individual systems which over time have been inter-connected to provide a more sustainable water supply system as a whole. An overview of the overall water system is illustrated in the following Figure 2-2. Each system is defined or known due to the area, and the wells that support it:

- System 1 – also referred to as Rural North – Buchanan Road Pumphouse
- System 2 and 2B – Black Sage Area – Black Sage and Miller Rd Pumphouses (system 2 is combined domestic and irrigation)
- Municipal System – includes area once referred to as System 3 – Rockcliffe and Tuc-el-Nuit Pumphouses
- System 4-7 – also referred to as Rural South – Fairview and Miller Rd 13 Pumphouses

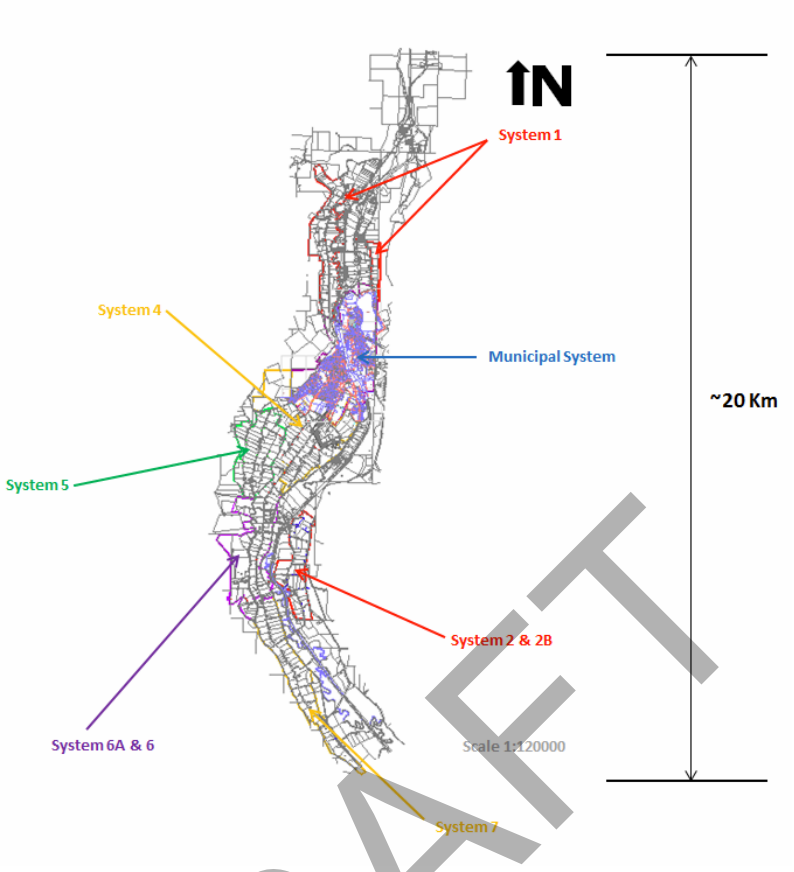

FIGURE 2-2: TOWN OF OLIVER'S 7 WATER SYSTEM OVERVIEW

2.2.1 Domestic Water System

The domestic water system provides service to all residential, commercial and industrial lands within the Town's municipal boundaries and also conveys domestic water to rural areas via a watermain twinning system that was recently constructed adjacent to the existing irrigation system. The various systems that are supplied via the domestic water system are discussed in the subsequent sections. A total of eight (8) drilled wells represent the water source for the domestic water system. The domestic system water supply well locations are illustrated in *Appendix A*. *Appendix A* also includes a map depicting the well locations, the mapped aquifers and Province of key water monitoring locations. The domestic water system is a single pressure zone controlled by the Town's three (3) municipal storage reservoirs having a combined storage capacity of 4,455m³ and a full water elevation of 380.7m. The municipal water system provides domestic service and fire protection consistent with accepted municipal water system design standards.

2.2.1.1 System 1 Domestic

System 1, also known as "Rural North," supplies domestic water to approximately 161 accounts. System 1 has an irrigation main, and a domestic main that runs approximately 4.5km from the

edge of town to the end of Sportsman Bowl Road. The Buchanan pump station supplies both Irrigation surface water and domestic ground water to System 1. System 1 is connected to the Municipal System at Highway 97 near the Town Boundary and at Vineyard Road and Tuc-el-Nuit Drive. Storage for System 1 Domestic is provided by the Municipal Reservoir.

2.2.1.2 System 2 & 2B Domestic

System 2, also known as "Black Sage" area, supplies domestic and irrigation water to approximately 52 accounts. System 2 is unique having separated into two areas, System 2, and 2B. System 2B, along with every other system, is twinned. Whereas System 2 is the only system that does not have separate water sources for both irrigation and domestic water. System 2 and 2B have two domestic pump stations within its boundary; Black Sage pump station, and Miller Well pump station.

2.2.1.3 Municipal System Domestic

The Municipal System, including what was System 3, supplies domestic groundwater to approximately 2,400 accounts. Municipal System utilizes two pump stations, and one booster station to supply its users within the Town boundary; Rockcliffe pump station, Tuc-el-Nuit pump station, and the Airport Booster station.

2.2.1.4 System 4, 5, 6 and 7 Domestic

Systems 4, 5, 6 and 7, also known as "Rural South," supplies domestic ground water to approximately 483 accounts. The Systems utilize the Miller Well pump station, 6A Domestic Booster station, and the Airport Booster station. The Miller Well pump station also acts as a supplemental source of domestic groundwater to System 2 during peak demands. Storage for Systems 4-7 Domestic is the Road 13 Reservoir. The Airport Booster Station is capable of pumping both directions which allows Town staff to move water between each system as required.

2.2.2 Irrigation Systems

The Town has a semi-arid climate with hot, dry summers. The average annual rainfall is only 284mm, which would not sustain the crops that are now grown in the Valley. The Town operates seven major irrigation systems which largely derive their water supply from the Town's Irrigation Canal.

With the exception of irrigation water supplied from the Buchanan Irrigation Well and the Fairview Irrigation Well and the combined irrigation/domestic water supplied to System 2 in the Black Sage area, the water source for the Town's irrigation systems serving the rural areas is the Irrigation Canal. The canal is supplied by diversion from the Okanagan River at the McIntyre Dam (refer to *Appendix A)*. Irrigation water for systems 1, 4, 5, 6 and 7 is supplied by pumphouses drawing water from the Irrigation Canal. In total, the Town's irrigation systems provide water to about 5,200 acres of agricultural land.

The canal is a 21-km long Town-owned asset that has enormous importance for the economy of Oliver and the surrounding communities. Oliver is known as the Wine Capital of Canada and as the centre of the wine industry in the Okanagan with the largest concentration of both vineyards and commercial wineries in British Columbia. New wineries and additional lands are being put into production in what is expected to be a growth industry. Tree fruit, vegetable and cattle production form an important base for secondary industries in the area. The horticulture industry is reliant on the canal. This is a key industry in the Okanagan, both for crop production and as a draw for increased tourism. The economic effects of a failure of the system would be severe.

It is understood that the water licenses associated with the Irrigation Canal are subject to the following conditions:

- A total withdrawal of 56,000 acre-feet for irrigation only between April 1st and September 30th and 1,600 acre-feet for irrigation only between October 1st and October 31st. Some discretion is exercised at either end of the season.
- Fisheries is a major constraint on water delivery. As per Table 2-1, MOE tries to maintain a minimum of 9.9 m³/sec (350 cfs) during the spawning season (i.e. September to November) and half of that during the incubation period. This table also summarizes the preferred flows in the Okanagan River throughout the operational season of the Irrigation Canal.

TABLE 2-1: PREFERRED FLOWS AT OLIVER TO SATISFY SOCKEYE SALMON LIFE-HISTORY STAGE REQUIREMENTS

Sockeye life history stage	Dates	Preferred range (m³/sec)
Adult migration	August 1st - Sept. 15th	8.5 - 12.7
Spawning	Sept. 16th - Oct 31st	9.9 - 15.6
Incubation	Nov. 1st - Feb 15th	5.0 - 28.3 Incubation flows ≥ 50% spawning
Fry migration	Feb 16th - April 30th	5.0 - 28.3

(Source: Fisheries and Oceans Canada. 2009)

- The Oliver canal requires a minimum water level of 327.355m at the diversion to take in and control the flow required to realize the canal's full hydraulic capacity of 2.97-3.11 m³/sec (105-110 cfs). For the purposes of this report, 3.11 m³/sec (110 cfs) is considered to be the maximum hydraulic capacity of the Town's Irrigation Canal. This maximum hydraulic capacity of the Irrigation Canal is approximately 3.2% of the Okanagan River's design hydraulic capacity of the 96.3 m³/sec (Ministry of Environment, Lands and Parks Water Management Division. April 1992), between McIntyre Dam and Osoyoos Lake.

The average volume pumped from the Irrigation Canal by the Town in the period of 2013 to 2015 was 11.7 ML or about 9,500 acre-feet. If we assume that 35% of water diverted from the Okanagan River is pumped, which is a comparable conclusion from the 1993 CH2M Hill Engineering report on canal capacity, then it can be assumed that the average diversion by the

Town is approximately 33.3 ML or about 27,030 acre-feet, which is 47% of its total license. In summary, the average approximate flow rates associated with the Irrigation Canal in the period of 2013 to 2015 are provided in the following Table 2-2. This table also compares average flows in the Irrigation Canal to preferred flow rates in the Okanagan River as per MOE.

TABLE 2-2: IRRIGATION CANAL AVERAGE FLOW RATES (2013-2015)

Flow associated with Irrigation Canal time period (number of days)	Quantity Acre-feet	Flow rate over period m^3/sec (cfs)	Preferred range in Okanagan River m^3/sec (cfs)
Total Available April 1st to September 30th (183 days)	56,000	4.4 (155)	8.5 (300) - 12.7 (450)
Total Available October 1st to October 31st (31 days)	1,600	0.74 (26)	9.9 (350) - 15.6 (550)
Average Withdrawn – April 1st to September 30th (183 days)	8,965	0.7 (25)	8.5 (300) - 12.7 (450)
Average Withdrawn October 1st to October 31st (31 days)	501	0.23 (8.1)	9.9 (350) - 15.6 (550)
Average Diverted April 1st to September 30th (183 days)	25,600	2.0 (71)	8.5 (300) - 12.7 (450)
Average Diverted October 1st to October 31st (31 days)	1,430	0.66 (23)	9.9 (350) - 15.6 (550)

From the above table, it can be concluded that:

- The maximum hydraulic capacity of the Irrigation Canal is less than the total licensed flow available. Therefore, a total maximum flow rate of 3.11 m^3/sec (110 cfs) has been utilized for the Irrigation Canal. Comparing the three-year average flow rate diverted from the Okanagan River to this total maximum flow rate results in the Town utilizing about 58% of the canal's rated capacity on an annual basis.
- This intake is the last major diversion between Skaha Lake and Osoyoos Lake. Therefore, if minimum Okanagan River flow requirements are not affected by the Town's surface water usage it can be concluded that irrigation demand has little affect on the Okanagan River.
- In order for the maximum hydraulic capacity to be achieved in the Irrigation Canal during operation (i.e. April to October), a preferred minimum flow rate of 11.61 m^3/sec (410 cfs) would have to be available in the Okanagan River immediately upstream of the McIntyre Dam structure. This preferred minimum flow rate would provide adequate flow in the Okanagan River near Oliver as per Fisheries and Oceans Canada recommendations (see Table 2-1). During extended drought conditions the minimum transborder flow is specified as 2.83 m^3/sec (100 cfs) (source: Ministry of Environment, Lands and Parks Water Management Division. March 1994). Therefore, a minimum flow rate of 5.94 m^3/sec (210 cfs) would have to be available in the Okanagan River immediately upstream of the

McIntyre Dam structure to satisfy the hydraulic capacity of the Irrigation Canal during an extended drought.

2.2.3 Reclaimed Water System

Wastewater from the Town is treated by a two-cell aerated lagoon system located in the Fairview area west of the core area of the Town. Treated effluent is then stored for irrigation (re-use) purposes. Separate reclaimed water mains originate from the treated effluent storage lagoon and supply the Fairview Mountain Golf Course and public lands, i.e. cemetery, airport, and school area within the Town's municipal boundaries.

The reclaimed water supply main on Fairview Road represents the opportunity to supply irrigation water to areas currently using the Town's municipal water system (i.e. South Okanagan Secondary School site) and supply irrigation water to currently irrigated areas which would 'normally' utilize domestic water (i.e. future lease areas on the airport site). The reclaimed water supply system which extends through the core area of the Town represents a water conservation opportunity which is unique to the Town.

The reclaimed water system supplies irrigation water to currently irrigated areas which would 'normally' utilize domestic water. This system provides a reliable water supply for irrigation purposes at these locations, thereby reducing demand on the Town's groundwater and surface water sources. As such, the reclaimed water system will not be discussed further in this report.

2.3 Current and Future Water Demand

As discussed in Section 2.2, the water system is twinned in Oliver, meaning that groundwater, generally used for domestic purposes, has its own pipe network while surface water, used for irrigation purposes, also has its own pipe network. The only exception for the irrigation system is System 2, which utilizes groundwater for both irrigation and domestic purposes. For the purposes of this report, the source water originating from groundwater sources in the System 2 area is considered to be used for irrigation purposes only. In reality, some portion of this source water is used for domestic purposes and therefore the domestic usage specified in the following sections is moderately higher while the irrigation usage is lower.

2.3.1 Existing Demand

Water usage for the period of 2011 to 2023 was reviewed to determine existing demand for both the domestic and irrigation water systems. Please refer to *Appendix C* for the Town's water reports for the period of 2016 to 2023.

As shown in the following Figure 2-3 and Figure 2-4, the Town consumed approximately 16,700 ML of water in 2015. The total water consumed in Oliver was high in 2015 with overall water consumption approximately 18% higher than the previous year. This high demand is influenced by a moderate increase in population but is likely more greatly influenced by annual weather

patterns. As stated in Section 1.1, the South Okanagan was at Level 4 drought from July 2015 until the end of September 2015. The hot and dry weather associated with drought conditions is considered to be the contributing factor for the increased demand in 2015.

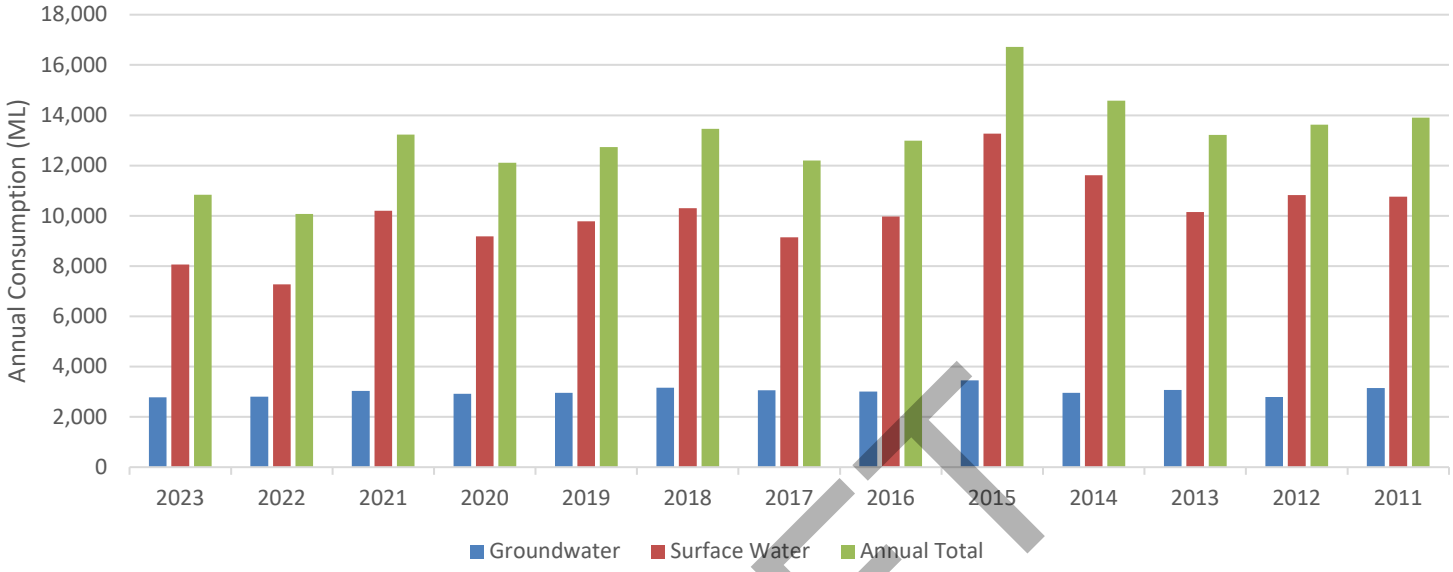

FIGURE 2-3: GROUNDWATER AND SURFACE WATER DEMAND (2011-2023)

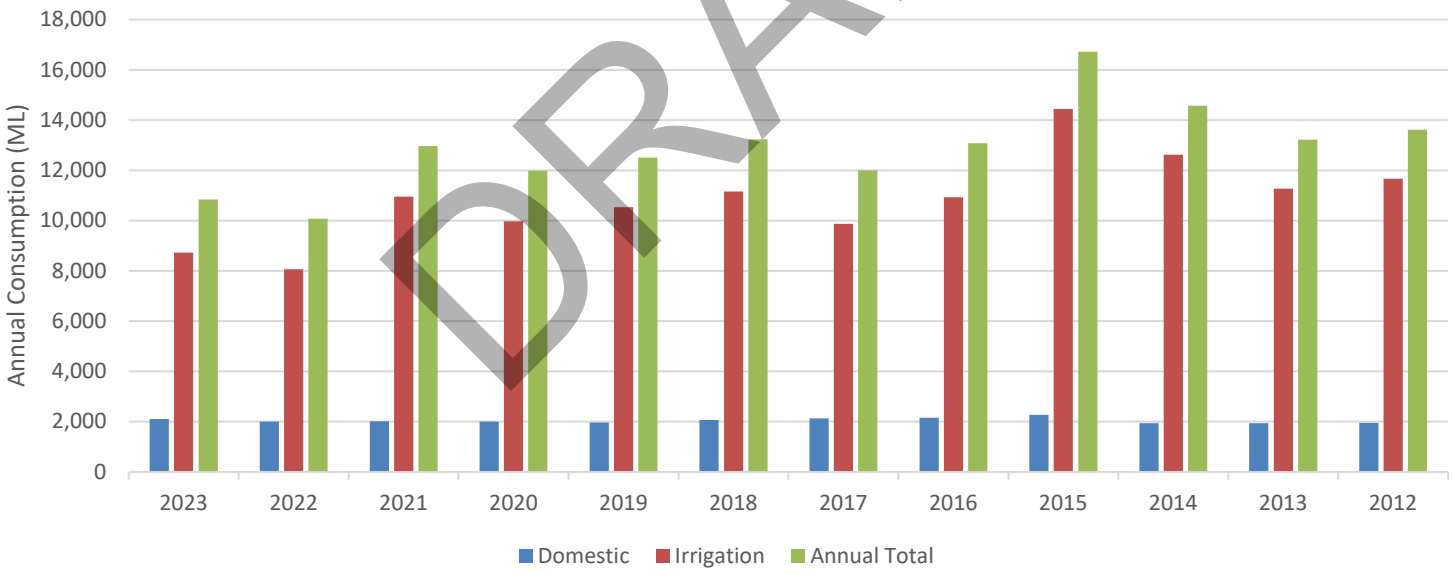

FIGURE 2-4: DOMESTIC AND IRRIGATION WATER DEMAND (2012-2023)

2.3.2 Future Demand

Future projections for water demand are generally assessed to determine system capacity and the requirement for capital improvements in relation to the maximum day demand (MDD). For the

purposes of this report, future demand projections have been assessed to determine whether future demand will require additional source capacity and whether future demand may negatively impact the existing source capacity during periods of extended drought.

Future demand projections are generally based on historical population growth and projected growth rates for the region. The Town's Draft Official Community Plan (Bylaw 1370) states that the period prior to 2011 showed modest but steady population growth of between 1% and 2% while projections for future growth in the area were obtained from BC Stats which projected a low growth rate of 0.25% in the period of 2015 to 2030. This projected growth rate is considered to be conservative for water demand projections since underestimating demand growth may lead to overestimating the adequacy of source water capacity. Therefore, a growth rate of between 1% and 2% has been utilized for the domestic water system while a more conservative growth rate of between 0.5% and 1% has been utilized for the irrigation system recognizing the higher level of demand associated with this system. Water demand projections are presented following in Figure 2-5.

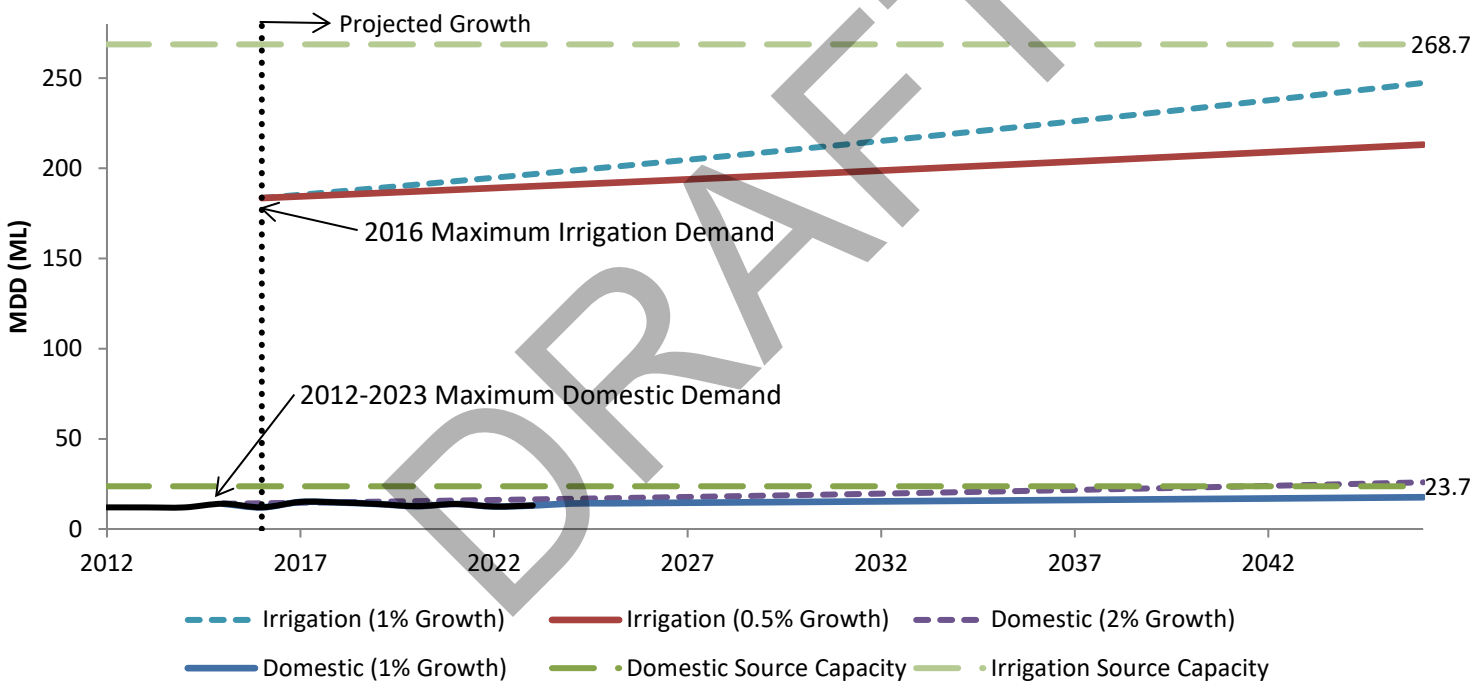

FIGURE 2-5: MAXIMUM DAY WATER DEMAND PROJECTIONS (2016-2046)

Related to the above figure:

- The maximum rate of irrigation flow for 2016 occurred on July 1 and was measured at 75 cfs (2.12 m³/sec), which equates to approximately 184 ML per day. It should be noted that Town staff and operators have indicated that the flow meter was replaced following the 2016 growing season and the resulting readings between the 2017 and 2023 growing seasons are likely not accurate due to a previously unrecognized calibration issue. This

issue was recently corrected and the Town plans to review irrigation usage regularly during the 2024 growing season. The results of this review may therefore necessitate an update to this analysis.

- Domestic demand projections have been based off high annual demand levels from 2015. Projecting demand levels based on higher-than-average demand provides conservative future demand projections. For the purposes of this report, conservative demand projections are considered appropriate as these projections likely provide an accurate representation of future demand during a Level 4 drought similar to the one that occurred in 2015.
- Domestic source capacity is greater than projected domestic demand. The source capacity of approximately 23.7 ML daily (equivalent to almost 8,650 ML annually) is based on the rated capacity of each existing domestic well servicing the Town's domestic water system. These domestic wells are as follows: Tuc-el-Nuit Well No. 2 & No. 3, Buchanan Domestic Well, and Rockcliffe Well. Note that Black Sage Well No. 1, No. 2, & No. 3, and Miller Domestic Well are not included in this total. Refer to *Appendix A* for the location of each of these water sources.
- The hydraulic capacity of the Irrigation Canal equates to approximately 57,500 ML annually which is less than the licensed maximum withdrawal amount of approximately 71,600 ML annually. The maximum daily demand associated with the Irrigation Canal's hydraulic capacity is therefore approximately 269 ML when considering the irrigation season of April 1st to October 31st.
- Both domestic and irrigation demand are currently well below the existing source capacity for each water system. Additional source capacity associated with the irrigation system should not be required for the foreseeable future. Further investigation of additional water sources for the domestic water system may be warranted in the near future, especially if pumping redundancy is desired for the provision of future maximum day demand.

3.0 Oliver Specific Factors Influencing the Potential for Drought

The Town is fortunate to have multiple sources of water supply and the ability to move water between systems in response to supply and demand changes. Surface and groundwater sources providing service for the Town's water systems are affected by flows in the Okanagan River. Surface water entering the Irrigation Channel is directly affected by the river while groundwater recharge rates and groundwater levels are also potentially affected, but to a lesser extent because flow maintenance in the Okanagan River serves to maintain minimum groundwater levels in the shallow aquifers close to the river. Additionally, surface flow responds more quickly to changing climate conditions than groundwater, and the time lag between a change in climate and a change in groundwater conditions is longer. However, a multi-year drought poses a greater threat to groundwater supplies.

The Province utilizes the Okanagan Lake Regulation System (OLRS) to control lake levels and releases from the Okanagan River from Okanagan Lake to the inlet of Osoyoos Lake. This system therefore directly influences source water availability for the Town's water systems. The OLRS consists of dams located at Okanagan Lake near Penticton, Skaha Lake near Okanagan Falls, and Vaseux Lake north of Oliver (source: OBWB. 2016). Other infrastructure associated with the OLRS includes the channelized sections of Okanagan River between Okanagan Lake and Osoyoos Lake, including the associated dikes and drop structures. The OLRS regulates lake levels that are affected by a gross drainage area of approximately 8,275 square kilometres.

The OLRS is operated to attain seasonal targets for mainstem lake elevations and river flows as per the 1976 Okanagan Basin Implementation Agreement. These targets consider flood and drought conditions while also accounting for water requirements for fish viability. To aid with drought forecasting, the OLRS utilizes inflow forecasts from the River Forecast Centre (RFC) which considers precipitation levels, snowpack levels, and hot and dry weather. Additionally, climate change is expected to intensify these issues.

The following sections are intended to provide the Town with specific factors which may directly influence surface and groundwater levels for the Town's water system sources. Since contributing factors such as precipitation levels, snowpack levels, and hot and dry weather are considered during operation of the OLRS, it is considered unnecessary for the Town to consider these factors in further detail.

3.1 Groundwater Factors

In 2016, the Province of B.C. completed a groundwater budget study for the aquifer systems in the Oliver Area (Western Water Associates 2016). This study developed a conceptual model of groundwater flow through the valley bottom, and identified monthly water budgets for normal, wet and dry year climate scenarios. Pumping from the Town of Oliver's wells was included in the water budget study, which found that adequate groundwater supplies are likely available year-round in each of the area aquifers, mapped by the Province B.C. as Aquifers 255, 254 and 256. As noted above, there is a map provided in *Appendix A* that is excerpted from the 2016 water budget study that shows the extent of the mapped aquifers, Oliver's wells, the Okanagan River gauge at Oliver at the observation wells discussed below.

The Ministry also maintains actively monitored water level observation wells in each of the aquifers. At the present time, the Ministry collects the water level data and provides the data for download in spreadsheet format but does not publish statistics on long-term water levels.

Some, but not all, of the observation wells report water levels in "real time." Those that are real-time can be used during a drought to assess whether or not abnormally low aquifer water levels are occurring. It is suggested that aquifer water levels be used as a supplemental drought indicator by the local drought response team. Fortunately, there are three wells that may be used as indicators of potential abnormally low groundwater levels, and these monitor conditions in all

three of the main aquifers. The following graphs depict the historical groundwater levels in three Provincial observation wells currently used in the Oliver area. From north to south these are: Observation Well (OW) 405, OW 407 and OW 332 completed in Aquifers 255, 256 and 254 respectively. The data from these wells are available online using the B.C. Provincial Observation Well Network interactive mapping tool which can be found by visiting: http://www.env.gov.bc.ca/wsd/data_searches/obswell/map/

Note that OWs 407 and 405 report real-time data while currently OW 332 does not. During a drought situation when updated information is needed, water level data for OW 332 may be obtained by emailing Groundwater@gov.bc.ca and requesting the latest available data. Although, it is important to note that no response has been received from this email stemming from data requests by Town staff during the 2023 calendar year.

The drought-related factor thought to have the greatest potential to stress the Town's groundwater supplies is simply increased demand for water during periods of drought. This might occur locally within one or more of the Town's Systems or broadly over the whole area. Pumping the wells for longer durations at the maximum pump capacity can increase the well and local aquifer drawdown below normal levels, and eventually could curtail the available supply. Low Okanagan River flow and associated lower river levels would also influence the local groundwater table but is less likely to stress groundwater supplies. To our knowledge, none of the Town's wells experienced supply issues during the 2015 drought. Therefore, we recommend that a groundwater level of more than 0.5 m below the lowest recorded water level in any of the three Provincial observation wells be used as an indicator of potentially drought-stressed groundwater supplies. This information is summarized in Table 3-1 below and should be used in combination with primary drought indicators. Graphs showing the OW water levels are provided in Figure 3-1, Figure 3-2, and Figure 3-3. The data include both "validated" and "unvalidated" water levels but are likely suitable for purposes of illustration for this report. Note that "unvalidated" measurements are indicative of levels recorded by remote sensors and have not been "validated" by Ministry personnel. It is not uncommon for individual monitors to give false, "unvalidated" readings due to temporary local conditions, and on occasion the readings can be grossly inaccurate.

The recommended indicators below should be considered provisional. A more robust approach would be to conduct detailed statistical analysis of long-term water level data and establish valley-wide definitions of "normal", "above normal" and "below normal" groundwater level conditions. This statistical approach would enable water suppliers and water managers to use selected observation wells as drought index wells. A U.S. Geological Survey publication by Taylor, C. and W. Alley (2001) provides a detailed discussion of the importance of long-term groundwater level data and how the data can be used in monitoring and forecasting drought.

TABLE 3-1: GROUNDWATER LEVEL DROUGHT STRESS INDICATORS

Observation Well Number and Aquifer Number	Historic low water level (m bgs)	Average/typical seasonal low water level (m bgs)	Suggested Stage 1&2 indicator water level (m bgs)	Suggested Stage3&4 indicator water level (m bgs)	Associated Town Wells
OW 405 (256)	20.0	18.7	18.7	20.5	Rockcliffe, Fairview
OW 407 (255)	11.85	11.7	11.7	12.35	Buchanan, Tuc-El-Nuit
OW 332 (254)	18.6	18.0	18.0	19.1	Miller Rd, Black Sage

Note: The difference between Stages is the duration of the observed water level at or below the threshold. Refer to Section 5.0 below.

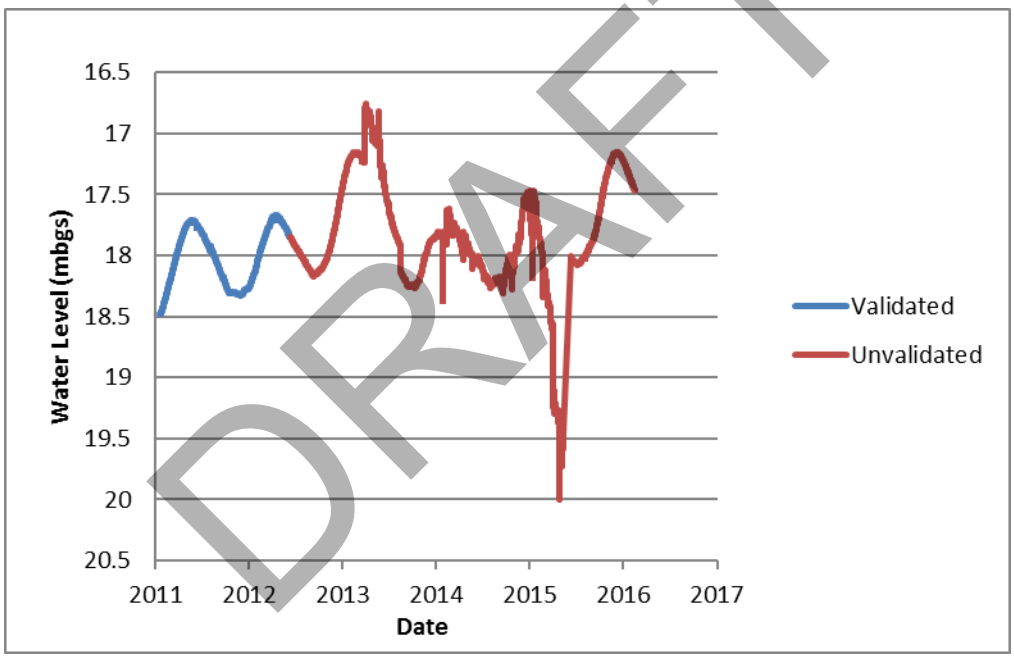

FIGURE 3-1: OBSERVATION WELL 405 HYDROGRAPH (INDICATOR FOR ROCKCLIFFE WELL)

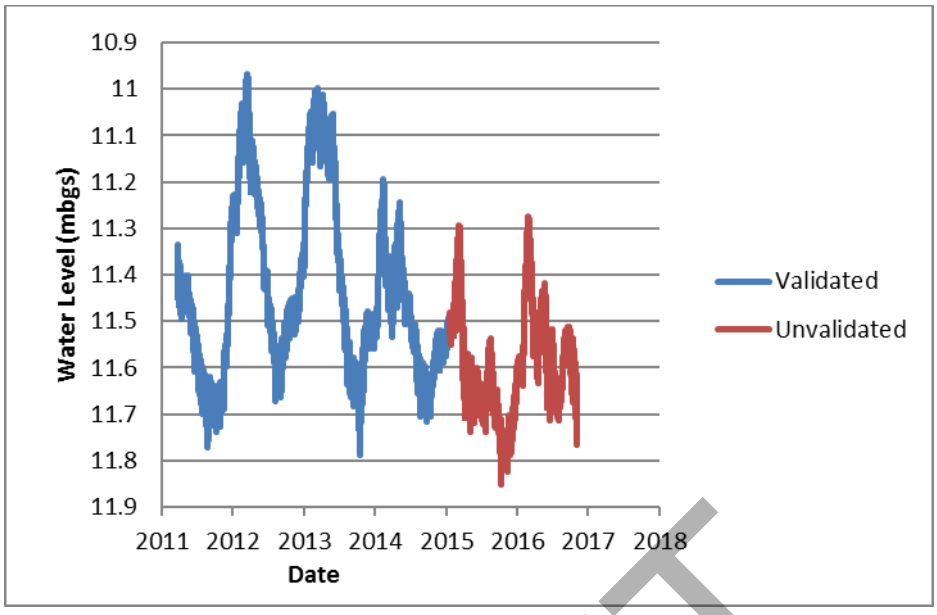

FIGURE 3-2: OBSERVATION WELL 407 HYDROGRAPH (INDICATOR FOR BUCHANAN WELLS)

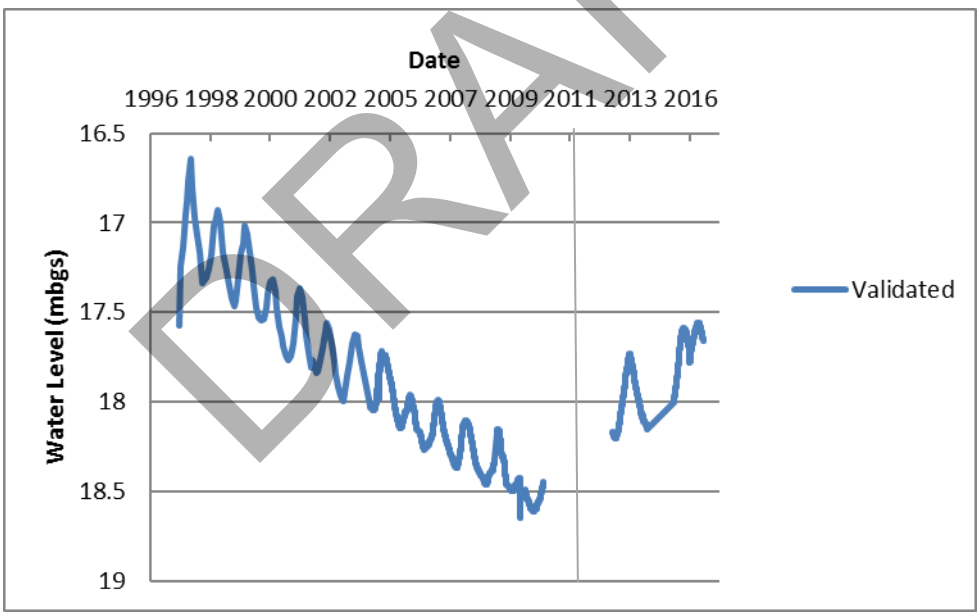

FIGURE 3-3: OBSERVATION WELL 332 HYDROGRAPH (INDICATOR FOR TUC-EL-NUIT AND SYSTEM 2 WELLS)

3.2 Preferred and required flows in Okanagan River at Oliver

The main objectives of the OLRS is flood control and drought management while also considering aquatic and riparian ecosystem needs by way of targeting the preferred flows as summarized in Table 2-1. Additionally, operation of the OLRS accounts for maintaining minimum transborder operating flows that were set for the following drought conditions (source: Ministry of Environment, Lands and Parks Water Management Division. March 1994):

- Second-year drought
  - (Aug 1st – Oct 31st) 5.66 m³/s (200 cfs)
  - (Nov 1st – Mar 31st) 2.83 m³/s (100 cfs)
- Third-year drought 2.83 m³/s (100 cfs)

The above flow rates are considered the minimum flow rates that must be maintained in the Okanagan River. The above third-year drought minimum Okanagan River flows correspond to measured flows near Oliver (Monitoring Station 08NM085) as summarized in the following Table 3-2 (source: Ministry of Environment, Lands and Parks Water Management Division. March 1994).

TABLE 3-2: MINIMUM FLOW RATES IN OKANAGAN RIVER NEAR OLIVER (08NM085)

Dates	Minimum flow rate m³/sec (cfs)
January 1st to end of February	2.83 m³/s (100 cfs)
March 1st to March 31st	3.51 m³/s (124 cfs)
April 1st to June 30th	2.83 m³/s (100 cfs)
July 1st to July 31st	3.91 m³/s (138 cfs)
August 1st to August 31st	3.74 m³/s (132 cfs)
September 1st to September 30th	2.86 m³/s (101 cfs)
October 1st to December 30th	2.83 m³/s (100 cfs)

Flow rates at this station have been reviewed for the period of June 2015 to December 2016. From these data, the following Figure 3-4 is presented as an illustration of typical river flow rates compared to the preferred range of flows in the Okanagan River (see Table 2-1) and the maximum operating capacity of the Town's Irrigation Canal (3.11 m³/sec). Data from this table has been reduced to the period of April 1, 2016 to October 31, 2016 to reflect the licensed operational period of the Town's Irrigation Canal.

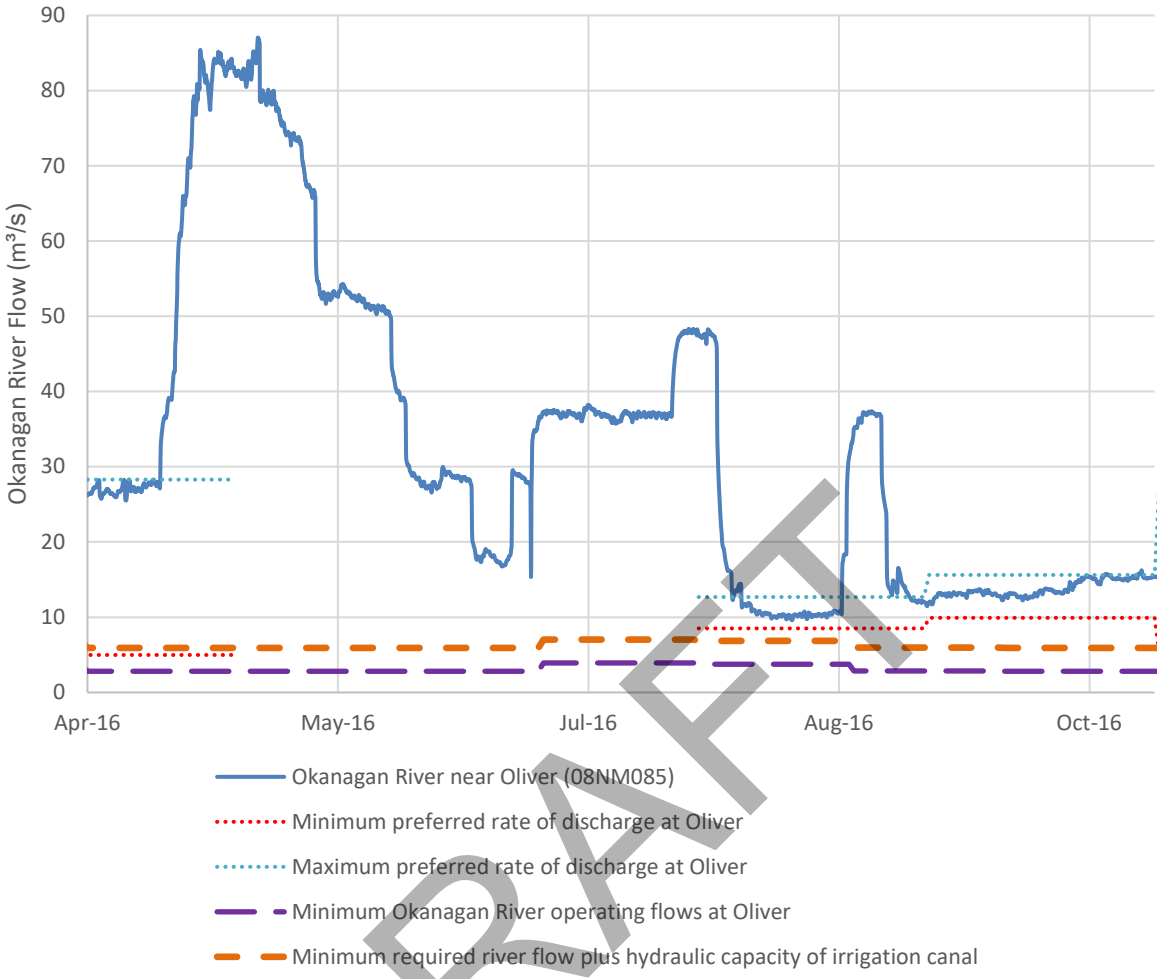

FIGURE 3-4: OKANAGAN RIVER FLOWS AT OLIVER (08NM085) - APRIL 1, 2016 TO OCTOBER 31, 2016

From the above figure:

- During the period of April 1, 2016 to October 31, 2016 the recorded Okanagan River flows near Oliver were found to be well above the minimum required operating flows.
- Adding the maximum operating capacity of the Town's Irrigation Canal (3.11 m³/sec) to the minimum required operating flows yields minimum required flows well below those recorded in the Okanagan River during this period. Therefore, if the Town utilized the maximum capacity of the Irrigation Canal for the full irrigation season, the minimum required flow in the Okanagan River would not have been compromised during this period. This result is encouraging for the continued success of the Town's Irrigation Canal as it indicates that maximizing the use of Irrigation Canal should not have a detrimental effect on flows in the Okanagan River.

Since 2016 was not considered to be a drought year, a similar analysis was conducted for the period of June 2, 2015 to October 31, 2015. This period represents available data for the 2015

Level 4 drought declared by the Province and is therefore indicative of flows that should be expected in the Okanagan River during periods of severe drought. The following Figure 3-5 is presented to illustrate Okanagan River flows in the period of June 2, 2015 to October 31, 2015.

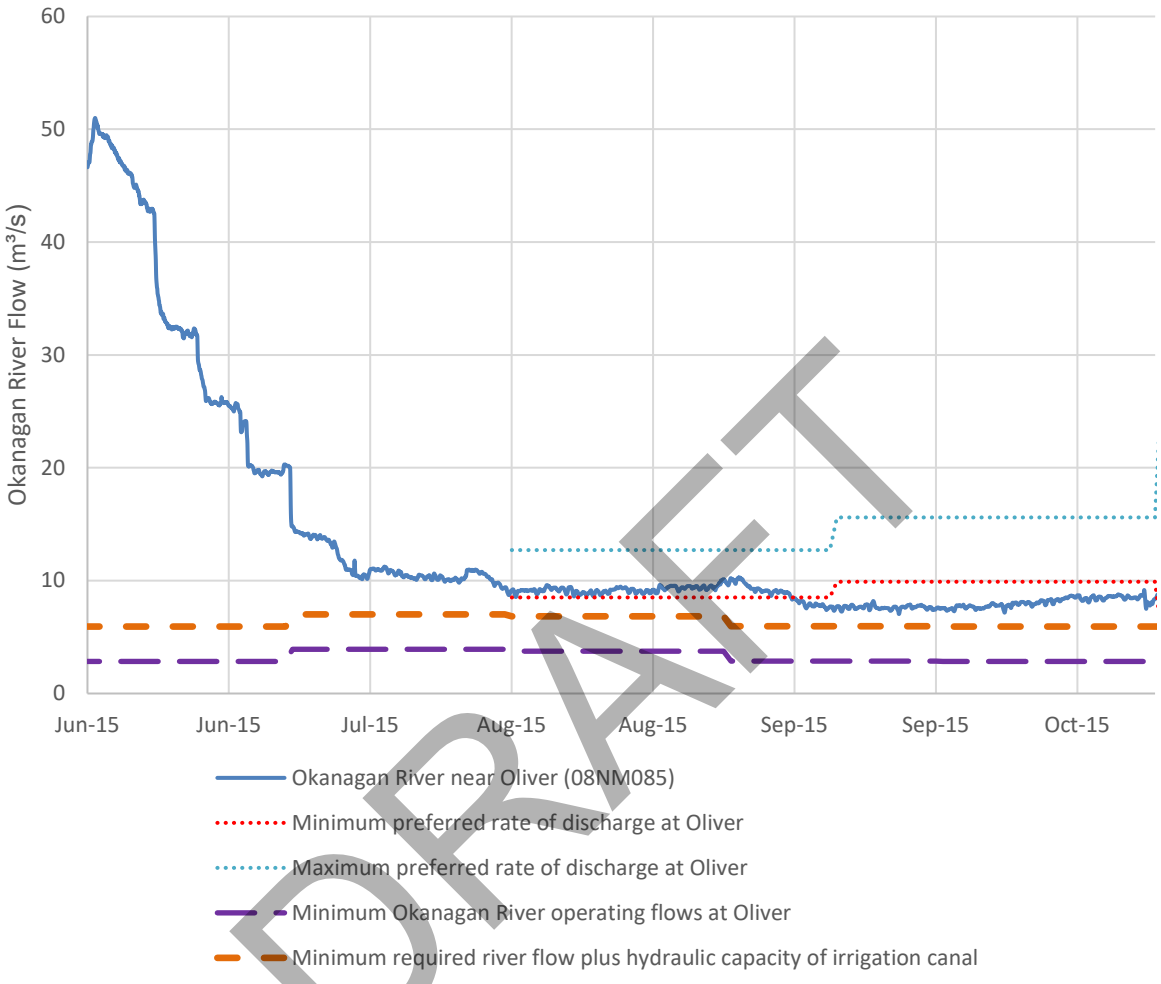

FIGURE 3-5: OKANAGAN RIVER FLOWS AT OLIVER (08NM085) - JUNE 2, 2015 TO OCTOBER 31, 2015

From the above figure:

- As with Figure 3-4, the recorded flow rate in the Okanagan River during the 2015 Level 4 drought was never lower than the minimum required operating flows. This analysis indicates that the OLRS will ensure that minimum flows are maintained in the Okanagan River during periods of severe drought.
- Okanagan River flows dropped below the preferred range (see Table 2-1) in this period. This effect is likely indicative of the severe drought conditions observed in the Okanagan Valley during this period.

4.0 Drought Forecast Approach

4.1 Groundwater Sources

As indicated in Section 3.1 above, the groundwater levels measured in the three Provincial observation wells can be used as secondary drought risk indicators. Although termed "secondary" the indicators could in theory be reached even if there is no Provincially declared drought.

Should the low water level indicator be reached at any of the three locations, the supplemental triggers, particularly those for Levels 3 and 4 drought risk, would alert the drought response team to increase monitoring of individual supply well output at the nearby associated wells (as shown in Table 3-1), and to monitor production well water levels to the extent possible and prepare to implement possible adaptive management strategies, such as shifting production from one area to another where low water level stress has not been reached.

4.2 Surface Water Sources

4.2.1 Okanagan Lake Levels

A purpose of this drought management plan is to forecast drought levels consistently with other water purveyors in the Okanagan Valley. OBWB's technical team has recommended that Okanagan Lake levels be utilized for this purpose. The justification for utilizing these targets is that the monitoring records for Okanagan Lake are readily available and that "the water required to satisfy the instream and withdrawal demands downstream of Okanagan Lake is primarily provided through releases from the lake." Monitoring the elevations of this lake provides an indication of the water volume available for release through OLRS works. Additionally, historical records of lake levels for the period since 1943 are readily available for Okanagan Lake. Therefore, an examination of these records by OBWB technical staff yielded target elevations which are considered indicative of drought conditions.

Table 4-1 provides a summary of the target, 20th percentile, 10th percentile, and 5th percentile elevations of Okanagan Lake at Kelowna for the critical period of July through November. This summary is consistent with the OBWB's October 2021 version 3 report entitled "Drought Trigger Guidelines for Okanagan Mainstem Lakes and River" which is provided via a link in *Appendix B* of this report. Utilization of these values as drought triggers will be discussed in Section 5.0. Real-time hydrometric data for the monitoring station at Kelowna can be found by visiting: http://wateroffice.ec.gc.ca/report/real_time_e.html?stn=08NM083.

TABLE 4-1: OKANAGAN LAKE ELEVATIONS (IN METRES GSC) ON 1ST OF THE MONTH

Month	Target Elevation	20th Percentile	10th Percentile	5th Percentile
July	342.44	342.227	342.046	341.981
August	342.24	342.097	341.929	341.869
September	342.04	341.950	341.802	341.667
October	341.89	341.796	341.655	341.511
November	341.84	341.681	341.575	341.421

(source: Monitoring Station 08NM083, Okanagan Lake at Kelowna, Period of Record - 1943-2021, Geodetic datum 340.236m and OBWB. 2021)

4.2.2 River Forecast Centre Bulletins

River flow forecasts are prepared by the Ministry of Water, Land and Resource Stewardship and are available through the RFC. The River Forecast Centre monitors, analyzes and models the streamflow conditions around the province by using a variety of scientific knowledge, methodologies, techniques and models with data input of snow surveys, weather and streamflow from BC Ministry of Environment, Environment Canada and other sources (source: MWLRS. 2024).

While the use of Okanagan Lake levels to forecast drought stages (see Section 4.2.1) is recommended to be consistent with other water purveyors in the Okanagan Valley, the Town should also routinely monitor Okanagan River flows. If at any time Okanagan River flows are forecasted to be less than the levels summarized in the following Table 4-2, the Town should proceed with declaring a Level 4 drought for irrigation users.

TABLE 4-2: MINIMUM OKANAGAN RIVER FLOWS AT MCINTYRE DAM TO MAINTAIN MAXIMUM HYDRAULIC CAPACITY OF IRRIGATION CANAL

Dates	Minimum flow rate m³/sec (cfs)
April 1st to June 30th	5.94 m³/s (210 cfs)
July 1st to July 31st	7.02 m³/s (248 cfs)
August 1st to August 31st	6.85 m³/s (242 cfs)
September 1st to September 30th	5.97 m³/s (211 cfs)
October 1st to December 30th	5.94 m³/s (210 cfs)

Related to the above table:

- As shown in Section 3.2, the OLRS manages flows in the Okanagan River and has shown to consistently maintain flow rates greater than those shown in the above table.
- In the event that flow rates in the Okanagan River approach the minimum threshold it is likely that the Province will independently mandate water usage restrictions. This effect, in combination with the highly controlled nature of flows in the Okanagan River, indicates that drought forecasting utilizing Okanagan River flows may not be an effective drought management method.

- As previously stated, if Okanagan River flows drop below the minimum flow rates at McIntyre Dam the Town should immediately declare a Level 4 drought. Note that, as shown in Figure 3-5, minimum flow rates were not observed during the 2015 Level 4 drought. Therefore, these thresholds may be indicative of an extended period of drought, and it can be concluded that if this event does occur it will likely coincide with the Province mandating Level 4 drought restrictions (see Section 4.2.3).

4.2.3 Provincial Drought Declarations

As per the Government of British Columbia:

> *"water users, whether licensed or not, are required to use water as efficiently as practicable. When voluntary conservation measures are not sufficient to meet all water rights, or to protect critical environmental flows or the survival of a fish population, the Water Sustainability Act (WSA) provides authority for statutory officials, under specified conditions, to regulate water diversion, use (and storage) by users of both stream water and groundwater. When this regulatory action is required, it can now involve groundwater users even if they do not have an authorization."*

Consistent with the above statement, the Province has prepared a Drought Response Plan which outlines specific responses during drought events with the goal of protecting water rights and protecting critical environmental flows. The following Table 4-3 summarizes each level of the Province's drought classification system along with associated drought response targets.

It is important to note that the Province's drought triggers vary greatly from the drought triggers presented in this report. Per a primer handout from OBWB, "*Local decisions on appropriate water restriction stages are not required to match the "Provincial Drought Levels," which are determined at a regional scale. That said, water restriction stages and provincial drought levels will tend to both increase as drought worsens.*"

The Town of Oliver recognizes that a regional drought declaration should be considered along with the local triggers presented in this report. The following Section 5.0 discusses this subject in further detail.

TABLE 4-3: PROVINCIAL DROUGHT LEVEL CLASSIFICATION (2023 UPDATE)

Level	Conditions	Impacts	General Response Measures
0 (Green)	conditions are average or wetter than average	There is sufficient water to meet socioeconomic and ecosystem needs	Preparedness actions
1 (Yellow)	conditions are starting to become dry	Adverse impacts to socio-economic or ecosystem values are rare	Conservation actions
2 (Peach)	conditions are becoming very dry	Adverse impacts to socio-economic or ecosystem values are unlikely	Conservation actions including local water restrictions where appropriate
3 (Orange)	conditions are becoming severely dry	Adverse impacts to socio-economic or ecosystem values are possible	Conservation actions including local water restrictions where appropriate
4 (Red)	conditions are extremely dry	Adverse impacts to socio-economic or ecosystem values are likely	Conservation actions including local water restrictions and regulatory action where appropriate
5 (Maroon)	conditions are exceptionally dry	Adverse impacts to socio-economic or ecosystem values are almost certain	Conservation actions including local water restrictions, regulatory action and emergency response measures where appropriate

(source: Province of British Columbia. 2023)

5.0 Drought Stages

The following sections describe the specific conditions under which the Drought Management Plan will be implemented. This section is summarized in Table 5-1.

TABLE 5-1: DROUGHT RESPONSE STATUS MATRIX

Status	Normal	Stage 1 - Dry	Stage 2 - Very Dry	Stage 3 - Extremely Dry	Stage 4 - Emergency
Groundwater Supply Trigger Factors	Groundwater supply is at or above normal levels.	The groundwater level in any of the three Provincial observation wells reaches the average / typical seasonal low water level for one week or more (OW 405 ≥ 18.7 bgs, OW 407 ≥ 11.7 bgs, OW 332 ≥ 18.0 bgs).	The groundwater level in any of the three Provincial observation wells reaches the average or typical seasonal low water level and remains at or below this level for four weeks or more (OW 405 ≥ 18.7 bgs, OW 407 ≥ 11.7 bgs, OW 332 ≥ 18.0 bgs).	The groundwater level in any of the three Provincial observation wells falls 0.5m below the historical low water level and remaining at or below this level for two weeks or more (OW 405 ≥ 20.5 bgs, OW 407 ≥ 12.35 bgs, OW 332 ≥ 19.1 bgs).	The groundwater level in any of the three Provincial observation wells falls 0.5m below the historical low water level and remaining at or below this level for four weeks or more (OW 405 ≥ 20.5 bgs, OW 407 ≥ 12.35 bgs, OW 332 ≥ 19.1 bgs).
Surface Water Supply Trigger Factors	Surface water supply is at or above normal levels.	The Okanagan Lake levels at Kelowna are less than the month beginning target elevations and equal to or greater than the historic 20th percentile month beginning elevations (utilize the measured value plus the geodetic datum of 340.236m).	The Okanagan Lake levels at Kelowna are less than the historic 20th percentile month beginning elevations and greater than or equal to the 10th percentile month beginning elevations (utilize the measured value plus the geodetic datum of 340.236m).	The Okanagan Lake levels at Kelowna are less than the historic 10th percentile month beginning elevations and greater than or equal to the 5th percentile month beginning elevations (utilize the measured value plus the geodetic datum of 340.236m).	The Okanagan Lake levels at Kelowna are lower than the historic 5th percentile month beginning elevations (utilize the measured value plus the geodetic datum of 340.236m).
Domestic Water Demand Goal	Encourage water conservation through measures presented in the Town's Water Conservation Plan.	Minimum 10% domestic usage reduction.	Minimum additional 20% domestic usage reduction to a minimum total of 30%.	Reduce domestic usage to maintain critical water supply (50% reduction).	Maintain minimum domestic water supply to maintain basic community health and safety (90% reduction).
Irrigation Water System Goal		Target 10% irrigation usage reduction	Target additional 20% irrigation usage reduction to a minimum total of 30%.	Reduce irrigation usage to maintain minimum crop yields (50% reduction).	Reduce irrigation canal flows to maintain minimum Okanagan River flows.
Corresponding Domestic System Drought Restrictions	Water conservation measures promoted by the Town.	Stage 1 Domestic Restrictions, characterized by reduced lawn and garden sprinkling to 3 days per week.	Stage 2 Domestic Restrictions, characterized by reduced lawn and garden sprinkling and other outdoor water use to 2 days per week.	Stage 3 Domestic Restrictions, characterized by severe restrictions in outdoor water use to one day per week.	Stage 4 Domestic Restrictions, characterized by a prohibition of outdoor water use.
Corresponding Irrigation System Drought Restrictions		Stage 1 Irrigation Restrictions, characterized by voluntary water conservation.	Stage 2 Irrigation Restrictions, characterized by voluntary water conservation.	Stage 3 Irrigation Restrictions, characterized by restrictions and regulatory action as mandated by Province of British Columbia.	Stage 4 Irrigation Restrictions, characterized by restrictions and regulatory action as mandated by Province of British Columbia.
Communication and Enforcement	Normal levels of communication with water users.	Heightened awareness by Town's drought response team.	High level of education and communication directed towards high domestic system water users.	High level of education and communication directed towards all water users. Town's drought response team directed to begin enforcement of domestic and/or irrigation system outdoor water use restrictions.	High level of education and communication maintained. All Town staff currently available will be used for enforcement of domestic and/or irrigation system outdoor water use restrictions.
The data relating to OW 405, OW 407 and OW 332 is available online using the B.C. Provincial Observation Well Network interactive mapping tool which can be found by visiting: http://www.env.gov.bc.ca/wsd/data_searches/obswell/map/ Real-time hydrometric data for the monitoring station at Kelowna (WM08NM083) can be found by visiting: http://wateroffice.ec.gc.ca/report/real_time_e.html?stn=08NM083.					

5.1 Normal / Stage 0 (No Drought, Average, or Wet Years)

The Normal status is defined as water sources being at or above target levels. In this stage, water conservation measures as presented in the Town's Water Conservation Plan would be encouraged for both domestic and irrigation water system users. From a drought perspective, water conservation measures should always be encouraged during Normal status to reduce the likelihood of moving to Stage 1 drought status.

The following Figure 5-1 illustrates the Town's Stage 0 Water Restrictions (From the Town's Water Restrictions Guide).

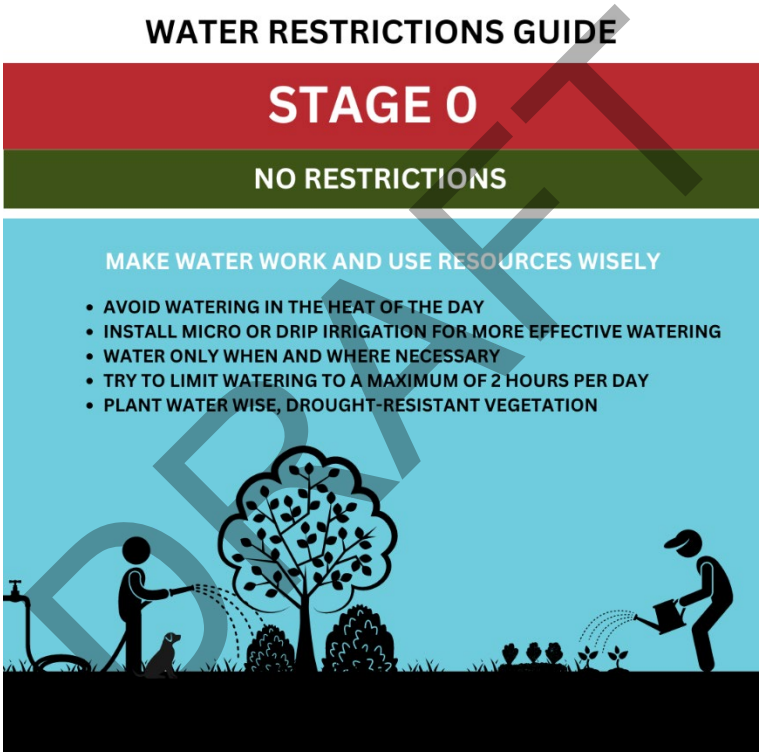

FIGURE 5-1: TOWN OF OLIVER WATER RESTRICTIONS - STAGE 0 (NORMAL)

5.2 Stage 1 – Dry (Mild Drought)

The Stage 1 status is representative of mild drought conditions. If this stage is encountered early in the year, it may be indicative of future water shortages. Management practices for this stage of a drought include public awareness and encouraging voluntary water usage reductions with the goal of reducing consumption by 10% overall by way of restricting domestic system outdoor water usage to a maximum of three (3) days per week. The Town's drought response team would also be made aware that a Stage 1 status has been declared and that further actions may be necessary if the Town moves to a Stage 2 status.

Triggers associated with each water source (i.e., groundwater and surface water) are as follows for a Stage 1 status.

Status Triggers Associated with Groundwater Sources

A supplemental trigger for Stage 1 would be the groundwater level in any of the three Provincial observation wells reaches the average / typical seasonal low water level (proposed in Table 3-1) for one week or more.

Status Triggers Associated with Surface Water Sources

As per recommendations presented by the OBWB, the target for moving to a Stage 1 drought status is as follows: The forecast or actual month beginning elevations of Okanagan Lake at Kelowna for the months July through November are less than the historic month beginning target elevations and equal to or greater than the 20th percentile month beginning elevations (see Table 4-1).

The Town will also consider moving to a Stage 1 drought status if the Province declares a Level 1 drought in the Okanagan region.

The following Figure 5-2 illustrates the Town's Stage 1 Water Restrictions (From the Town's Water Restrictions Guide).

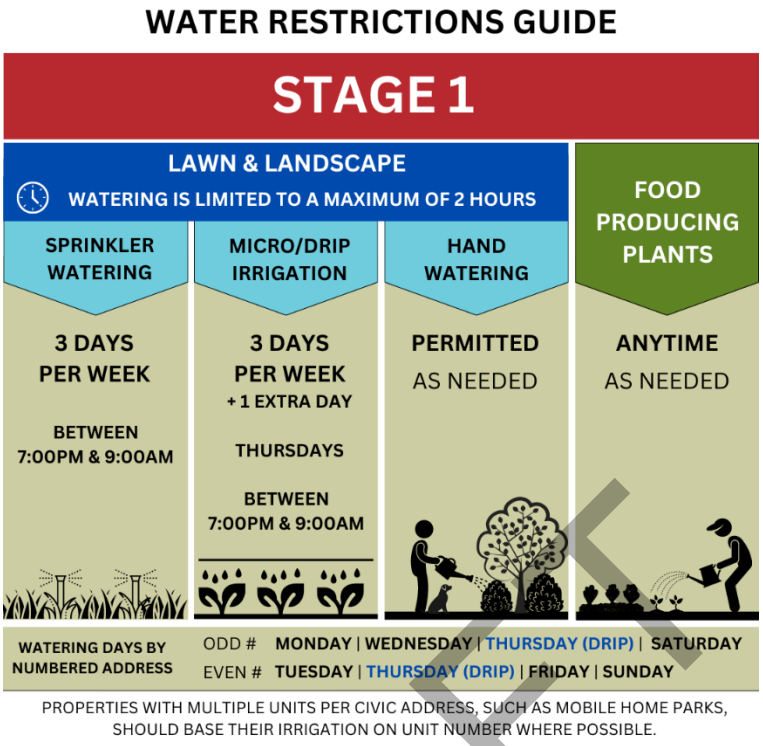

FIGURE 5-2: TOWN OF OLIVER WATER RESTRICTIONS - STAGE 1

5.3 Stage 2 – Very Dry (Moderate Drought)

The Stage 2 status is representative of very dry conditions. Management practices for this stage of a drought include reduced outdoor water use with the goal of reducing water consumption by 30% overall by way of restricting domestic system outdoor water usage to a maximum of two (2) days per week. The Town's drought response team would be in contact with high water users to promote voluntary usage reductions.

Triggers associated with each water source (i.e., groundwater and surface water) are as follows for a Stage 2 status.

Status Triggers Associated with Groundwater Sources

A supplemental trigger for Stage 2 would be the groundwater level in any of the three Provincial observation wells reaches the average or typical seasonal low water level (Table 3-1) for the period of record and remains at or below this level for four weeks or more.

Status Triggers Associated with Surface Water Sources

As per recommendations presented by the OBWB, the target for moving to a Stage 2 drought status is as follows: The forecast or actual month beginning elevations of Okanagan Lake at

Kelowna for the months July through November are less than the historic 20th percentile month beginning elevations and greater than or equal to the 10th percentile month beginning elevations (see Table 4-1).

The Town will also consider moving to a Stage 2 drought status if the Province declares a Level 2 drought in the Okanagan region.

The following Figure 5-3 illustrates the Town's Stage 2 Water Restrictions (From the Town's Water Restrictions Guide).

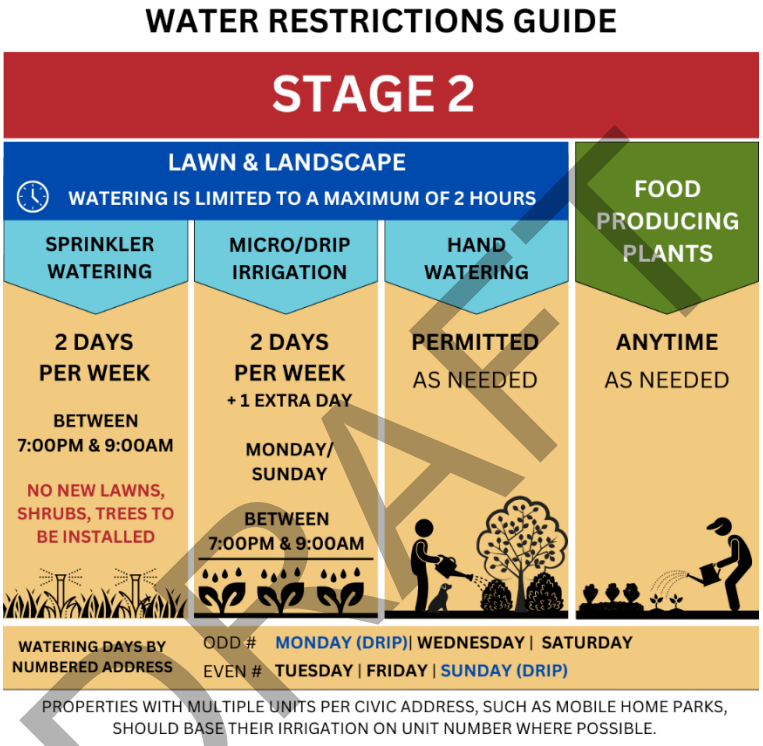

FIGURE 5-3: TOWN OF OLIVER WATER RESTRICTIONS - STAGE 2

5.4 Stage 3 – Extremely Dry (Severe Drought)

The Stage 3 status is representative of extremely dry conditions. Management practices for this stage of a drought include severe restrictions related to outdoor water use for the domestic water system by way of restricting domestic system outdoor water usage to a maximum of one (1) day per week. The Town would also not mandate any usage restrictions for irrigation users unless mandated by the Province. The Town's drought response team would begin enforcement of outdoor water restrictions for the domestic system and for the irrigation system if directed by the Province. Moderate fines would be imposed in the event of non-compliance.

Triggers associated with each water source (i.e., groundwater and surface water) are as follows for a Stage 3 status.

Status Triggers Associated with Groundwater Sources

A supplemental trigger for Stage 3 would be the groundwater level in any of the three Provincial observation wells falling 0.5 m below the historical low water level (Table 3-1) and remaining at or below this level for two weeks or more.

Status Triggers Associated with Surface Water Sources

As per recommendations presented by the OBWB, the target for moving to a Stage 3 drought status is as follows: The forecast or actual month beginning elevations of Okanagan Lake at Kelowna for the months July through November are less than the historic 10th percentile month beginning elevations and equal to or greater than or equal to the 5th percentile month beginning elevations (see Table 4-1).

The Town will also consider moving to a Stage 3 drought status for the following reasons:

- If the Province declares a Level 3 or Level 4 drought in the Okanagan region.
- If one or more municipal or irrigation water system pumps are not functioning.

The following Figure 5-4 illustrates the Town's Stage 3 Water Restrictions (From the Town's Water Restrictions Guide).

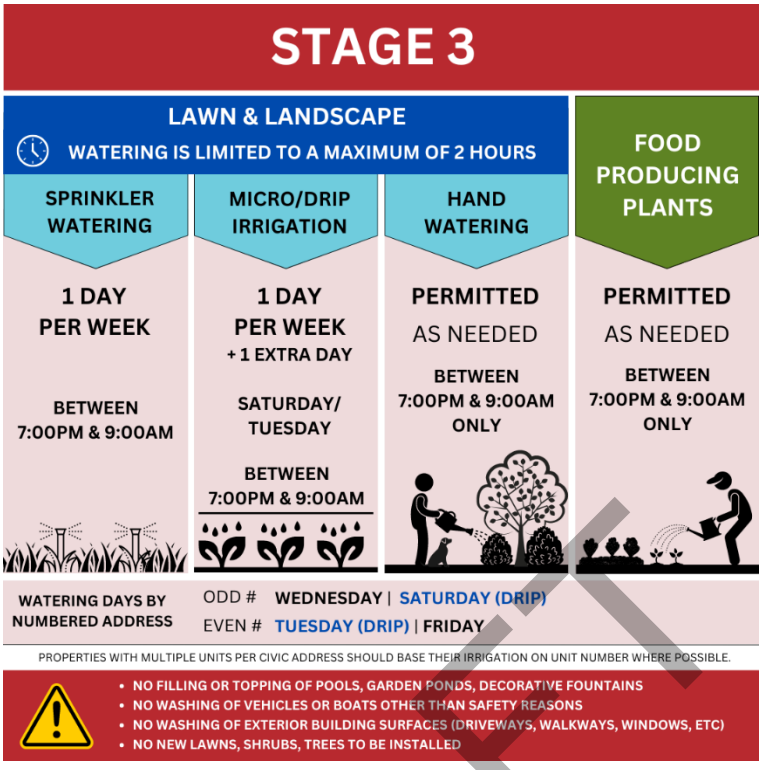

FIGURE 5-4: TOWN OF OLIVER WATER RESTRICTIONS - STAGE 3

5.5 Stage 4 – Emergency

The Stage 4 status is representative of emergency conditions and the potential for compromised fire protection and a loss of source water supply. Management practices for this stage of a drought include a prohibition of outdoor water use for the domestic water system. The Town would also not mandate any usage restrictions for irrigation users unless mandated by the Province or if Okanagan River flows are found to be inadequate. At this stage of a drought all available Town staff would be utilized for enforcement of outdoor water restrictions for the domestic system and for the irrigation system if directed by the Province. Moderate fines or disconnection from the water system would be imposed in the event of non-compliance.

Triggers associated with each water source (i.e., groundwater and surface water) are as follows for a Stage 4 status.

Status Triggers Associated with Groundwater Sources

A supplemental trigger for Stage 4 would be the groundwater level in any of the three Provincial observation wells falling 0.5 m below the historical low water level (Table 3-1) and remaining at or below this level for four weeks or more.

Status Triggers Associated with Surface Water Sources

As per recommendations presented by the OBWB, the target for moving to a Stage 4 drought status is as follows: The forecast or actual month beginning elevations of Okanagan Lake at Kelowna for the months July through November are lower than the historic 5th percentile month beginning elevations.

The Town will also consider moving to a Stage 4 drought status for the following reasons:

- If the Province declares a Level 5 drought in the Okanagan region.
- If one or more municipal or irrigation water system pumps are not functioning.
- If, at Oliver (08NM085), Okanagan River flows are below the minimum required plus the hydraulic capacity of the irrigation canal.
- If a local state of emergency has been declared by Town Council.

The following Figure 5-5 illustrates the Town's Stage 4 Water Restrictions (From the Town's Water Restrictions Guide).

FIGURE 5-5: TOWN OF OLIVER WATER RESTRICTIONS - STAGE 4

5.6 Sequence of Drought Stages

The following flow chart illustrates how the Town will proceed throughout the various stages of drought declarations.

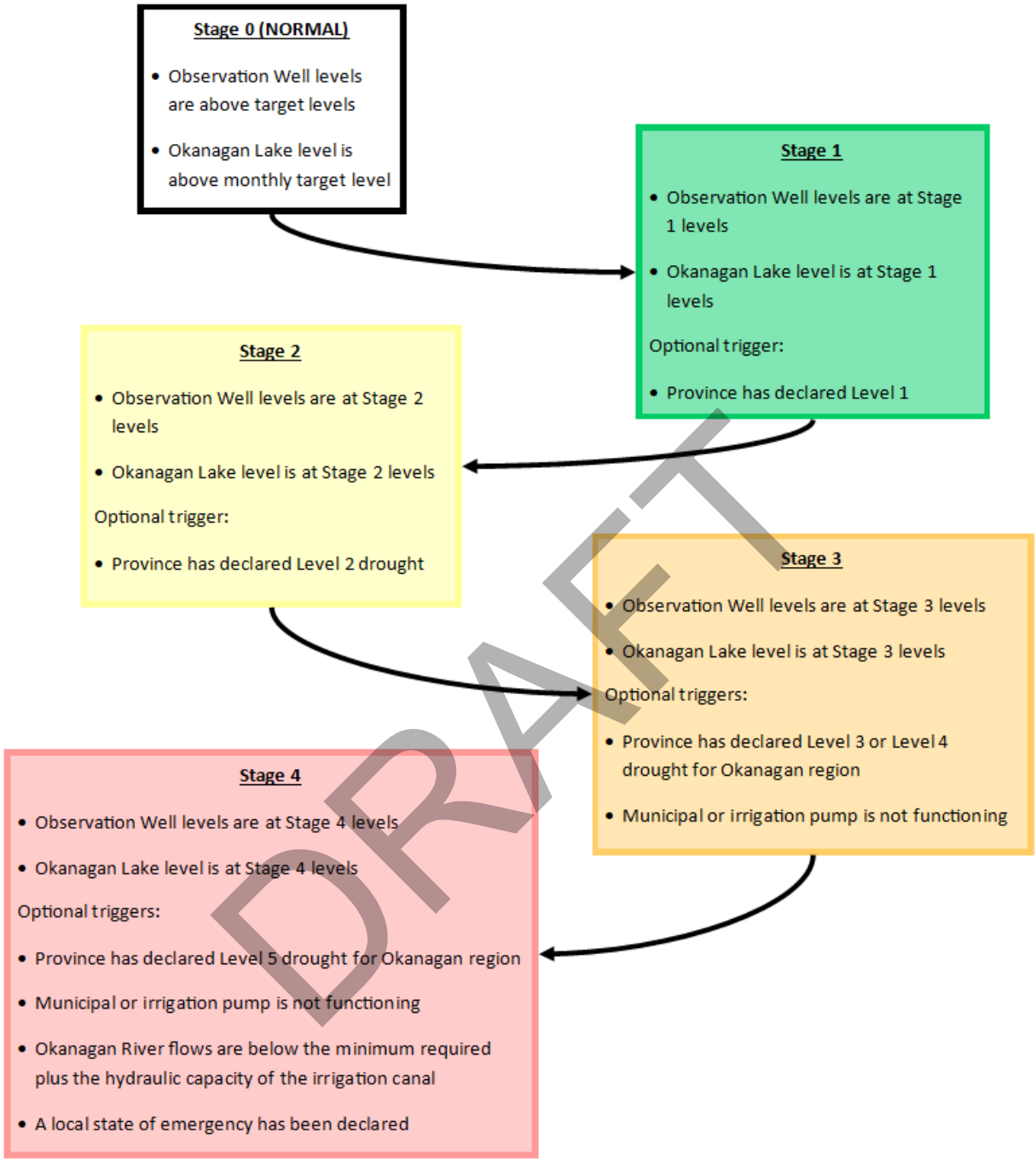

FIGURE 5-6: SEQUENCE OF DROUGHT STAGES FOR TOWN OF OLIVER

6.0 Drought Plan Implementation (Drought Response Plan)

From Table 5-1, the Town's domestic system water restrictions aim for a range of approximately 10% reduction during a Stage 1 drought to 90% usage reduction during a Stage 4 drought. To achieve this level of domestic system water usage reductions, the following outdoor watering restrictions are proposed:

- Stage 1: Outdoor watering (not associated with agricultural irrigation) is allowed 3 days per week.
- Stage 2: Outdoor watering (not associated with agricultural irrigation) is allowed 2 days per week.
- Stage 3: Outdoor watering (not associated with agricultural irrigation) is allowed 1 day per week.
- Stage 4: Moratorium on outdoor water use (not associated with agricultural irrigation).

The following sections are presented to aid the Town with achieving the above drought management plan objectives. These sections include:

- Outlining the Town's personnel resources available during drought conditions.
- Forms of communication that the Town will utilize during drought conditions.
- Methods that Town staff will utilize to determine drought stages.
- Conducting annual water supply assessments and annual water supply plans each spring.
- Operational measures that the Town will utilize in the event of severe drought conditions.

It should be noted that this Response Plan applies to all water supplied by the Town, but does not apply to the use of rainwater, gray water, recycled, reclaimed water or other sources of water outside the domestic and irrigation systems. The use of alternative sources of water such as those listed above should be encouraged by the Town since these alternative sources may assist with limiting the effects of drought conditions.

6.1 Drought Response Team

The Town's drought response team is listed in the following Table 6-1. As per Table 5-1, the drought response team will be responsible for varying degrees of enforcement between drought Stages 1 and 4. The Director of Operations is responsible for implementation of each stage of the drought response matrix.

TABLE 6-1: DROUGHT RESPONSE TEAM

Personnel	Task
Director of Operations	Implementation of drought response plan.
Engineer Technologist	Monitoring of Okanagan Lake and Observation Well Levels.
Public Works Clerk	Work with Engineer Technologist and implementation of notifications as necessary.
Utility Operators	Provide high users with notifications and provide enforcement services.

6.2 Communications

The following Table 6-2 outlines the Town's drought management communications strategy.

TABLE 6-2: DROUGHT MANAGEMENT COMMUNICATIONS STRATEGY

Drought Level	Domestic System	Irrigation System
Normal	▪ Website notifications promoting water conservation	
Stage 1	▪ Website notifications limiting outdoor watering to 3 days per week. ▪ Signage on Main Street.	▪ Website notifications promoting water conservation
Stage 2	▪ Website notifications limiting outdoor watering to 2 days per week. ▪ Signage on Main Street. ▪ Letters sent to high water users.	▪ Website notifications promoting water conservation
Stage 3	▪ Website notifications limiting outdoor watering to 1 day per week. ▪ Signage on Main Street. ▪ Drought response team begins enforcement through individual user visits.	▪ Website notifications promoting water conservation ▪ Drought response team begins enforcement through individual user visits if mandated by the Province.
Stage 4	▪ Website notifications informing users of outdoor water use moratorium. ▪ Signage on Main Street. ▪ All available staff utilized for enforcement.	▪ Website notifications providing a schedule of rolling pumphouse shutdowns through each irrigation system, as necessary. ▪ All available staff utilized for enforcement if mandated by the Province.

6.3 Monitoring and Supply Planning

Okanagan Lake Levels

Okanagan Lake water levels measured at Kelowna (Monitoring Station 08NM083) should be monitored on an ongoing basis during periods of potential drought and increased to daily monitoring during drought conditions. It will be the responsibility of the Director of Operations to implement each stage of the drought response matrix if lake levels are found to be lower than the elevations specified in Table 4-1. Real-time hydrometric data for the monitoring station at Kelowna (WM08NM083) can be found by visiting:

http://wateroffice.ec.gc.ca/report/real_time_e.html?stn=08NM083.

Okanagan River Flows

As per Figure 3-5, during the 2015 Level 4 Drought the Okanagan River was found to never be lower than the minimum required operating flows necessary for maintaining aquatic and riparian ecosystem needs while also continuing to provide source water for the Town's Irrigation Canal. Therefore, for the purposes of this report, it is concluded that the OLRS will maintain minimum flow requirements in the Okanagan River and the Town should not establish drought targets based on Okanagan River flows. Further to this point, if minimum flow requirements are not achieved in the Okanagan River, it can be assumed that the Province will have mandated Level 4 Drought Conditions.

Groundwater levels

To the greatest extent possible, monitor Town well water levels during Stages 1 to 4. Increase the frequency of monitoring from weekly in Stages 1 to 3 to daily during Stage 4 and report any abnormally low water levels or reduced production from any well to the drought response team. Check water levels in the associated Provincial observation wells on the same frequency. The data relating to OW 405, OW 407 and OW 332 is available online using the B.C. Provincial Observation Well Network interactive mapping tool which can be found by visiting:

http://www.env.gov.bc.ca/wsd/data_searches/obswell/map/

Each year, ideally in the early spring, the Town's drought response team should complete a supply assessment based upon monitored conditions such as snowpack and forecasted river runoff. This assessment can then be used to inform an Annual Supply Plan that is based on presumed scenarios, such as normal year to maximum Stage 1 drought; Stage 1 to 2 drought; and Stage 3 to 4 drought conditions. This plan can be implemented in concert with demand management and other adaptive management measures.

6.4 Operational Measures During Severe Drought

Surface Water Sources

If severe surface water shortages are impacting the supply from the Irrigation Canal, commence rolling shut down of irrigation system pumphouses. The rolling shut down would sequentially provide irrigation water to each irrigation system within the Town's boundaries and would ensure that system users do not have access to irrigation water for as short a period as possible.

Groundwater Sources

If severe low groundwater levels are impacting or have the potential to impact the supply from one or more of the Town's wells, shift production to other parts of the system to even out the demand across systems in order to maintain adequate water levels. Avoid depending on only one or two well sources, especially during Stages 3 and 4.

7.0 Drought Plan Updates

The drought triggers presented in Section 5.0 have been recommended by the OBWB's technical team of experts in the field of drought management. These drought triggers were recommended as quantifiable indicators of Valley-wide drought conditions which can easily be utilized by each water purveyor in the Okanagan Valley. To these triggers, we have added the suggested secondary indicator / trigger of groundwater levels in Provincial observation wells. Using the observation wells as potential drought index wells is recommended not just for Oliver, but for the entire Okanagan valley. The recommended approach is to develop statistics that would define "normal" as water levels between the 25th and 75th percentile of monthly mean water levels, "below normal" as 24th percentile and below, and "above normal" as 76th percentile and above. Ideally, this information would be accessible using the same or similar existing interactive mapping application. Observation wells could also be colour-coded on the map based on the drought index condition (i.e., below normal, normal or above normal).

A further recommendation by the OBWB is that each water purveyor test the recommended drought triggers to help determine their effectiveness. It is of utmost importance that drought response plans are consistent with observed drought conditions in each community. If not, individual water users may begin to ignore these declarations and will not recognize the importance of water conservation during periods of drought.

Therefore, the Town should review the drought response plan triggers on an ongoing basis. These triggers should be discussed with OBWB to determine the effectiveness of the recommended triggers and whether new triggers should be recommended. If the recommended triggers prove to not be an effective drought management method, the Town should recommend triggers that more closely resemble conditions of water supply sources for the Town's irrigation and domestic water systems.

8.0 References

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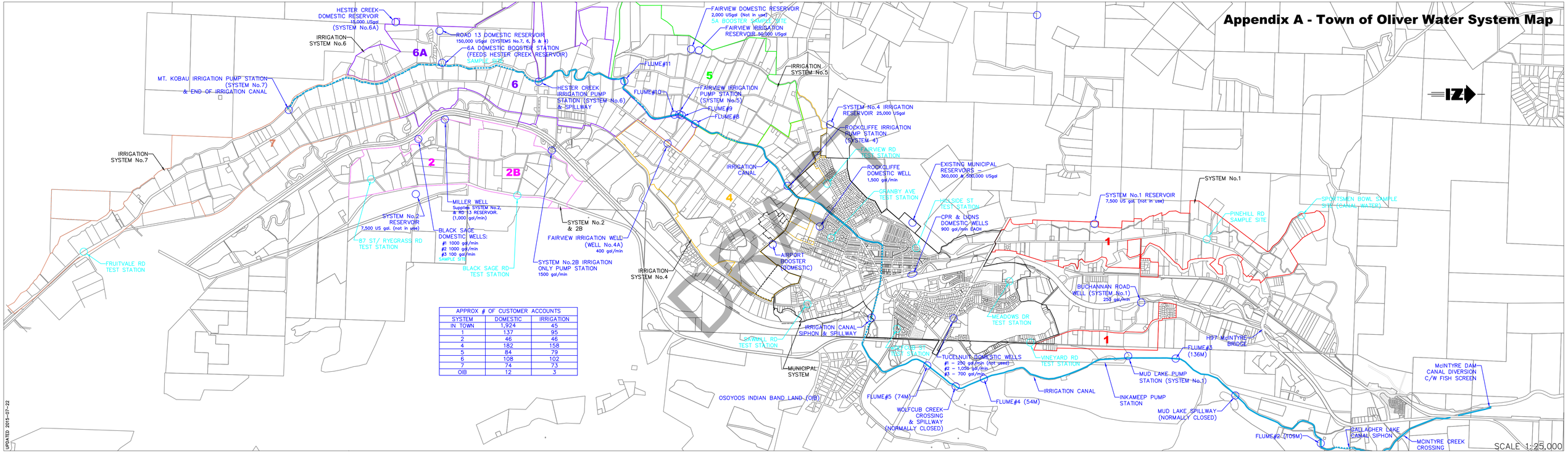
APPENDIX A

Town of Oliver Water System Map and Oliver Area Aquifer Map

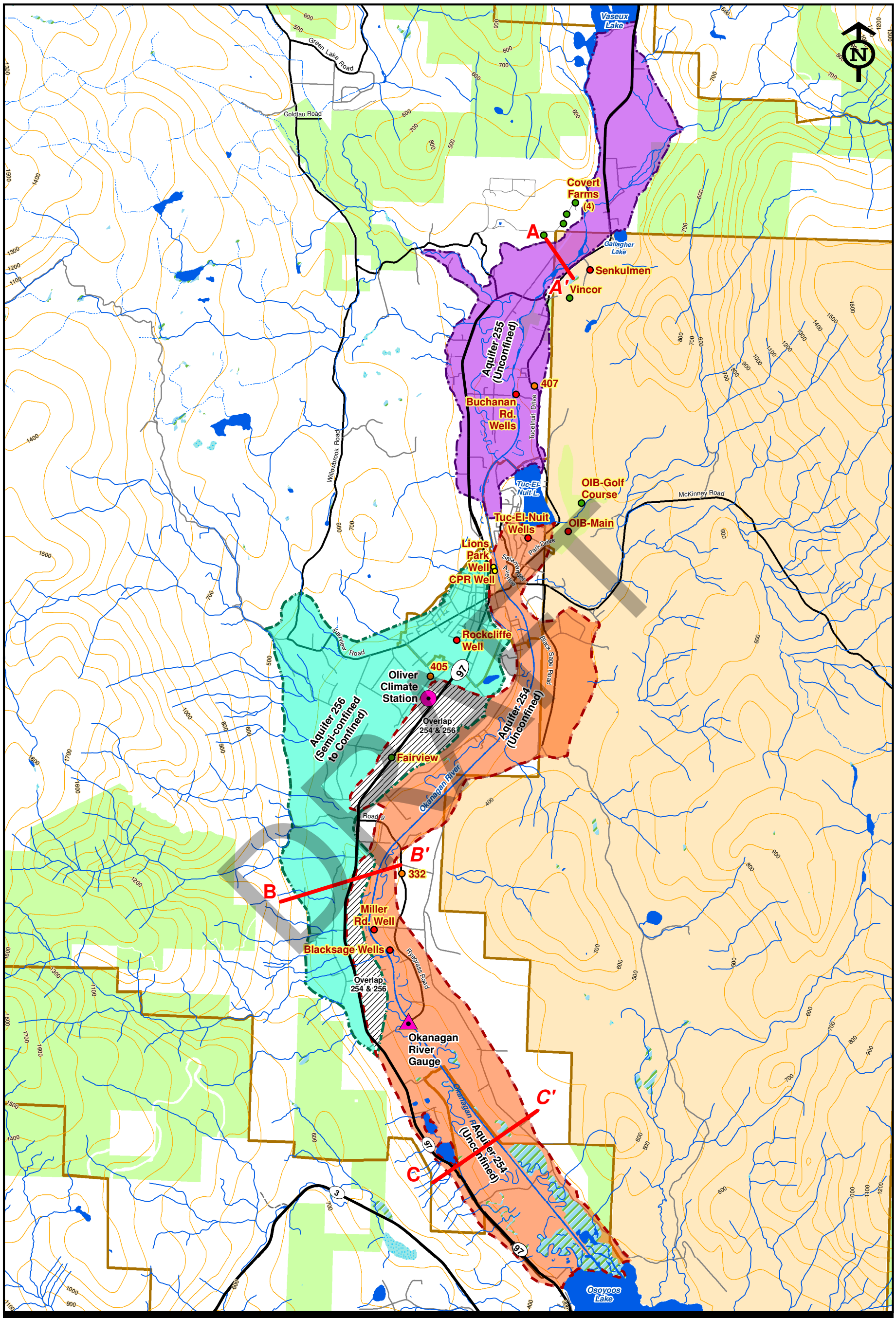
Appendix A - Town of Oliver Water System Map



APPROX # OF CUSTOMER ACCOUNTS		
SYSTEM	DOMESTIC	IRRIGATION
IN TOWN	1,924	45
1	137	95
2	46	46
4	182	158
5	84	79
6	108	102
7	74	73
OIB	12	3

UPDATED 2015-07-22

SCALE 1:25,000



LEGEND

- Aquifer 254
- Aquifer 255
- Aquifer 256
- Overlap 309.4 Ha
- First Nations
- BC Parks
- Golf Courses
- Municipal Parks
- Railway
- Elevation (100m)
- Rivers / Streams
- Intermittent
- Indefinite
- Water Body
- Indefinite Lk.
- Wetlands

Figure 2: Mapped Aquifers and Selected Wells
Monthly Groundwater Budget for Oliver Area Aquifers

Domestic · Irrigation · Deactivated · Observation

Okanagan River Gauge (Stn. 08NM085) · Oliver Climate Station

1 0.5 0 1 2 3 4

Kilometres

Data Sources and Disclaimers

Date: May 18 2016
Map Created By: Geo Earth Mapping
Map Reviewed By: D.G.
Project #: 16-004-01
File: 16-004.01-Fig2.mxd
Coordinate System: NAD 83 UTM Zone 11N

western water ASSOCIATES LTD
Consultants in Hydrogeology and Environmental Science

Source data provided by DataBC and Geogratis. The data used in these maps does not originate from legally recorded surveys. It is part of a GIS database system which may contain errors and/or omissions and is subject to change, therefore accuracy cannot be guaranteed.

APPENDIX B

OBWB - Drought Stage Trigger Guidelines for Okanagan Mainstem Lakes and River

Please Visit:

https://www.obwb.ca/newsite/wp-content/uploads/obwb_mainstem_drought_triggers_report_v3_22june2021.pdf

APPENDIX C

Town of Oliver – Annual Water Reports (2016 to 2023)

Please Visit:

2016: https://www.oliver.ca/sites/oliver.ca/files/2022-03/2016-Annual-Water-Report.pdf

2017: https://www.oliver.ca/sites/oliver.ca/files/2022-03/2017-Annual-Water-Report.pdf

2018: https://www.oliver.ca/sites/oliver.ca/files/2022-03/2018-Annual-Water-Report.pdf

2019: https://www.oliver.ca/sites/oliver.ca/files/2022-03/2019-Annual-Water-Report.pdf

2020: https://www.oliver.ca/sites/oliver.ca/files/2022-03/2020-Annual-Water-Report-Final.pdf

2021: https://www.oliver.ca/sites/oliver.ca/files/2023-04/2021%20Annual%20Water%20Report%20-%20Final.pdf

2022: https://www.oliver.ca/sites/oliver.ca/files/2023-04/2022%20Annual%20Water%20Report%20-%20Final.pdf

2023: https://www.oliver.ca/sites/oliver.ca/files/2024-04/2023%20Annual%20Water%20Report.pdf