KERR WOOD LEIDAL
consulting engineers

Kootenays
302 - 625 Front Street
Nelson, BC V1L 4B6
T 250 352 3404

Water Metering Study

Final Report
August 2019
KWL Project No. 0758.002

Prepared for:
Ootischenia Improvement District

Contents

Figures

Tables

1. Purpose and Scope

The Ootischenia Improvement District (OID) is a growing community in the south Kootenay region of British Columbia with authority over treatment and delivery of its own water supply. OID is committed to providing safe, high quality water services to the community, while maintaining a standard of excellence in customer service and environmental conservation. As the community continues to grow, OID must ensure the long-term sustainability of its water resources. To ensure sustainability, OID is considering implementation of universal water metering on all connections in the community. To assist with decision making, OID requires a practical, need-based water metering assessment that includes a cost-effectiveness review of options for customer metering, and recommendations that consider OID's specific context and needs.

This report provides a summary of the water metering assessment methods and results, a review of advantages and disadvantages for water metering as well as recommendations for or against implementing a water metering program and ultimately for ensuring sustainability of OID's water supply.

2. Population

To assist with projection of water demands and the potential impact of water metering, the current and future population of OID was estimated.

2.1 Current Population

- From Statistics Canada census data and information from the OID water committee, the existing population of OID was estimated to be 1080 people with 419 current active residential connections.
- From OID data, there are 9 institutional, commercial or industrial (ICI) active connections in OID. Water consumption from these ICI sources is estimated as equivalent to 18 additional people.
- From OID data, there are currently 147 inactive or dormant connections in OID.
- The maximum system capacity is approximately 600 total connections. With 428 active connections and 147 dormant or inactive connections, this leaves 25 additional remaining connections available in OID.

Estimates for the existing population are summarized in Table 1.

Table 1: Existing Population

Number of Active Connections	Current Population	Available Connections
Residential[1]	Residential[2]	Total Available
419	1080	600
ICI[1]	ICI (Population Equivalent)[3]	Inactive or Dormant
9	18	428 + 147
Total	Total	Remaining Available
428	**1098**	**25**

1. OID data
2. Statistics Canada, 2017
3. Estimated from OID water meter data and information about the types of ICI connections.

2.2 Projected Population

- Using trends in Statistics Canada data between 2001 and 2016, the projected population of OID in 2050 is estimated to be 1910 people with 740 residences.
- From data trends, it is estimate that there will be 16 ICI connections in 2050. Water consumption from these ICI sources is estimated as equivalent to 32 additional people.
- There are margins of uncertainty inherent with projecting populations. Trend analysis suggests that the future population may be as high as 2,500 people and as low as 1,420 people.
- The 2007 Capital Expenditure Report for OID indicated a 20 year build out of 1200 lots based on ½ acre (2025 m^2) lot restrictions. Assuming 2.5 people per lot (as is current density), this translates to a maximum build-out population of 3000 people, which is higher than is predicted based on trend analysis. Therefore, land availability is not considered a restriction for population growth in this assessment.

An illustration of population growth trends is provided in Figure 1. Estimates for the forecast population are summarized in Table 2.

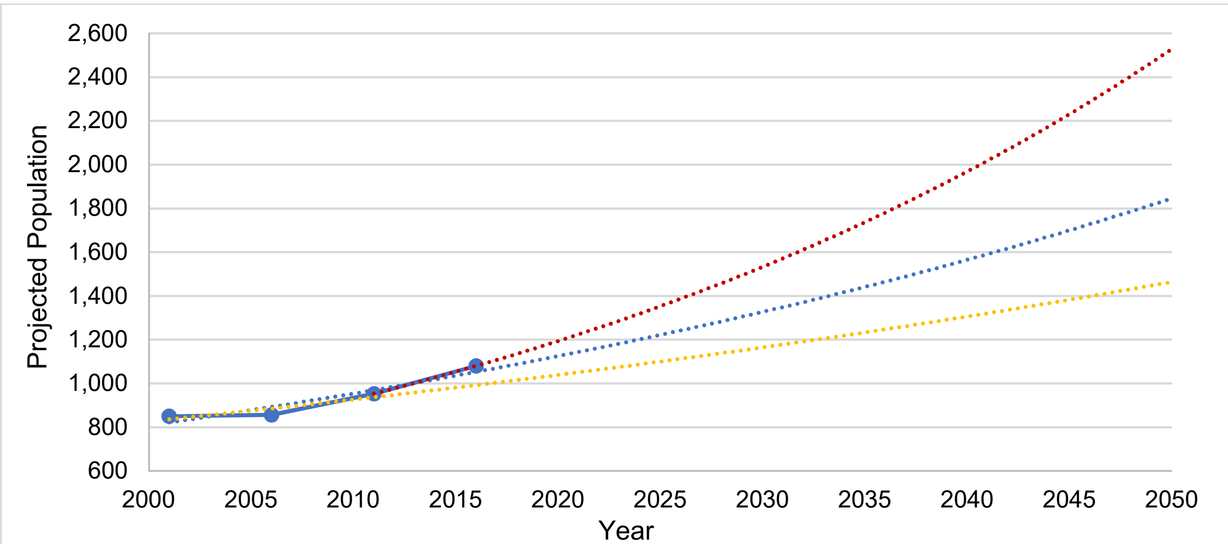

Figure 1. 2050 Project Population (High, Middle, and Low)

Table 2: 2050 Population Projection

Number of Connections	Forecast Design Population
Residential[1]	Residential[2]
740	1910
ICI[2]	ICI (Population Equivalent)
16	32
Total	Total
756	**1942**

1. OID data
2. Statistics Canada, 2017

3. Water Conservation

A planned adaptive strategy enables conservation measures to be tailored to meet the changing needs of the community over time. The following conservation measures are currently undertaken in OID.

3.1 Water Metering of New Connections

OID requires installation of water meters on all new connections to the water distribution network.

- Meter pits are installed just inside the property line and are buried below the land surface with only the lid being visible.
- Two different water meters are currently available for installation and both are compatible with OID's meter readers. These models are provided by two companies: Sensus and Badger. Meter pits are also specified and are provided by Mueller.
- 288 existing connections currently have a meter installed.

3.2 Summer Irrigation Restrictions

Irrigation restrictions are imposed on residents of OID. The following conditions apply:

- A 2 imp gal/min dole valve is required on outside sprinklers and a 4 gal/min dole valve is required on inground sprinklers.
- Odd numbered dwellings can sprinkle on odd numbered days and even numbered dwellings can sprinkle on even numbered days. No sprinkling is allowed on the 31st of each month.
- Sprinkling is prohibited between 11 AM and 5 PM from April 15 to October 15.
- No open hoses are permitted at any time.
- Automatic systems must include a rainfall sensor and backflow preventer.

Residents must submit a request for additional sprinkling if this is required for a new lawn installation. The application allows for 5 periods of 20 minute sprinkling during the day for 30 days on new seed or 14 days on new turf. Requests are not accepted in July or August.

3.3 Connection and Utility Fees

Fees are assessed for new and existing water connections in OID.

- New connections to the water distribution network are currently provided at a cost of $7,350 to the applicant requesting the connection.
- An additional cost of $1000 for meter installation plus the current cost of the water meter and pit is required for new connections (approximately $1000 as of 2019).
- Existing residents are charged based on the type of building connection. Currently all buildings are assessed using the unmetered water rates. Metered water rates are only used for temporary connections.
- Annual water tolls and taxes are listed in Table 3 and Table 4.

Table 3: Water Toll Rates in OID

Unmetered Water Rates (Annual)	
Single Family Dwelling	\$350.20
Duplex or Apartment Building	\$350.20/unit
School	\$350.20/classroom
Commercial Building	\$700.40
Light Industrial Building	\$968.20
Metered Water Rates (Temporary Connections)	
<85 m^3	\$61.80
>85m^3	\$0.65/m^3

Table 4: Water Tax Rates in OID

Land Classification	Water Tax Rate Per Parcel
Group A	\$339.90 + \$30.90 (irrigation)
Group B	\$345.05
Group C	\$350.20
Group D	\$360.50
Group E	\$494.40
Group F	\$504.70
Group G	\$509.85
Group H	\$515.00
Group J	\$339.90/connection

4. Climate Change

Climate change has the potential to impact future water demands. Projections of future water demand have been prepared with consideration of climate change and targets should be designed with consideration for adaption to climate change.

4.1 Impact on Supply and Demand

Future weather in OID is likely to become drier in the summer and wetter in the winter. According to the Pacific Climate Impacts Consortium (PCIC; plan2adapt.ca), by the 2050s, precipitation in the region where OID is located is expected to change from current normals as follows (median of forecasts, and range of 10th to 90th percentiles):

- Annual +6% (-2% to +10%),
- Summer -11% (-23% to -2%), and
- Winter +6% (-4% to +17%).

Extreme weather events (temperature and precipitation, drought and flooding) are expected to increase in frequency.

The impacts on water services may include increased supply for summer seasonal demand and increased storage requirements for balancing peak flows.

4.2 Adaptation and Mitigation

- Water demand targets should take these seasonal climate change impacts into account. This includes accounting for increased demand for irrigation during the dry season.
- Water conservation programs should be designed to assist OID with adaptation to climate change. This may include educating water users about low-water irrigation options and the benefits of reducing water consumption for improving the economic and environmental sustainability of the community.

5. Water Demand

Water demand was estimated using data from system metering as well as a subset of metering on dwellings. Water demand was broken down into sources to prepare a total system water balance and was broken into monthly demand to estimate base demand versus seasonal demand.

5.1 Current Average and Maximum Day Demand

- Current average and maximum day (ADD, MDD) water demands were estimated from system meter data provided by OID for 2017 and 2018. Due to recent installation of the majority of the water meters, the full data range was used in the assessment. Data was available for 69 active connections in OID, which is roughly 20% of all connections and is considered representative based on the full population.
- Average day demand was taken as the annual demand total divided by 365 days in the year.
- Maximum day demand was calculated from the maximum month demand in the data provided by OID and multiplied by a factor of 1.2[1].
- The current ADD was estimated to be 1,365,000 L/day or 1,264 L/cap/day (‘cap’ is per capita, or individual user). The current MDD was estimated to be 4,304,000 L/day or 3,985 L/cap/day.

Average and maximum day demand are considered high compared to other communities of this size in British Columbia. After accounting for operational and system demand, the current MDD was compared to the volume expected from the 2012 British Columbia Design Guidelines for Rural Residential Community Water Systems (DGRRCWS) and found to be significantly (23%) higher than expected.

The current average per-capita water demand from all sources (1,264 L/cap/day) is significantly higher than British Columbia benchmark values for communities without a water metering policy (800 L/cap/day[2]).

- This is an indicator that demand management, potentially including universal metering, have high potential to reduce water demand.

A summary of estimated values for current ADD and MDD is provided in Table 5.

[1] Munksgaard, D and Young, J. (1980). Flow and load variations at wastewater treatment plants. Journal of the Water Pollution Control Federation, 52(8), 2131-2144.
[2] BC Municipal Water Survey 2016. University of British Columbia Water Planning Lab.

Table 5: Current Average and Maximum Day Demand

Unit	Average Day Demand	Maximum Day Demand
L/day	1,365,000	4,304,000
L/cap/day	1,264	3,985

1. Based on flow records provided by OID for 2017 and 2018

5.2 Current Demand by Season

Water meter data from 2017 and 2018 was broken into months and then analyzed for variation by season.

- Base water demand is equal to the minimum daily water demand multiplied by 365 days per year.
- Peak winter demand is equal to the highest monthly water demand in the winter season minus minimum monthly demand.
- Seasonal demand is equal to total annual water demand minus both base water demand and peak winter demand.

Breaking 2017 and 2018 demand data into seasons identified that:

- Peak monthly demand in July is roughly eleven times higher than base demand.
- Seasonal demand comprises 67% of total annual demand, largely occurring in the summer months. This demonstrates that there is a strong irrigating culture in OID. Irrigating includes lawns, gardens, fruit trees, and other outdoor summer uses.

Figure 2 illustrates the seasonal demand calculation and Table 6 summarizes the seasonal water demand.

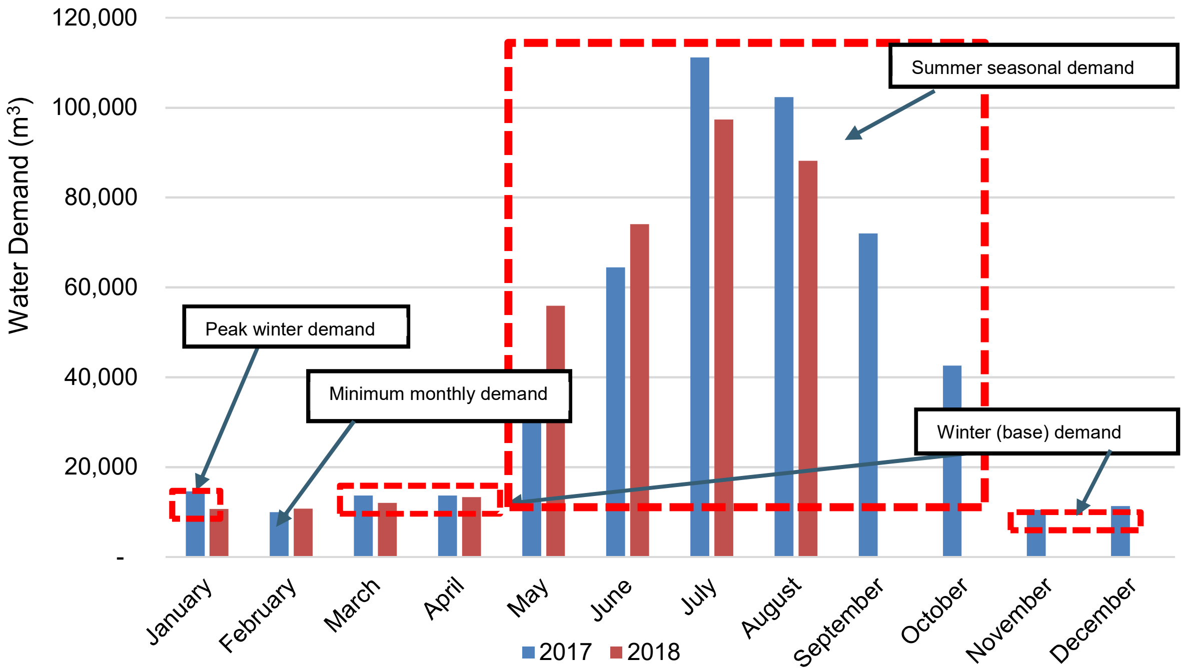

Figure 2: Illustration of Seasonal Demand

Table 6: Current OID Seasonal Demand[1]

Total Demand				
Unit	Total	Base[2]	Peak Winter[3]	Seasonal[4]
L/year	498,203,000	123,675,000	43,155,000	331,372,000
L/day	1,365,000	339,000	118,000	908,000
L/cap/day	1,264	314	109	841

1. Based on OID system meter data for 2017 and 2018.
2. Base demand is minimum monthly demand multiplied by 365 days.
3. Peak winter demand is the peak monthly demand in the winter minus minimum monthly demand.
4. Seasonal demand is total demand minus both base demand and peak winter demand.

5.3 Current Demand by Source

- To assist with future demand projections and assessment of the potential impact of universal water metering, total annual demand was broken into operational, system and domestic sources.
  - Operational demand includes flushing of the distribution system and fire hydrants.
  - System demand includes distributional leakage.
  - Domestic demand includes residential leakage, ICI and residential demand.
- Total non-revenue generating usage (operational, system and residential leakage) in OID's system was estimated to be roughly 135,000,000 L/year or 27% of total water demand.

- OID's piping system is largely comprised of PVC pipe, which tends to have less leakage than older copper pipes and fixtures. It is not expected that major reductions in water demand could be achieved through distribution system upgrades.
- ICI water demand is a very small fraction of total demand. If any ICI facilities are known to be using once-through cooling systems (e.g. for air conditioning or commercial refrigeration systems, retrofitting or replacing those systems with air cooled equipment may be an opportunity to reduce water demand. Otherwise the ICI sector is not expected to be an area of opportunity for significant demand reductions.
- Estimates of total residential demand were compared with OID's existing Bylaw No. 96 for Water System Design and Construction Specifications (June 1999) and were found to be within a similar range. KWL estimates total residential demand, including leakage, to be 936 L/cap/day, whereas Bylaw 96 specifies a design ADD of 800 L/cap/day.
- Residential demand is 23% higher than average for communities in BC with populations of about 1000 people[3].
- Analysis of seasonal demand is reflected in the high ratio between residential outdoor and residential indoor demand.

A summary of the current OID water balance is provided in Table 7.

Table 7: Current OID Estimated System Water Balance

Total Demand							
		Operational	System	Domestic			
Unit	Total[1]	Flushing[2]	Distribution Leakage[3]	Residential Leakage[3]	ICI[4]	Residential Indoor[4]	Residential Outdoor[4]
L/year	498,203,000	54,648,000	67,894,000	12,932,000	6,570,000	119,258,000	236,881,000
L/day	1,365,000	150,000	186,000	35,000	18,000	327,000	649,000
L/cap/day	1,264	139	172	33	17	303	601

1. Based on OID system meter data for 2017 and 2018.
2. Flushing was taken as total water demand minus residential, ICI and leakage.
3. Provided as a nightly demand measurement between 1 AM and 4 AM. 70% of this measurement was estimated to be true leakage with the remaining 30% estimated to be nighttime water usage. Research from the Water Research Foundation (2016) suggests that leakage should be split into 16% residential and 84% distributional for small communities.
4. Estimated from meter readings on a subset of 69 dwellings in OID.

5.4 Projected Average and Maximum Day Demand

Average and maximum day demand were projected for OID using the population projection in Section 2.2 and using expected water demands for new or retrofitted dwellings.

- New connections are expected to have residential indoor water demand of 140 L/cap/day.
- Water fixture improvements are expected to improve existing residential indoor water demand from the existing 303 L/cap/day to 140 L/cap/day at a rate of 3% per year.
- All other water demands were expected to remain consistent on a per capita basis.

[3] BC Municipal Water Survey 2016. University of British Columbia Water Planning Lab.

- The 2050 ADD was estimated to be 2,111,000 L/day or 1,105 L/cap/day. The 2050 MDD was estimated to be 6,654,000 L/day or 3,484 L/cap/day.
- These numbers reflect typical fixture efficiency improvements but no other new demand management programs.

A summary of estimated 2050 values for ADD and MDD is provided in Table 8.

Table 8: Projected Average and Maximum Day Demand

Unit	Average Day Demand	Maximum Day Demand
L/day	2,111,000	6,654,000
L/cap/day	1,105	3,484

1. Based on flow records provided by OID for 2017 and 2018.
2. Population projections for 2050 were used to estimate the increase in residential demand.
3. New connections are expected to have residential indoor water demand of 0.14 m^3/cap/day. Water fixture improvements are expected to improve existing residential indoor water demand from the existing 303 L/cap/day to 140 L/cap/day at a rate of 3% per year.
4. All other water demands were expected to remain consistent on a per capita basis.

6. Water Supply Capacity

An assessment of existing water supply capacity was performed to determine whether existing water demands are met for OID and to help with estimating when future water licenses are expected to become required.

6.1 Current Water Supply

OID currently has three active water licences. Details are summarized in Table 9.

- The existing water supply capacity is 6,541,000 L/day when all wells are active. This exceeds the existing MDD of 4,304,000 L/day and is nearly equal to the 2050 MDD of 6,654,000 L/day.
- For maintenance purposes, there may be periods when OID needs to take 1 well off line. If the largest well (Well #6) is taken off line, OID would have a remaining supply capacity of 4,088,000 L/day, which does not meet the existing MDD or the projected 2050 MDD.

Table 9: OID Water License Summary

Licence Number	Type of Licence	Source	Year Constructed	Capacity (L/s)	Capacity (L/day)	Capacity (L/year)
100,689	Groundwater	Well 2	1976	26.5	2,289,000	835,637,000
26,986	Groundwater	Well 5	1995	20.8	1,799,000	656,572,000
27,065	Groundwater	Well 6	2009	28.4	2,453,000	895,326,000
Total				75.7	6,541,000	2,387,535,000

6.2 Projected Upgrade Requirements

- Assessment of existing supply capacity in OID suggests that without changes to per capita water demand, OID will need to add an additional well to its supply in the next few years. Support for an additional well would likely require a provincial environmental assessment[4], which may take as long as 2 years for approvals. There is potential that the new well would not be approved unless OID has demonstrated that an adequate water conservation plan has been enacted.
- At current water consumption levels, the existing supply is expected to support a maximum of 600 total water connections while there are currently 575 total water connections. Beyond this, development of additional properties would not be possible. Water conservation or development of additional supply will be necessary in order to support population growth in OID.
- Because the existing supply capacity with one well offline is nearly capable of meeting the existing water demand (95%) and because per capita demand is high in OID compared to other similarly sized communities in BC (see Section 5.1) there is high potential to delay future supply upgrades through water conservation measures, including implementation of a universal water metering and billing program.

7. Water Demand Targets

7.1 Considerations and Findings from Demand Analysis

Water demand targets should be set to maximize cost savings, meet water supply capacities, and delay future supply upgrade requirements. Analysis of OID's water conservation programs and meter data identified a number of important considerations for setting water demand targets:

- OID has a growing population. This will increase future water demand.
- Without changes to existing practices, average per capita water demand is expected to decrease from 1,264 L/cap/day in 2018 to 1,105 L/cap/day in 2050 due to fixture replacements and retrofits.
- The current average per-capita water demand from residential sources in OID (900 L/cap/day) is higher than British Columbia municipal benchmark values (800 L/cap/day)[5].
- Peak monthly demand in July is roughly eleven times higher than base demand and seasonal demand comprises 67% of total annual demand, largely occurring in the summer months. High outdoor residential water demand is an indicator that demand management, potentially using universal metering, will result in significantly reduced per capita water demand.
- Leakage in OID's system is low compared to other similarly sized communities in BC and this is expected because OID's existing water distribution infrastructure is generally newer than the infrastructure of many older communities. It is not expected that major improvements to water demand can be made through distribution system upgrades.

---

[4] BC Environmental Assessment Office. Water Policy Bulletin: Environmental Assessment Certificate Requirements for Groundwater Users. https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/environmental-assessments/news-and-annoucements/eao-eac-requirements-for-groundwater-users.pdf

[5] BC Municipal Water Survey 2016. University of British Columbia Water Planning Lab.

- Because of the small number of ICI connections in OID, ICI water demand is low compared to total demand. ICI is not expected to be an area for significant demand reductions.

7.2 Demand Targets

Based on the key considerations and findings, the following water conservation targets are recommended:

- Reduce the ADD from 1,260 L/cap/day (1,365,000 L/day) to 1,050 L/cap/day (1,157,000 L/day) by:
  - reducing indoor residential water demand by 10 % for existing residences;
  - reducing outdoor residential water demand by 30 % for existing residences by 2021 and 50% for existing and future residences by 2050; and
  - determining whether ICI connections are using once through cooling.

This results in an overall 28% reduction in the ADD per capita by 2050.

- Reduce current MDD from 3,980 L/cap/day (4,304,000 L/day) to 3,420 L/cap/day (3,758,000 L/day) in the next 2 years, which is 8% less than the existing combined well supply capacity with the largest well out of service, by:
  - reducing outdoor residential demand for irrigation by 20%; and
  - ensuring system maintenance (flushing) is timed to not occur during peak periods in July and August.

This results in an overall 14% reduction in the MDD per capita over the next 2 years.

- Reduce the projected 2050 MDD from 3,480 L/cap/day (6,654,000 L/day) to 2,030 L/cap/day (3,951,000 L/day), which is 3% less than the existing combined well supply capacity with the largest well out of service, by:
  - reducing indoor residential demand by 10%; and
  - reducing outdoor residential demand for irrigation by 50%.

This results in an overall 42% reduction in the MDD per capita by 2050.

Table 12 provides a summary of the projected impact of the demand targets while Figure 3 illustrates projected water demand with and without implementation of the recommended targets. From the figure, it is clear that the suggested targets would allow OID to meet supply capacity while delaying the need for the installation of an additional well. The targets set here are within the typical range of targets set by other similar communities undertaking water conservation initiatives in BC.

Table 10: OID Estimated System Water Balance with Incorporation of Water Demand Targets

	Total	Residential Indoor	Residential Outdoor
Average Day Demand			
2018 ADD (L/cap/day)	1,260	300	600
Projected 2050 ADD (L/cap/day)	1,100	140	600
Target Percent Savings	17%	10%	30%
Adjusted 2018 ADD (L/cap/day)	1,050	270	420
Adjusted Projected 2050 ADD (L/cap/day)	790	130	300
Maximum Day Demand			

	Total	Residential Indoor	Residential Outdoor
2018 MDD (L/cap/day)	3,980	950	2,810
Projected 2050 MDD (L/cap/day)	3,480	450	2,810
Short-term Target Percent Savings	14%	0%	20%
Long-term Target Percent Savings	42%	10%	50%
Adjusted 2018 MDD (L/cap/day)	3,420	950	2,250
Adjusted Projected 2050 MDD (L/cap/day)	2,030	410	1,400

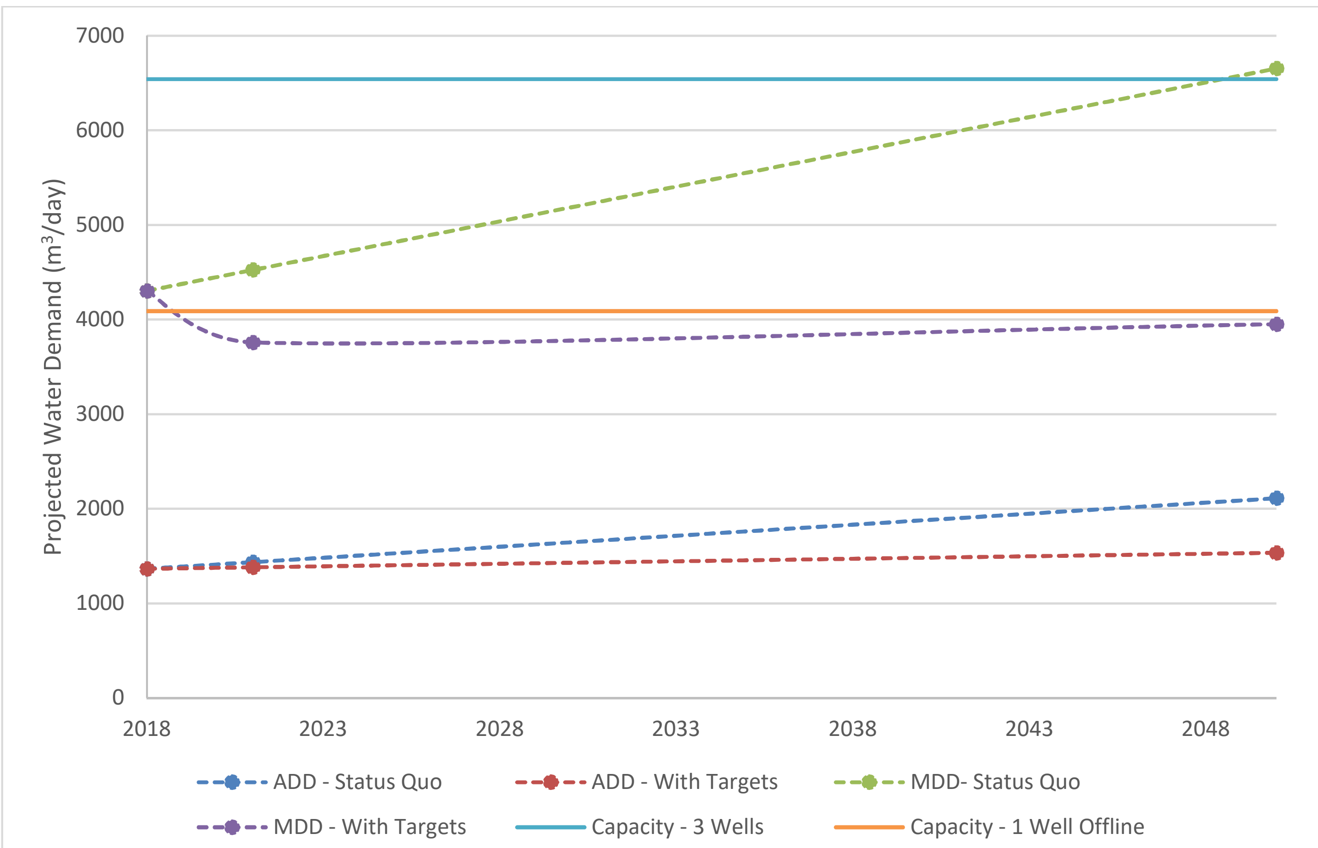

Figure 3: Projection of Future Water Demand with and without Implementation of Recommended Demand Management Targets

8. Metering Program Assessment

8.1 Case Studies

To assist with the metering program assessment, four relevant BC communities were reviewed as case studies for advantages and disadvantages of metering as well as for cost-benefit analysis. These communities were Grand Forks in BC's West Kootenays, Magic Lake Estates on Pender Island in BC's south coast, Rossland (approximately 40 km south of OID), and Cumberland on Vancouver Island. Due to OID's dry climate, ½ acre lot size restrictions, existing water demand, and high population growth with relatively small existing population, OID is a unique community in BC from a water demand and supply perspective and no other community will be directly comparable. Therefore, a range of communities of similar size and climate were researched in these case studies.

8.1.1 Grand Forks

In 2009, the City of Grand Forks had a population of 4,126 with low population growth. The City completed a Water Conservation Plan in 2010, which set a target to reduce water demand by 33% over average day demand of 1,178 L/cap/day in 2008 by 2020. This target was set in order to avoid or delay a costly supply upgrade through installation of an additional groundwater well. The measures considered to achieve the reduction target were leak detection, education, replacement/retrofit programs, residential metering, conservation water pricing and a waterwise irrigation program. In 2010, residential metering was considered high priority, but further assessment was recommended for cost and feasibility. Public consultation was performed for the metering program and ultimately metering was included in the City's Sustainable Community Plan, published in 2011. Since 2011, two other water studies were completed and concluded that benefits of residential metering would outweigh costs and, ultimately, all residential water meters were installed by July 2016. The City found that roughly 2% of water users were in opposition to the installation of water meters and developed their meter program to allow for some flexibility during the installation of the meters and implementation of the meter-based billing program.

The City of Grand Forks obtained $1.3 million in funding from the Federal Gas Tax program to cover the cost of water meter installations. Mock billing began in 2016 and the City began moving towards consumption-based billing in 2017. Water demand in Grand Forks fell by roughly 11% between 2009 and 2013 but statistics on water demand since universal metering was implemented have not been published yet.[6]

8.1.2 Magic Lake Estates, Pender Island

In 2014, the Capital Regional District's Magic Lake Estates Water Service Area had 1,005 residential connections to their water system and capacity to allow an additional 201 future connections. The Magic Lake Estates community decided to invest in water metering in 2006 and achieved universal water metering in 2010. Customers began to see their water consumption listed on utility bills in 2011 and consumption-based billing was established in 2013. Between 2007 and 2014, the community saw a 19% decrease in residential water demand. As part of ongoing water conservation planning required for federal infrastructure grant applications, the community developed two conservation goals in 2014, (1) reduce total demand by 42% over 2014 levels by 2022 and (2) reduce residential demand by 24% over 2014 levels by 2022. The targets are expected to be achieved through a combination of watermain replacement and residential demand management (technological efficiencies and education). Fees for water consumption currently include $72.84/connection quarterly plus $0.50/m^3 for quarterly usage over 50 m^3 (applies to top 15% of water users) and $1.00/m^3 for quarterly usage over 80 m^3 (applies to top 6% of water users).

[6] http://datacat.cbrdi.ca/sites/default/files/attachments/Trends_Analysis_Water_Consumption_Fall_2104.pdf

In 2008, funding was allocated for the purchase of meter transceivers at $123 each, water meters at $500 each, and the meter reading equipment costing $38,500. Meters were installed in buried plastic boxes at the locations of existing curb stops at the property line. The total metering project cost was $1.175 million, or approximately $1,170 per connection, including the reading equipment. In 2008, it was estimated that the start up cost for a meter reading vehicle and operator training would be approximately $15,000 and an ongoing annual budget of $3,300 would be needed to read and import data on water usage.

8.1.3 Rossland

The City of Rossland began installing water meters in 2006 and established its meter based billing program in 2009. The community saw a 30% decrease in water usage between 2010 and 2016. There were 1,747 water connections in 2016 of which 1,706 were metered. Average demand in 2010 was 511 L/connection/day while average demand in 2016 was 413 L/connection/day. The metering program is currently run as a semi-mandatory program where metered residences are billed using meter data and the community is working towards universal metering. However, in 2018, technological challenges led Rossland's City Council to seriously consider returning to a fixed rate billing structure[7]. Upgrades to the metering system were ultimately approved at an initial cost of $420,000 and an annual subscription cost of $26,000. Rossland currently values each meter at $500 and expects a 15 year product life. The costs for upgrades led to the City enacting a 5% increase in 2018 water utility fees for its customers and an annual 4% increase to fees in each following year. Rossland ultimately decided to move forward with the meter upgrade as it allowed the community to avoid a $1.2 million supply upgrade.

Fees for water consumption in 2018 include $18.50/connection monthly plus $0.30/m^3 for monthly usage up to 30 m^3, $0.49/m^3 for additional monthly usage between 30 m^3 and 60 m^3, $0.73/m^3 for monthly usage between 60 m^3 and 100 m^3, and $1.08/m^3 for usage over 100 m^3. Rossland is currently looking at redeveloping its water rate structure to place more emphasis on volumetric charges and less emphasis on the fixed rate charge.

8.1.4 Cumberland

The Village of Cumberland developed a water conservation plan, including universal metering, in 2011 after comparing its water demand without metering to the nearby community of Royston, which had implemented water metering in 1997. In 2011, average day demand and max day demand in Cumberland were 830 L/cap/day and 1,600 L/cap/day, respectively, whereas average day demand and max day demand in Royston were 425 L/cap/day and 825 L/cap/day, respectively. Cumberland set a goal in their 2011 water conservation plan to decrease max day demand by 36% based on data in their Master Water Plan and results achieved by Royston. Universal metering and billing, which came fully into effect in 2014, helped the community to achieve a 25% reduction in demand over 2012 levels by 2016.

Prior to implementing consumption based billing, Cumberland issued four rounds of 'mock water bills' to educate users of their potential water bill and to help them identify possible leaks in their connections.

Fees for water consumption in 2019 include a fixed rate of $50/connection quarterly and a consumption based rate of $0.72/m^3 for residential connections and a fixed rate per connection quarterly plus a consumption based rate of $1.09/m^3 for commercial connections.

---

[7] https://www.trailtimes.ca/news/rossland-abandons-water-metering-to-return-to-flat-rate/

8.2 Implementation Considerations

Before OID implements a water metering and consumption based billing program, a number of items require additional consideration including:

Confirmation of support for water metering,

Some community members may be opposed to universal water metering, before or after it is implemented. Providing clear information about the purpose of a water metering program, and its benefits to the community as a whole, is an important step in implementing the program. It is also important to communicate the range of potential impacts on individual users. When a volume-based billing structure is adopted, some users will likely pay significantly less for water service, and a few very high users will likely pay much more than they currently pay, unless they greatly reduce water use (e.g. by reducing the area of lawn they irrigate). An effective communication strategy will ensure that these impacts are understood by community members before meter installation begins and will also ensure that high users have opportunities to reduce their water use before volume-based billing begins. The transition to volume-based billing may be phased in over a period of three to five years to provide an opportunity for users to adapt to the new structure.

Implementation of a water metering program will require meaningful public consultation to educate water users on the need for sustainable development of the water utility and to form shared values for water resources in the community. Public input on topics including the timeline for metering implementation, educational resources, costs for metering versus alternative, concerns over installations on private property, and decisions on the billing and rate structure can be addressed through public meetings, mail-ins, or online feedback/responses.

Confirmation of conservation goals and targets,

The goals and targets for water conservation may be brought forward to the OID Board of Trustees and confirmed as these will form the basis for implementing any chosen water conservation initiatives.

Exploration of funding programs and grants,

Funding may be available through a government program, such as the Federal Gas Tax Funding program or through other conservation initiatives. OID may want to commission a review of funding opportunities to aid with payment for the capital costs for water meters. Implementing universal metering as a component of a demand management strategy may assist OID in accessing infrastructure grants. Although improvement districts are currently ineligible for federal/provincial infrastructure grants, they are able to access application-based funding through the UBCM Gas Tax programs with the support of a regional district board. Effective demand management demonstrates good stewardship of water resources and infrastructure and is considered favourably in the technical review of grant applications.

Preparation of education and stakeholder engagement material and a communication strategy,

Examples from the case study jurisdictions, such as Grand Forks, may be used to further develop content on OIDs website or in mail-outs. There are also useful resources that can be linked to such as WaterSmart, BC Adapts or the Regional District of Central Kootenay's water conservation measures. An effective communication strategy will provide water users with the background information needed to understand the need for water conservation, the changes they can make to conserve water, and the purpose of water metering in addressing leaks, pay equity, and asset management.

Installation and payment for meters on unmetered properties,

Implementing a metering and billing program will involve both one-time costs (to install the meters and set up the meter reading and billing systems), and ongoing costs (to read meters, process data and prepare and issue volume-based water bills, and to maintain and renew the meters, reading and billing systems over time). It is important to take the costs and required staff time and competencies into consideration in the decision to proceed with universal metering.

If universal metering is implemented, OID will need to prepare an inventory of all existing properties that require meters, provide notice to residents that meter installations will be taking place and work with residents to ensure payment of the meters and timely installation is possible.

Initiation of a meter reading and reporting program,

After installation of the meters, water operators will need to begin performing bi-monthly readings of the meters and a suitable software for reporting and preparing bills based on water consumption will need to be selected. The success of a metering program in conserving water, avoiding costs of increasing water supply capacity and improving user-pay equity, is dependent on a robust and well designed and managed rate structure, bylaw and policy framework. Billing cycles must be sufficiently frequent to provide timely price signals to users, and the combination of fixed and volume-based charges must provide stable revenue for the essential needs of the utility while providing a significant incentive to conserve discretionary water use. Water budget-based rates, inclining block rates or seasonal rates are options to achieve these objectives.

Definition of a consumption-based billing system,

Options for consumption-based billing include:

- Flat rate ($/month or quarter),
- Uniform rate ($/m^3),
- Block rates ($X/m^3 for first volume, followed by $Y/m^3 for additional volume),
- Seasonal rate ($/m^3 in summer season), and
- Combination rate ($/month or quarter + $/m^3).

Determination of linkages to other relevant plans, programs and bylaws.

The targets and conservation initiatives should be linked to other community plans and initiatives and may be implemented through amendments to existing water use bylaws.

8.3 Advantages and Disadvantages

Economic, social, environmental and operational/feasibility advantages and disadvantages were considered for implementation of universal metering and billing, a mixed system of both metering and flat rates or continuing the existing flat rate program. These advantages and disadvantages are summarized in Table 11.

Table 11. Advantages and Disadvantages of Various Metering Programs and Rate Structures

Program	Concept	Advantages	Disadvantages
Universal Metering and Consumption Based Billing	Meters would be installed on all properties and OID would move toward billing all customers based on actual water consumption.	**User-pay equity** – all end users pay directly and equally based on their consumption. **Reduced complexity** – compared to mixed billing systems since all connections follow the same formulae. **Conservation** – communities of similar sizes have reduced their water demand by between 20-60%. **Economics** – reduced demand may increase available supply capacity and may allow for extended infrastructure upgrade timelines. **Revenue generation** – connections with very high water consumption can by billed at higher rates with funds put towards long term initiatives. **Asset Management** – metering improves leak detection, prioritization for upgrades, and sequencing of community planning. **Education** – Consumption based billing provides customers with greater understanding of services provided by the utility and patterns of their consumption. **Environment** – reduced greenhouse gases due to water conservation and delayed infrastructure upgrades, improved sustainability of groundwater systems. **Maximize value of existing infrastructure** – OID has installed meters on a majority of properties, which is an investment towards developing universal metering further. **Improved positioning** – for federal and provincial infrastructure grant applications through demonstration of water conservation initiatives. **Improved resiliency** – decreasing demand allows for additional capacity saved for emergency purposes.	**Up-front cost and potential unforeseen costs** – to purchase and install meters and to maintain the meters. **Increased staffing and resources** – for both meters and management of the billing program. **Resistance to meters, fees, and pricing methods** – by customers that may be underpaying through the fixed system or prefer predictability of the existing structure. **Political will** – required to gain consensus and implement mandatory change.
Semi-Mandatory or Voluntary Metering and Consumption	**Semi-Mandatory** Meters would be required on all new or upgraded properties and OID would move toward billing	**Conservation** – communities of similar sizes have reduced demand by 10-40%[8].	**Potential unforeseen costs** – to purchase and install meters and to maintain the meters.

[8] https://docs.google.com/viewerng/viewer?url=https://www.obwb.ca/newsite/wp-content/uploads/WCG_Design3.0_Web.pdf&hl=en_US

Program	Concept	Advantages	Disadvantages
Based Billing or Flat Rate	existing metered connections based on actual water consumption while unmetered connections would be billed at fixed rates. **Voluntary** Customers can choose to install a meter and customers with meters may voluntarily move to a consumption based billing system. All other connections would be billed using a fixed rate.	**Economics** - reduced demand may improve available supply capacity may allow for extended infrastructure upgrade timelines. **Revenue generation** – connections with very high water consumption can by billed at higher rates with funds put towards long term initiatives. **Asset Management** – metering improves leak detection, prioritization for upgrades, and sequencing of community planning. **Education** – Consumption based billing provides customers with greater understanding of services provided by the utility and patterns of their consumption. **Environment** – reduced greenhouse gases due to water conservation and delayed infrastructure upgrades, improved sustainability of groundwater systems. **Maximize value of existing infrastructure** – OID has installed meters on a majority of properties, which can move toward metering with relative ease.	**Increased complexity** – to maintain multiple means of customer billing. **Increased staffing and resources** – for both meters and management of the billing program while not metering all connections. **Resistance to meters, fees, and pricing methods** – by customers that may be underpaying through the fixed system or prefer predictability of the existing structure.
Flat Rate Only	All connections would be billed using a fixed rate structure, as is currently done.	**Simplicity** – no additional billing or management compared to existing program. **Metering capital and operations cost** – no new costs for metering passed on to customers. **Education** – budget that may have been put towards installation of water meters can be put towards additional education or other means to reduce water demand. **Non-resistance** – customers unlikely to lobby for water metering but could be resistant toward a metering program.	**Economics** – growth in demand may require capacity upgrades in the near term. **Asset Management** – reduced capacity for leak detection and community planning.

8.4 Projected Impact of Metering on Average and Maximum Day Demand

Based on the reduction in water demand due to implementation of universal metering in other BC communities and outlined in the case studies, it is expected that OID would meet its target reductions through implementation of universal metering, as illustrated in Figure 3. Communities have widely reported average day demand reductions in the range of 20% and it is expected that OID could also achieve reductions in this range, given the existing high water demand for summer irrigation. Additional demand reductions could likely be achieved through education, stricter irrigation restrictions, and low water landscaping (xeriscaping) initiatives.

8.5 Cost Benefit Analysis

A cost-benefit analysis of universal metering versus increasing supply was performed. Existing data on potential costs and benefits was compiled from OID and the case studies and represents the most accurate data that was could be obtained with available resources. Due to the inherent uncertainty in projecting costs into the future as well as in projecting population growth, the costs and benefits should be considered to be accurate within a margin of uncertainty of +/-25%.

8.5.1 Costs

An estimate of capital costs for a universal metering program in OID was prepared with the following assumptions:

- Badger model 35LL (NSF 61-G) meters, Sensus model #3096 readers and Mueller model #203C1548FSBS meter pits with existing costs of $550 for meters and $700 for installation based on figures supplied by OID and cost data referenced in the case studies.
- All meters are pit meters located at the property line.
- For multi-family connections, a single meter for the building is used.

An estimate of operational costs was prepared with the following assumptions:

- Operators would use a radio-based system to read meters every second month at a cost of $400/billing cycle.
- Customers would be billed every second month with administration costs of $1,200/billing cycle.
- Maintenance and service would be required periodically throughout the year (allow $10,000).

An estimate of replacement costs and costs for new installs was prepared with the following assumptions:

- Meters are assumed to have a 15 year lifespan.
- Population growth for a 2050 buildout of 756 connections as outlined in Section 0.
- Costs are expressed in 2019 CAD.

Startup and annual costs are outlined in Table 12. Based on this assessment the initial capital cost to implement a metering program is $181,000 and the annual cost for operations, new connections and replacements is $46,000. Assuming the initial capital cost is spread over a payment period of 15 years, this equates to approximately $12,000. Therefore, the overall annual cost of implementing a metering program is estimated to be $58,000/year. Of the annual costs, roughly $8,200 is attributed to the purchase and install of meters for new connections. It is expected that these costs will be paid for directly by the applicant for a new connection rather than by OID. Therefore, the annual cost to OID is estimated to be approximately $49,800.

Table 12. Startup and Annual Costs for OID Universal Metering Program

Costs	Units	Cost/Unit	Total Cost
Capital			
Existing metered properties	288	-	
Existing meters in stock	15	-	
Existing pit chambers	288	-	
Additional meters needed	123	$ 550.00	$ 67,650.00
Additional pit chambers and install	138	$ 700.00	$ 96,600.00
Contingency (10%)			$ 16,425.00
	TOTAL		$ 180,675.00
Operational			
Meter reading operator	6	$ 400.00	$ 2,400.00
Meter reading vehicle	6	$ 100.00	$ 600.00
Billing administrator	6	$ 1200.00	$ 7,200.00
Maintenance and service	Allow		$ 15,000.00
	TOTAL		$ 25,200.00
Replacements and New Connections			
Replacement Meters	28	$ 250.00	$ 7,100.00
Meters for new connections	11	$ 773.00	$ 8,227.00
Pit chambers for new connections	11	$ 984.00	$ 10,472.00
	TOTAL		$ 25,800.00

8.5.2 Benefits

An estimate of benefits for a universal metering program in OID was prepared with the following assumptions:

- Reduced average day water consumption of 17% would also translate to an average 17% reduction in power required for well pumps and chemical disinfection (chlorine) consumption.
    - Annual costs for existing well power as listed in OID's 2018 financial statement.
    - Annual costs for existing supplies were assumed to be treatment and disinfection chemicals (chlorine) as listed in OID's 2018 financial statement.
    - This equates to annual savings of $4,460 for reduced power and $240 for reduced chemical consumption.
- Capital costs for the installation of a new well were taken from OID's 2007 Capital Expenditure Report and inflated to 2019. The estimated cost for an additional well was estimated to by $360,000 in 2007. With a 2% inflation rate, this is equivalent to $454,000 in 2019. Benefits were considered to be an avoided cost realized as a benefit of 3% of the capital cost per year (i.e. an amortization period of 33 years.)

- Operational and maintenance costs for a new well were estimated to be $30,000 per year over the lifetime of the new well. These costs include power ($15,000/year), treatment chemicals ($1000), and operations/maintenance/repairs ($14,000/year).
- Costs are expressed in 2019 CAD.

Financial benefits for a metering program in OID are summarized in Table 13. Based on this assessment, the annual benefit of implementing a metering program is approximately $49,300. This calculation does not consider the potential additional cost for an environmental assessment prior to addition of a new well, which could add further financial benefits in favor of the metering program over increasing supply capacity. Alternately, there is opportunity to further assess the installation of a new well with the option of upgrading an existing well that was taken out of commission.

Table 13. Annual Benefits for OID Universal Metering Program

Benefits	Current	Savings	Annual Benefits
Existing Power	$ 26,250.00	17%	$ 4,462.00
Existing Treatment chemicals (chlorine)	$ 1,386.00	17%	$ 236.00
Deferred Well Installation	$ 453,623.00	3%	$ 14,633.00
Deferred Well Operation (power, chlorine, maintenance)	$ 900,000.00	3.33%	$ 30,000.00
	TOTAL		$ 49,300.00

9. Recommendations

9.1 Water Metering

The assessment of water metering indicates that from a cost-benefit perspective, the cost for metering versus the cost for adding supply capacity are approximately equal. However, the metering program should provide OID with greater planning capacity and ability to raise revenue through equitable means while also reducing impacts to the environment. In addition, installation of a new groundwater well may trigger the need for an environmental assessment, which could be costly and require several years to complete while pursuing water metering would place OID in a more competitive position to attract grants and funding from provincial and federal sources. For these reasons, it is recommended that OID consider moving forward with a universal metering program over increasing supply capacity. A 'do-nothing' approach is not recommended since the available water supply would not allow for continued development passed 600 water connections and would not support population growth. This 'do nothing' approach would restrict economic growth and business development in OID.

9.2 Other Water Conservation Practices

Review of existing water conservation programs in OID identified a number of other opportunities to reduce water demand, which may be coupled with water metering to improve the timeline for reaching the water demand targets.

Education

The benefits of a well-developed water conservation education program and implementation considerations were outlined in Section 8.2. In short, a well-rounded education program will assist OID with bringing forward a metering program and maximizing the benefits of investing in all other water conservation initiatives.

Xeriscaping or low water demand landscaping program,

This may consist of online material, community outreach, voluntary audits or demonstration projects to educate water users about low water landscaping, proper irrigation techniques and the benefits of reducing water consumption. Depending on budget availability, paper handouts may be developed for community events or a summer student could be hired, or volunteers could be enlisted to visit individual residences and review irrigation systems with water users. It is expected that about 200 homes could be visited by one student in a year. Demonstration projects for xeriscaping may have potential for OID owned property or for volunteering properties. Xeriscaping could also be incentivised or required for new properties in OID.

Sprinkling restriction update,

The existing sprinkling restrictions in OID could be updated to reflect the existing supply availability. Currently, max day demand is at about 95% capacity, if one well is taken out of service and a large proportion (about 2/3) of summer demand is attributed to irrigation. Options for updating the sprinkling restriction include changing the timeframe when sprinkling is prohibited (e.g. change the window from 5 PM to 11 AM to instead from midnight to 8 AM.

Report Submission

Prepared by:

KERR WOOD LEIDAL ASSOCIATES LTD.

Jessica LeNoble, M.A.Sc., EIT
Junior Engineer

Don Nash, P.Eng.
Project Manager

Reviewed by:

Association of Professional Engineers and Geoscientists of the Province of British Columbia
C. P. SUNDERLAND
ENGINEERING LICENSEE
Limited Licence
194942
Aug. 8, 2019

Colwyn Sunderland, Eng.L., AScT
Technical Reviewer

Statement of Limitations

This document has been prepared by Kerr Wood Leidal Associates Ltd. (KWL) for the exclusive use and benefit of Ootischenia Improvement District for the Water Metering Study. No other party is entitled to rely on any of the conclusions, data, opinions, or any other information contained in this document.

This document represents KWL's best professional judgement based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by members of the engineering profession currently practising under similar conditions. No warranty, express or implied, is made.

Copyright Notice

Revision History

Revision #	Date	Status	Revision	Author
0	August 7, 2019	Final	Report submitted as Final to client.	JLN
B	July 2, 2019	Final Draft	Report submitted as draft for council review and comments	JLN
A	May 30, 2019	Draft	Report submitted as draft to client for review and comments	JLN

OQM CERTIFIED

The Association of

PROFESSIONAL ENGINEERS AND GEOSCIENTISTS

of the Province of British Columbia

SERVIRE CREARE PERMANERE

LIMITED LICENCE

Colwyn Sunderland has signed an undertaking and is therefore authorized to engage in the practice of Professional Engineering in the Province of British Columbia, within the limited scope as specified hereunder:

Discipline: Civil
Field of Practice: Municipal
Limited to:

1. Water supply, treatment and distribution systems
2. Sanitary sewer and stormwater systems
3. Water efficiency audits of buildings and irrigation systems
4. Work that is in conformation with commonly published codes, guidelines and standards
5. Development of regulations, codes, guidelines and standards for waterworks, sanitary sewer and stormwater systems.

Granted March 6, 2019