KERR WOOD LEIDAL
consulting engineers

Greater Vancouver
200 - 4185A Still Creek Drive
Burnaby, BC V5C 6G9
T 604 294 2088
F 604 294 2090

Water Conservation Plan

Final Report
May 2018
KWL Project No.3485.005

Prepared for:

GILLIES BAY IMPROVEMENT DISTRICT

Contents

Figures

Tables

Appendices

1. Purpose and Scope

In support of the application for a new Cranby Lake water diversion licence to support current and future water demand, this Water Conservation Plan identifies targets and opportunities for sustainable water use in the Gillies Bay Improvement District (GBID) service area. The geographical scope of future water demand is expanded from the existing service area to include potential servicing of Shelter Point; however, the geographical scope of the Water Conservation Plan covers only the GBID service area.

2. Population and Potential Growth

2.1 Current Population

- From Canadian Census data and information from the GBID water committee, the existing population of GBID was estimated to be 367 people with 236 current residences.
- The Shelter Point area was assumed to be fully built out with 42 connections and a total connected population of 105 people.
- From GBID water meter data, there are 11 institutional, commercial or industrial (ICI) connections in GBID. Water consumption from these ICI sources is estimated as equivalent to 13 people.
- Estimates for the existing population are summarized in Table 1.

Table 1: Existing Population

Community	Number of Connections	Current Population
	Residential	Residential
Gillies Bay	236[1]	367[1]
Shelter Point	42[2]	105[2]
	ICI	ICI (Population Equivalent)
Gillies Bay	11	13[3]
TOTAL	**289**	**485**

1. Statistics Canada
2. KWL 2014 Water Treatment and Distribution Concept Technical Memorandum. Assumes that Shelter Point is fully built-out.
3. Estimated from Gillies Bay water meter data

2.2 Forecast Future Population

- 20-year future population projections were forecast as a component of the Gillies Bay Master Water Plan (KWL, 2016).
- The population of GBID has fallen by approximately 30% in the last 15 years. Given the decrease in population, it was determined that utilizing a percent annual growth rate (or decline) was not appropriate to project the population for the 20-year planning period.

- Instead, a full build-out population was estimated by assuming all lots with the potential for development will be subdivided, adding 118 connections to the current inventory, and then by assuming all lots within the GBID service area will be connected at the end of the study period.
- The future population was then determined using the total number of future connections and assuming an occupancy of 1.6 people per residence (Statistics Canada, 2016).
- It was also assumed that there would be no increases in ICI.
- Accordingly, the full build out population used for the conservation plan will be 668 people.
- The future population projections are listed in Table 2.
- A map showing existing and future serviced lots is provided in Appendix A.

Table 2: Full Build-Out Population Projection

Community	Number of Connections	Projected Population
	Residential	Residential
Gillies Bay	354	550[1]
Shelter Point	42	105[2]
	ICI	ICI (Population Equivalent)
Gillies Bay	11	13[3]
TOTAL	**407**	**668**

1. Assumes all parcels are connected and lots which have potential for development are subdivided
2. Adapted from KWL 2014 Water Treatment and Distribution Concept Technical Memorandum. Assumes that Shelter Point is fully built-out.
3. Assumes no increases in ICI.

3. Current Water Demand

3.1 Data Analysis

- The GBID provided water consumption data from 2006 to 2018.
  - Prior to 2014, only data on average, maximum, and minimum demand was provided.
  - After 2014, detailed monthly water meter data was provided.
  - As the GBID metering program has expanded over time, demand data has become more extensive with each subsequent year of the metering program.
  - The 2010 and 2011 data was excluded from analysis based on measurement errors.
- No historical flow data was available for the Shelter Point area.
- Data from 2014 to 2017 was used for more detailed demand analysis because these years included more extensive operational, system, residential and ICI water meter measurements.

3.2 Maximum and Average Day Demand

- With the 2010/2011 data excluded, for the entire period, for GBID, the average maximum day demand (MDD) was determined to be 708 m³/d and the average daily demand (ADD) was determined to be 309 m³/d.
- From previous reports, historical demand for GBID was estimated to be as high as 925 m³/d. This represents the maximum day flow rate through the chlorination system into the distribution system.
- The MDD and ADD for the Shelter Point area was previously calculated using the 2012 British Columbia Design Guidelines for Rural Residential Community Water Systems (DGRRCWS) to be 160 m³/d and 64 m³/d, respectively.
- As the Shelter Point area is assumed to be fully built out, the present MDD and ADD will remain unchanged for the remainder of the design horizon.
- After accounting for operational and system demand, such as flushing and bleeding, the current MDD was compared to the volume expected from the DGRRCWS and found to be significantly (11%) higher than expected.
- The current average per-capita water demand from all sources, is 788 L/capita/d, which is significantly higher than Canadian municipal benchmark values.
    - There may be an opportunity to defer future capacity upgrades by implementing a demand management program.
- Estimates for the current MDD and ADD are summarized in Table 3 and Table 4, respectively.

Table 3: Current Maximum Day Demand

Community	Historical	Past Reports
Gillies Bay	708 m³/d [1]	925 m³/d[2]
Shelter Point	Not supplied by GBID	160 m³/d[3]
TOTAL		**1,085 m³/d**

1. Based on flow records provided by GBID for 2006 to 2018 period excluding 2010 and 2011.
2. McElhanney 2006 Water Supply System Upgrading Options Report.
3. KWL 2014 Water Treatment and Distribution Concept Technical Memorandum.

Table 4: Current Average Day Demand

Community	Average Day Demand
Gillies Bay	309 m³/d[1]
Shelter Point	64 m³/d[2]
TOTAL	**373 m³/d[3]**

1. Based on flow records provided by GBID for 2006 – 2018 period excluding 2010 and 2011.
2. McElhanney 2006 Water Supply System Upgrading Options Report.
3. KWL 2014 Water Treatment and Distribution Concept Technical Memorandum.

3.3 GBID Water Demand by Source

- Data from GBID for 2014 to 2017 was used for more detailed demand analysis because these years included more extensive meter measurements.
  - Note that the average demand of 289 m^3/d (105,588 m^3/year) between 2014 to 2017 is slightly lower than the average demand of 309 m^3/d (112,785 m^3/year) between 2006 to 2018.
- Meter measurements were broken into operational, system, and domestic demand sources.
  - Operational demand includes flushing of the distribution system and fire hydrants.
  - System demand includes bleeding and distributional leakage.
  - Domestic demand includes residential leakage, ICI and residential demand.
- A summary of current GBID estimated water balance is provided in Table 5.

Table 5: Current GBID Estimated System Water Balance

Year	Average Daily Demand (m^3/year)						
	Total[1]	Operational	System		Domestic		
		Flushing[2]	Bleeding[2]	Distribution Leakage[3]	ICI[2]	Residential Leakage[3]	Residential Indoor and Outdoor[4]
2014	109,310	3,711	20,326	13,061	3,258	13,061	55,893
2015	109,789	6,757	22,344	13,061	3,234	13,061	51,332
2016	107,714	9,410	19,201	13,061	4,131	13,061	48,850
2017	95,538	6,407	10,039	13,061	3,712	13,061	49,258
Average	**105,588**	**6,571**	**17,978**	**13,061**	**3,584**	**13,061**	**51,333**

1. Provided as annual totals.
2. Provided as water meter measurements.
3. Provided as a nightly demand measurement (2 AM) of 70 L/min. 70% of this measurement was estimated to be true leakage. Research from the Water Research Foundation (2016) suggests that leakage should be split into 16% residential and 84% distributional for small communities. From discussions with the GBID water treatment operator, estimates for the residential component of total leakage are as high as 70% but there is high uncertainty. Leakage was split into 50% residential and 50% distributional. Further monitoring may be required to confirm this breakdown.
4. Residential indoor and outdoor demand is the total demand minus all other demand sources.

- Table 5 illustrates that a substantial portion of annual water demand is due to wastage, either by operational or system based factors.
  - **Operational demand, system demands and domestic leakage amount to an average of 50,671 m^3/year or 48% of total annual demand.**
  - **This finding illustrates that there is significant opportunity for improvement using water conservation measures and system upgrades.**

Seasonal Water Demand

- To provide a better understanding of demand sources, water meter data was broken into months and then analyzed for variation by both season and source. For this analysis:
    - Base water demand is equal to the minimum daily water demand (167 m^3/d since 2014) 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 base water demand minus peak winter demand.
- Breaking demand into seasons and sources identified that:
    - Peak monthly demand in July is roughly three times higher than base demand.
    - Roughly 8% of the seasonal demand is sourced from seasonal residences and ICI.
    - The remaining seasonal demand comprises 39% of total annual demand, largely occurring in the summer months. This demonstrates that there is a strong lawn watering culture in GBID.
- Figure 1 illustrates the seasonal demand calculation and Table 6 summarizes the seasonal water demand.

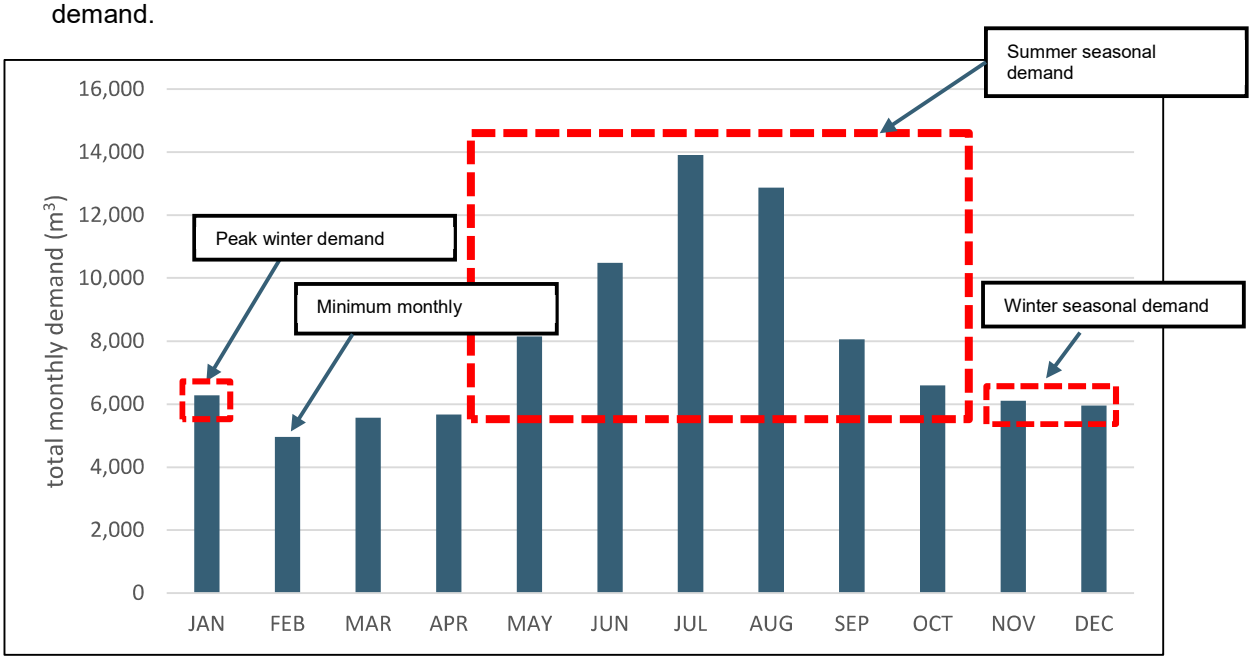

Figure 1: Illustration of Seasonal Demand

Table 6: Current GBID Seasonal Demand

Year	Annual Demand (m^3/year)			
	Total	Base	Peak Winter	Seasonal (winter and summer)
2014	109,310	64,822	207	44,281
2015	109,789	60,013	120	49,656
2016	107,714	60,919	112	46,683
2017	95,538	57,719	143	37,676
Average	**105,588**	**60,868**	**146**	**44,574**

1. Base demand is minimum daily demand multiplied by 365 days.
2. Peak winter demand is the peak monthly demand in the winter minus minimum monthly demand.
3. Seasonal demand is total demand minus base demand minus peak winter demand.

4. Water Supply Capacity

4.1 Surface Water

Water Licences

The GBID currently owns three diversion water licences and one storage licence. Details are summarized in Table 7.

Table 7: GBID Water Licence Summary

Licence Number	Type of Licence	Source	Date Issued	Volume Allowed	Status
27762	Diversion	Cranby Lake	Jan. 28, 1963	30,000 gal/d (113.6 m^3/d)	In use
24579	Diversion	Ball Park Creek	Feb. 2, 1959	500 gal/d (1.9 m^3/d)	Not in use
?	Diversion	Halley Creek	?	20,000 gal/d (77.8m^3/d)	Not in use
120005	Storage	Cranby Lake	Oct. 14, 2004	310 acre feet per annum (382,379 m^3/year)	Issued in substitution of Licence 27763

The GBID is currently only using the Cranby Lake storage and diversion licences. No other diversions from Cranby Lake were found (Cranby Lake Reservoir Assessment; KWL, 2016)

Flow records indicate that GBID is using more water than allowed in their licence (113.6 m^3/d). An assessment of the Cranby Lake watershed determined that the maximum sustainable lake withdrawal from Cranby Lake is 2,384 m^3/d (KWL, 2016). GBID has applied for an increase to their water diversion licence on Cranby Lake to meet the current MDD for both GBID and Shelter Point – this amounts to 870 m^3/d. The application is pending review from the provincial government.

Detailed information about water quality in Cranby Lake is provided in the Master Water Plan (KWL, 2016).

4.2 Groundwater

Given the high total organic carbon, colour and turbidity in the Cranby Lake water, the GBID had considered developing a groundwater source in the area. Feasibility studies and proposals were developed in 1989 and in 2014. Both proposals suggested that sufficient groundwater might be present, but it would cost between $70,000 and $174,000 to confirm.

This money could be spent on a drilling program without finding water. Additionally, the proposed work programs focused on available water quantity and not on water quality. The quality of groundwater must also be considered when determining the most appropriate water supply because if the groundwater is not of sufficient quality or considered to be under the influence of surface water, filtration and disinfection would likely be required to meet the *Guidelines for Canadian Drinking Water Quality Guidelines*.

The water quality of Cranby Lake has been extensively monitored over a 40 year period and is well understood (refer to Master Water Plan; KWL, 2016). To gain an understanding of the potential water quality of available groundwater, past contact between GBID staff and Vancouver Coastal Health identified some wells in the area have elevated levels of antimony, arsenic, selenium and uranium. The Shelter Point area also has several wells. One drilled well in the Shelter Point area was over-pumped leading to saltwater intrusion and others have elevated levels of metals. Most other wells on Texada Island have been dug instead of drilled which means that, while they typically do not have elevated levels of metals, they would be considered a surface water source which can have bacteriological issues. Because of the water quality risks, the potential groundwater sources may require different water treatment technologies, which would add additional costs for using groundwater to increase supply capacity.

Given the costs and risks along with the limited potential for savings with a groundwater source, it was previously recommended that the GBID continue to rely on Cranby Lake as its water supply (KWL, 2016)

5. Wastewater System Capacity

- Except for a sewage lagoon serving a small number of residences, GBID has a decentralized wastewater treatment system that uses onsite conventional septic tanks.
    - Changes to Ministry of Health regulations may require wider use of enhanced treatment systems or creation of a combined sewage disposal system in the future (Texada Island Official Community Plan, 2005).
- Because the wastewater treatment system is decentralized and population growth is low, the capacity for wastewater treatment is not considered a limiting factor for water demand in GBID. However, decreased water demand puts less stress on septic systems, which may extend the life of these systems and provide cost savings over time.

6. Climate Change Adaptation and Mitigation

- Future weather in GBID 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 GBID is expected to change from current normals as follows (median of forecasts, and range of 10th to 90th percentiles):
  - Annual +5% (0% to +11%)
  - Summer -8% (-19% to +3%)
  - Winter +6% (-3% to +13%)
- Extreme weather events (temperature and precipitation, drought and flooding) are expected to increase in frequency. The impacts on water and sewer services may include increased storage requirements for balancing peak flows, and increased peak inflow into the wastewater treatment plant.
- Water demand targets should take these seasonal climate change impacts into account.

7. Water Demand Targets

Water demand targets should be set to maximum cost savings and meet water licence allowances. This requires a balance between implementing a demand management program for residential water use and performing upgrades to the water treatment and distribution system.

For GBID, the following water conservation targets are recommended:

- Total annual supply flow at WTP: Reduce ADD from 289 m^3/d (105,588 m^3/year) to 192 m^3/d (70,000 m^3/year), which is the sum of current available water licences.
  - This target can be achieved by:
    - reducing operational water demand (flushing) by 50%;
    - reducing system water demand (bleeding and distributional leakage) by 40%; and
    - reducing residential water demand by 30% (residential leakage 40%; ICI 25%; and domestic 30%).
- Maximum day demand (MDD) at WTP: Reduce from 708 m^3/d to 650 m^3/d:
  - This can be achieved by:
    - Focusing efforts on reducing water demand for irrigation.

Achieving these targets will rely on a combination of educational and regulatory measures to reduce water demands in existing buildings, water-efficient new construction, and implementation of the treatment plant and distribution system upgrades outlined in the GBID Master Water Plan. If these measures are implemented, the targets are achievable with a full build out water service area population of 668.

Figure 2 illustrates projected water demand with implementation of the recommended targets.

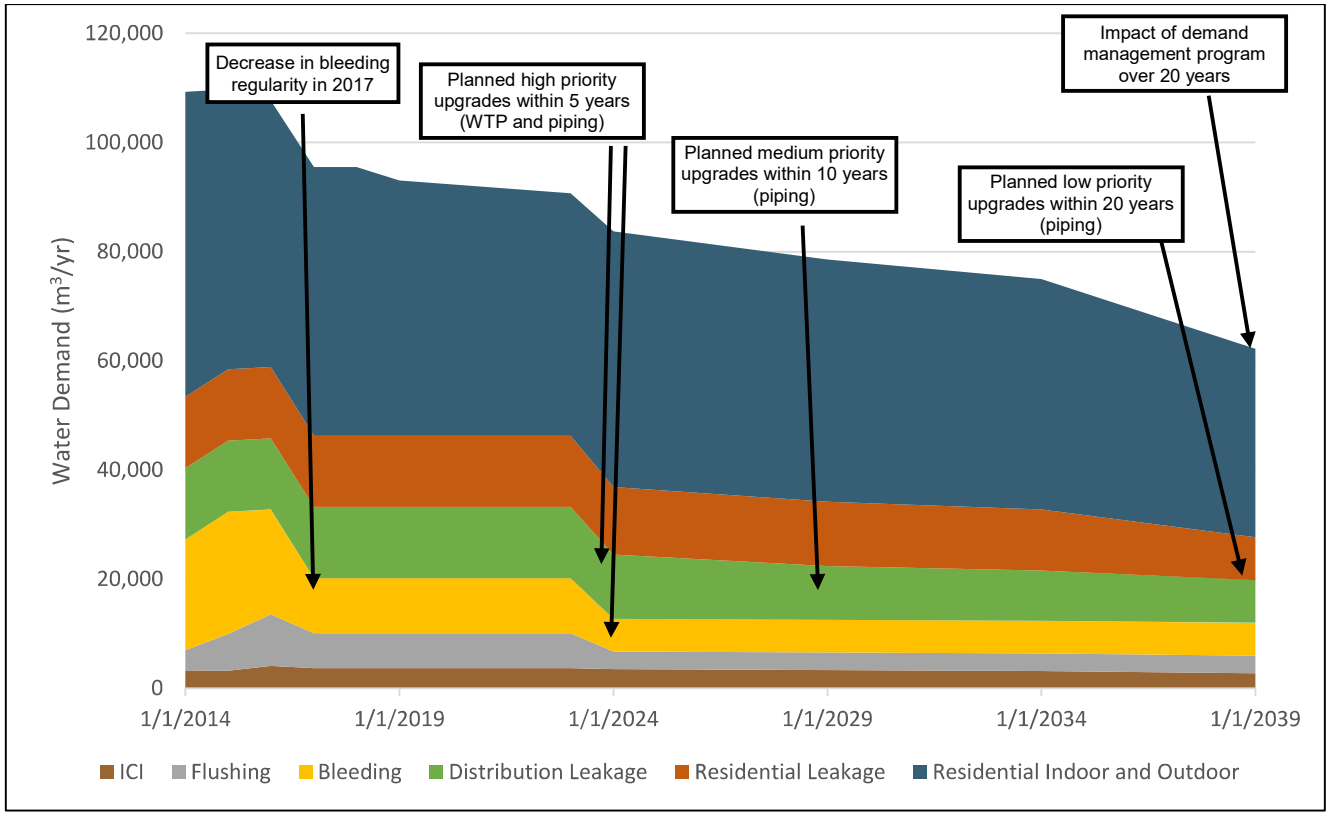

Figure 2: Projection of Future Water Demand by Demand Source

8. Water Conservation Measures

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 or are planned for implementation as required.

8.1 Current Measures

1. **Regulation** – In 2018, GBID passed the Water Tolls and Other Charges Bylaw No. 228, 2018 which provides a fixed base rate for residential connections and a fixed base rate plus metered rate for ICI connections.
2. **Regulation** – In 2018, GBID passed the Water Distribution Regulation Bylaw No. 226, 2018 which defines regulations for water use including:
   a. establishing authority to install water meters on all properties; and
   b. introducing potential for sprinkling restrictions.
3. **Retail metering and volume-based pricing program** – As of 2018, all ICI connections are currently metered with volume based pricing outlined in Bylaw 228. Costs for this program include: meter supply and installation, meter reading, billing, customer care, maintenance and renewal.

8.2 Planned Measures

1. **Water Treatment Plant Upgrades** – These upgrades are outlined in the GBID Master Water Plan. The upgraded system will include better looping to keep water fresh and the treatment process will decrease the rate that the chlorine residual declines in the system. These upgrades are projected to decrease the system flushing requirements to the levels of regular O&M activities for well-designed systems.
2. **Watermain Upgrades** – These upgrades are outlined as high priority (5 years), medium priority (10 years) and low priority (20 years) items in the GBID Master Water Plan. The planned upgrades may replace most of the existing piping network and substantially reduce distributional leakage. Repairs and upgrades can be prioritized to address areas with the greatest leakages in an orderly fashion.
3. **Demand Management Program** – GBID will design and implement a program to reduce peak and annual water use to allow deferral of capacity upgrades, including a community awareness campaign. Potential elements of the plan are outlined in Appendix B.
4. **Residential metering program** – All new and existing residential customer connections to the water system will be fitted with a water meter by 2021. This will assist GBID with identifying residential leakage and overconsumption. Costs for implementing this program include: meter supply and installation, meter reading, billing, customer care, maintenance and renewal.
5. **Consumption based billing program** – Metered customers may be billed for water service based on water consumption. Developing appropriate rate structures can achieve stable revenues and appropriate incentives to reduce base and peak demands. Potential specifications for the billing program are outlined in Appendix C.
6. **Reporting usage and water budgets on water bills** – Displaying information about water use on water bills will raise customer awareness about their water use. Comparing each customer's water use to a system average, or to a water use budget based on system constraints will enable customers to make informed and timely decisions about how they use water.
7. **Water Conservation Plan Renewal** – A review of this plan will be conducted approximately every five years to update forecasts and targets, consider additional information, and adjust program activities as required to meet targets.

9. Program Implementation Responsibility, Cost and Schedule

The GBID Water Committee will have overall responsibility for the water conservation program. The program will be budgeted under the water fund. Most of the planned items will proceed within the next two years (subject to budget approvals), and are consistent with recommendations of the GBID Master Water Plan.

10. Linkages to Other Plans and Policies

This Plan supports the Texada Island Official Community Plan; GBID Master Water Plan and GBID bylaws.

Report Submission

Prepared by:

KERR WOOD LEIDAL ASSOCIATES LTD.

This document is a copy of the sealed and signed hard copy original retained on file. The content of the electronically transmitted document can be confirmed by referring to the filed original.

Jessica LeNoble, MASc, EIT
Junior Environmental Engineer

Jurek Janota Bzowski, PEng
Project Engineer

Reviewed by:

Colwyn Sunderland, A.Sc.T.
Technical Reviewer

Statement of Limitations

This document has been prepared by Kerr Wood Leidal Associates Ltd. (KWL) for the exclusive use and benefit of Client Name for the Water Conservation Plan. 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	May 16, 2018	Final	Report submitted as final	JLN
A	April 23, 2018	Draft	Report submitted as draft to client for review and comments	JLN

OQM CERTIFIED

KERR WOOD LEIDAL
consulting engineers

Appendix A

Existing Future Serviced Lots

GILLIES BAY IMPROVEMENT DISTRICT
Gillies Bay Water Conservation Plan

Legend

- Reservoir
- Booster Pump
- Hydrant
- Contour Index (10m)
- Contour Intermediate (2m)

Existing Water Mains

- 100 mm dia
- 150 mm dia
- 300 mm dia

Service Connections

- Existing Connections
- Potential Future Lot Division
- Potential Future New Connections

Note: Potential future lot division (dark green) represents lots that may be developed to have multiple connections (houses) in the future.

Reference: Orthophoto provided by Powell River Regional District.

KERR WOOD LEIDAL consulting engineers

100 0 100 (m)

1:6,000

Project No.	Date
3458-005	April 2018

Existing and Future Serviced Lots

Appendix A

KERR WOOD LEIDAL
consulting engineers

Appendix B

Table B-1: Potential Elements of GBID Demand Management Plan

Table B-1: Potential Elements of GBID Demand Management Plan

Program	Implementation Rate	Estimated Water Savings Range[1]	Selected Savings[2]	Total Demand Reduction over 10 Years		Rough Annual Cost	Notes/Assumptions
				(L/capita/day)	(m^3/year)		
Education	10 Year Program	0-2% of total	0.5%	4	528	$5,000-$10,000	Assumes distribution of education material during implementation of water conservation measures. Although education is ineffective in isolation, it is a necessary component for all other program measures.
Irrigation Audits and Restrictions	10 Year Program	30% or more of irrigation	30%	92	12295	$10,000-$20,000	Recent experience has shown that retrofit rebate programs have not had a cost effective reduction on water demand. Landscape and irrigation auditing alongside summer restrictions and education have proven to have more cost effective savings. For example, District of North Vancouver reduced irrigation demand by over 50% using this method.
Residential Water Audits and Retrofits	10% of homes per year	45 L/capita/day	45 L/capita/day	45	6028	$12,500-$15,500	Assumes all houses reduce leakages and are retrofitted with low flush toilets and low flow showerheads and faucets.
Clothes Washer Rebate/Education Program	Half of all homes over 10 Year Program	37-50 L/day per residential connection	37 L/day/residence	12	1594	$12,000-$14,000	Assume half of residents replace older clothes washers with high efficiency models. Program can either be to offer rebates for new purchases or an education program
ICI Audits	Audit every 2 years	25% per ICI connection	25%	7	896	$14,000-$18,000	Typical water savings of 35% for hotels and 30-80% for restaurants
Residential Metering and Volume Based Pricing	Meters within 2 year, volume based pricing to follow	10-45% per residential connection	20%	83	11103	$70,000-$100,000	Water demands decreased by 15% in 2006-2007 in the District of Chetwynd and 25% in 2005-2008 in West Vancouver following universal metering and volume based billing. Assumes $1000 capital cost per meter.
Total Reduction over 10 years				**242**	**32443**		
% Reduction of Total Demand				**31%**			

1. Estimates are generic and based on best available information.
2. There may be some overlap between program savings. Therefore, total program savings may be lower than estimated if several measures are implemented.

KERR WOOD LEIDAL
consulting engineers

Appendix C

Table C-1: Suggested Design Parameters for Residential Water Rates

Table C-1: Suggested Design Parameters for Residential Water Rates

Parameter
• A fixed base charge per connection on every water bill should cover at least two thirds of the utility's annual revenue needs (same for all customer types, but consider higher charges for connections with meters larger than 1" if there are any).
• Residential accounts should have a three-tier inclining block consumption charge
• Non-residential accounts should have a uniform consumption charge equal to the residential Tier 2 charge.
• The Tier 1 and 2 consumption charge revenues should be sufficient to cover all of the annual revenue needs that are not covered by fixed charges and other miscellaneous revenues (service fees, late payment penalties etc).
• The Tier 1 rate should be about 2/3 of the Tier 2 rate.
• The Tier 1-2 threshold should cover all residential consumption up to what we estimate the base (winter/indoor) demand would be for 2 people in a house with efficient fixtures (say 160 L/ca/d = about 120 m^3/year, or 20 m^3 every 2 months).
• The Tier 2-3 threshold should be high enough to cover all base demand for a family of four or five with efficient fixtures (say 40 or 50m^3 every 2 months).
• The Tier 3 rate should be about 2x the Tier 2 rate, providing a strong incentive to minimize irrigation use or for large households to retrofit toilets and washing machines but not so much that watering a modest garden would cost more than a few hundred dollars per year.
• The Tier 3 consumption charge revenue would be contributed to a dedicated reserve fund that could be used for special water conservation initiatives (e.g. incentives to convert lawns to drought-tolerant landscaping), and/or to build up a fund to cover increased costs and lower revenues in drought years.

Figure C-1 illustrates tiered components for a potential water rate program.

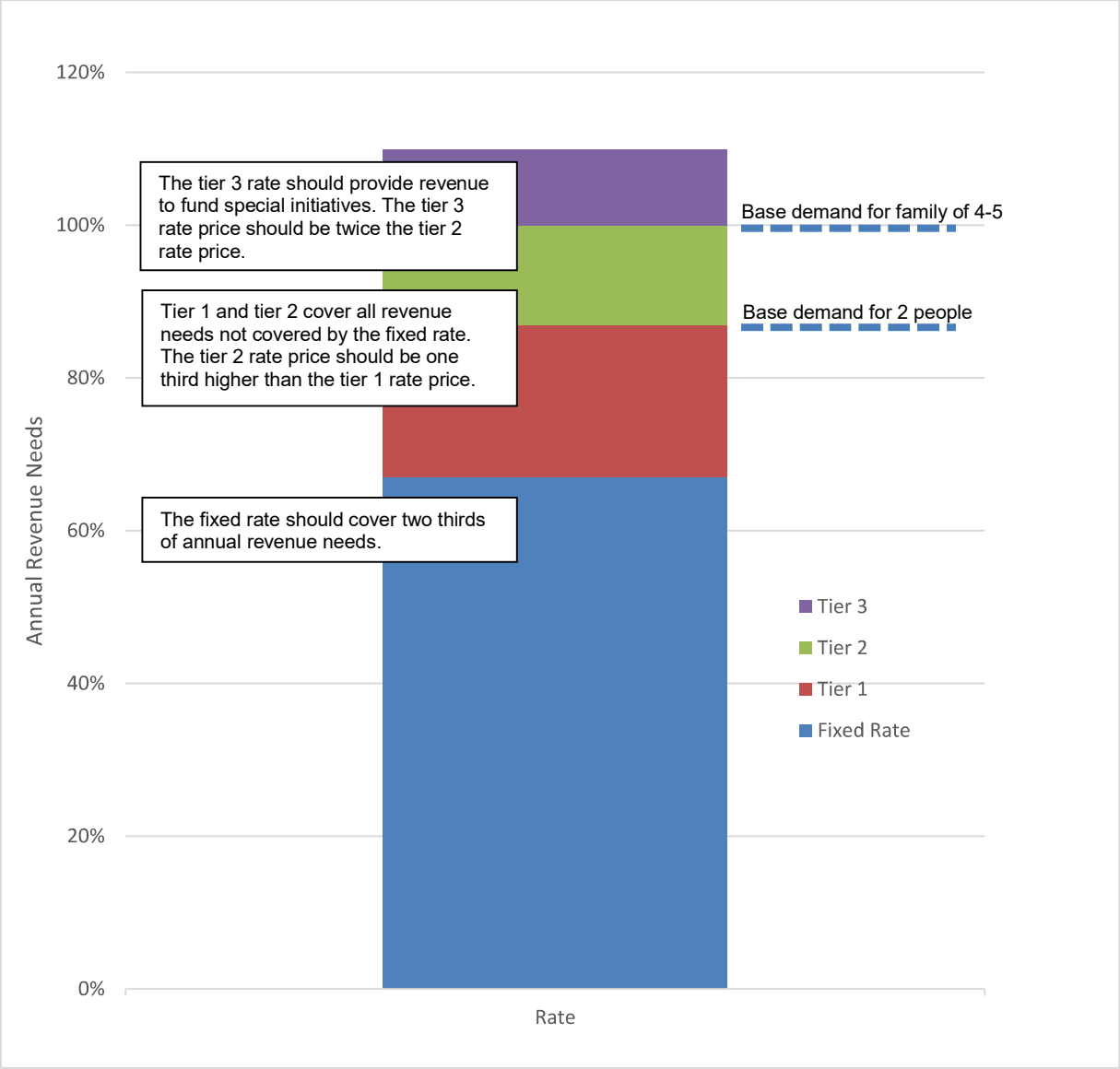

Figure C-1: Tiered Components for a Potential Water Rate Program