Regional District of Nanaimo
Water Service Areas
Water Conservation Plan - 2020-2030

June 2020

Prepared by:

econics

www.econics.com
info@econics.com
+1 250 588 6851

Table of Contents

Appendices

List of Tables

List of Figures

Executive Summary

The Regional District of Nanaimo (RDN) is committed to providing residents and businesses within its nine Water Service Areas (WSAs) with ample, high quality drinking water. By using this invaluable resource as efficiently as possible, together we can ensure that it will be there for us all in the future.

Building on its 2013 predecessor (Aquavic, 2013), this updated Water Conservation Plan sets out a refreshed direction for the decade from 2020 to 2030. It provides objectives for this next operational period, sets out a renewed program and suite of measures, establishes data-based targets, and outlines implementation strategies and schedules. The scope applies to the nine RDN WSAs listed in the following table:

RDN's Water Service Areas

Water Service Area	Year Established	Water Source	Number of Connections
Decourcey	1998	Groundwater (1 well)	5
Englishman River	2003	Groundwater (well series)	151
French Creek	1980	Groundwater (well series)	238
Melrose Terrace	2005	Groundwater (1 well)	28
Nanoose Bay	2005	Groundwater supplemented from Englishman River	2205*
San Pareil	1999	Groundwater (well series)	288
Surfside	1986	Groundwater (2 wells)	39
Westurne Heights	2016	Groundwater (1 well)	17
Whiskey Creek	2011	Surface water (Crocker Creek)	125

From a community sustainability perspective, conservation will contribute to making RDN's water supplies more resilient to seasonal and longer-term droughts. Climate change will place more stress on drinking supplies and environmental flows for fish and ecosystems. To mitigate this, decreasing per capita use is a top priority. Addressing high summer use is another priority. Controlling seasonal spikes in consumption will enable RDN to maximize existing infrastructure and may contribute to deferral of costly capital upgrades.

Water Conservation Plan Objectives

The following supporting objectives will guide implementation of this plan:

- continue to reduce per capita production and consumption in all WSAs year round;
- continue to reduce peak demand in the summer in order to better prepare for climate change impacts and improve resiliency to drought and other water shortages;
- focus resources to provide additional support to residents or WSAs with above average demand;
- improve understanding of non-revenue water and better manage system losses from leakage and other sources;
- support RDN's asset management program; and,
- foster a water stewardship ethic and ensure we collectively act as good neighbours to surrounding communities who share use of our aquifers and streams.

While the scope of this plan focuses narrowly on water conservation within the boundaries of RDN's WSAs, the objectives above are nested within the broader vision, mission and goals of the regional DWWP Action Plan 2.0.

2020 - 2030 Water Conservation Program

The updated program builds on years of work by RDN, partners and residents under RDN's Team WaterSmart program, the 2013 Water Conservation Plan, and the DWWP Program. It places strong emphasis on helping residents becoming more efficient and positioning RDN to make better-informed decisions around water management in the future. In some cases, the measures are enhancements of tools that are already in place. In other cases, new programs will be developed and implemented. Actions are organized around five themes:

1. **Reduce Outdoor Water Use**: enhance effectiveness of existing incentives and regulations to help residents reduce outdoor irrigation of lawns and gardens.

2. **Implement a Commercial, Institutional and Multi-Family Residential Pilot Project:** help the small group of WSA customers that do not fall into the single family residential category control their consumption.

3. **Review Water Service Rates to Optimize Conservation-Orientation:** as part of a planned review aimed primarily at ensuring revenue sufficiency, review rates and the rate structure to ensure they provide incentives to conserve.

4. **Improve Water Use Accounting and Management of Non-Revenue Water:** improve data on consumption and production, identify sources of non-revenue water including leakage, and implement appropriate measures to control losses.

5. **Continue Team WaterSmart Outreach Implementation:** raise awareness of the importance of water conservation, assist residents to reduce use indoors, continue outreach to youth, and foster a community stewardship ethic.

The following table provides a summary of the program measures under each theme, their current status, and the sectors they target.

2020-2030 Water Conservation Plan Program Summary

Theme	Code	Measure	Status	Sector
#1 Reduce Outdoor Water Use	1.1	Residential irrigation system check-ups	Enhance	Residential
	1.2	Irrigation upgrades and soil improvements rebate	Continuing	Residential
	1.3	Outdoor watering restrictions	Continuing	All
#2 Commercial, Institutional and Multi-Family Residential Pilot Project	2.1	Commercial, institutional and multi-family pilot project	New	Commercial, Institutional and Multi-Family
#3 Review Water Service Rates	3.1	Water service rate review	Enhance	All
#4 Improve Water Use Accounting and Management of Non-Revenue Water	4.1	Water use accounting improvement and water audit	Enhance	Water Utility
	4.2	Non-revenue management water and reduced system losses	Enhance	Water Utility
#5 Continue Team WaterSmart Outreach Implementation	5.1	Team WaterSmart publications, events and online resources	Continuing	Residential
	5.2	Team WaterSmart youth outreach	Continuing	Residential
	5.3	Rainwater harvesting rebate	Continuing	Residential

Plan Targets and Implementation

RDN will pursue realistic water production and use targets to measure success towards implementation of this plan, as follows:

Target 1: Residential Consumption

- Reduce single family residential consumption by 15% to 275 liters per capita per day (LCD) by 2030, benchmarked against 323 LCD in 2018/19.

Target 2: Peak Season Demand

- Maintain maximum month average day total water production at or below 5,300 cubic meters per day, benchmarked against the July 2018 daily average.

Target 3: Non-Revenue Water

- Quantified target to be established as an early implementation priority.

Implementation will continue between 2020 and 2030. Early priorities include the following:

- complete a water audit commencing in 2020 to improve understanding of non-revenue water and sources of loss;
- based on water audit results, develop and commence implementation of an ongoing system loss management program in 2020/21;
- in 2021, identify and implement enhancements to the irrigation system check up program;
- in 2022, conduct a water services rate review that includes investigation of conservation-oriented pricing in its scope; and,
- in 2023, design and implement the commercial, institutional and multi-family residential pilot project.

Plan implementation will be led by RDN's Water Services Department. Regular progress reports will be provided to the RDN Board. Consistent with the path set out in the DWWP Action Plan 2.0, implementation will follow an adaptive management framework. This means learning from experience and responding as needed to fine-tune delivery in response to feedback and outcomes.

By continuing to encourage efficient water use, this plan will play an integral role in making WSA communities more sustainable. It will help us adapt to future pressures from climate change and provide a range of other social, ecological and financial benefits. It will also support ongoing pursuit of the DWWP Action Plan 2.0's vision for healthy, safe and resilient water resources in the region, enabled through strong partnerships.

1.0 Introduction

The Regional District of Nanaimo (RDN) is committed to providing residents and businesses within its nine Water Service Areas (WSAs) with ample, high quality drinking water. By using this invaluable resource as efficiently as possible, together we can ensure that it will be there for us all in the future. This is particularly important in light of a changing climate, which will place increasing pressure on streams and aquifers and may lead to increased scarcity as summers become drier and longer.

In 2013, the first RDN Water Conservation Plan was completed (Aquavic, 2013). Implementation commenced in 2014. This updated Water Conservation Plan sets out a refreshed direction for the decade from 2020 to 2030. It provides objectives for this next operational period, sets out a renewed program and suite of measures, establishes data-based targets, and outlines implementation strategies and schedules. It balances between ensuring that customers can use water to enjoy the amenities of their homes, businesses and outdoor spaces while continuously improving efficiency. It also supports ongoing implementation of RDN's Drinking Water and Watershed Protection (DWWP) Action Plan 2.0 and its vision for healthy, safe and resilient water resources in the region, enabled through strong partnerships.

The plan has seven main parts, as follows:

- Section 2 discusses the benefits of water conservation;
- Section 3 provides background and history on the plan;
- Section 4 is an overview of the WSAs and a profile of water use;
- Section 5 sets out the plan objectives;
- Section 6 is a brief inventory of current water conservation programs;
- Section 7 outlines the 2020 - 2030 Water Conservation Program under five themes;
- Section 8 provides a high level implementation plan including targets, a schedule, early priorities, and a monitoring and evaluation framework.

How This Plan Was Developed

Creation of this updated plan commenced in early 2020. The first step involved a review of RDN's current conservation program including strengths, challenges and opportunities (see Technical Memo #1). Subsequent steps included quantitative analysis of water production and consumption trends building on recent RDN analysis (see McSorley, 2018b), and demand forecasting (see Technical Memo #2). Work was facilitated by a series of virtual workshops with RDN staff engaged in utility management and conservation program administration. These workshops looked at issues such as program objectives, targets, delivery themes and measure selection. Feedback from the community was solicited via the RDN "Get Involved" online portal, which included information about the project and a short survey. This was advertised via information in a utility bill insert and social media posts. Plan development was generally guided by direction in the Province's Water Conservation Guide (Province of BC et. al., 2013) as well as North American industry best practices as set out in AWWA (2006), AWWA (2013), Maddaus (2014), and Vickers (2001).

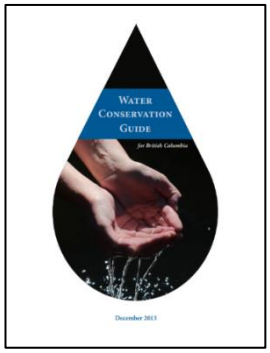


Figure 1: BC Water Conservation Guide

2.0 Benefits of Water Conservation

Benefits of conservation vary from community to community depending on capital expansion plans, operating costs, energy use, the current demand profile, the water loss rate, and environmental drivers, among other factors. However, some typical environmental, financial, and community benefits residents might gain from implementation of this plan include the items listed in Table 1, below.

Table 1: Benefits of Water Conservation

Community Benefits	**Financial Benefits**
• enhanced resilience to prolonged drought and a changing climate • retained water in aquifers and reservoirs for firefighting and other emergency needs • potentially enhanced drinking water quality, particularly during times of shortage • enhanced aquatic recreation opportunities • greater equity and fairness (those who waste and put excessive demand on the system will pay more than those who conserve) • mitigated or avoided saltwater intrusion for coastal wells (particularly pertinent to Decourcey, San Pareil, Surfside, and Nanoose WSAs) • promotion of a stewardship ethic within the community; offers ways for individuals to reduce their own ecological footprints	• deferred or avoided capital investment in new bulk supply and treatment infrastructure (i.e., needs are met with conservation rather than new supplies) • reduced operations and maintenance costs • avoided costs for RDN and for residents from reduced energy use with less water pumping and heating • improved chances of Provincial and Federal Government infrastructure funding and other grants by adoption of best practices • reduced peak demand – the point at which water use is greatest (usually hot summer days) - provides the opportunity to downsize new pipes, pumps, treatment plants and reservoirs, resulting in significant cost savings
Environmental Benefits	**Policy and Legislative Linkages**
• reduced or avoided impacts from construction of new infrastructure • reduced chemical use and disposal in water and wastewater treatment • reduced sewage disposal to the environment • reduced energy use and greenhouse gas emissions due to reductions in water treatment and pumping • enhanced stormwater attenuation on the land during heavy rainfall events (for example, improved soils hold more water longer) • maintained environmental flows for streams, fish and aquatic ecosystems	• supports objectives in the *RDN Board Strategic Plan 2019-2022* • supports objectives in RDN's *Regional Growth Strategy* • Supports objectives in RDN's *Asset Management Policy* • Supports objectives in RDN's *Liquid Waste Management Plan* • supports implementation of the *Drinking Water and Watershed Protection Action Plan* • contributes to meeting obligations under the Province's *Water Sustainability Act*, *Drinking Water Protection Act* and *Environmental Management Act*

From a community sustainability perspective, conservation will contribute to making RDN's water supplies more resilient to seasonal and longer-term droughts. Within our region, climate change models project increases in hot and dry conditions (RDN, 2020a). More precipitation will fall as rain due to warmer winter temperatures, which results in less snowpack accumulation at elevation (RDN 2020b). Long-term drawdown of aquifers is also a concern. All of this could place more stress on drinking supplies and environmental flows for

fish and ecosystems in creeks that rely on seasonal groundwater contributions for baseflow. To mitigate this, decreasing per capita use is a top priority.

As discussed below in Section 4.2, addressing high summer use and peak demand is another priority. Peak demand is the largest volume consumed in the WSAs in a single month, day or hour. This normally occurs in summer, coinciding with heavy lawn and garden irrigation and other outdoor use. In RDN's WSAs, this can sometimes double average demand, setting a key parameter for infrastructure design. System components (e.g., pipes and wells) must be sized large enough so they can meet demand at peak times, as well as provide extra capacity for firefighting.

Decourcey WSA, for example, depends on a single coastal bedrock aquifer. High summer use over the past few years has resulted in the need to enforce Stage 4 restrictions year-round to protect the well. Alternative sources will be difficult and costly to build for a small customer base. In Englishman River WSA, peak demand has begun to push up against pending Provincial licence allocations, and the Region has been forced to seek approval for an additional well. These examples illustrate how excess seasonal consumption place stress on the environment and create new costs for customers. Efforts to control these spikes in consumption will enable RDN to maximize existing infrastructure and may contribute to deferral of costly capital upgrades.

3.0 Background and History

This plan builds on decades of efforts aimed at improving efficiency and fostering a community sustainability ethic both in the RDN WSAs and across the region. RDN first passed bylaws prohibiting water waste as early as 1986. Through the 2000s, interest in watershed protection grew and the RDN Board identified this as a priority in its 2003-2005 Strategic Plan. This ultimately led to completion of the original DWWP Action Plan in October 2007. That plan identified education and outreach as a central theme, with associated goals to 1) promote awareness and stewardship of the watersheds and drinking water resources in the Region; and, 2) promote efficient water use in all sectors (Lanarc, 2007).

In 2008, a referendum in RDN's electoral areas led to creation of a drinking water and watershed protection service under RDN Bylaw 1556-0. Implementation commenced in 2009 with the following purposes:

a) increase the level of knowledge regarding drinking water sources to support the long-term sustainability of the water resource;
b) coordinate efforts of provincial and local governments and non-governmental organizations with respect to drinking water source protection;
c) increase the level of public awareness regarding drinking water and watershed protection requirements and strategies (RDN, 2008).

Throughout the 2010s, RDN continued to expand and improve its conservation program under the Team WaterSmart banner, bolstered by the region's four municipalities' decision to join in and support this work and the DWWP Action Plan more broadly. This greatly expanded resources and reach.

In 2013, RDN commissioned a Water Conservation Plan, completed by Victoria-based AquaVic. Like this plan, its scope was limited specifically to RDN's WSAs (numbering eight at that time). However, it also provided an example for other service providers in the region to create their own plans for their areas. It followed a planning framework set out by the Provincial Government (Province of BC, 2013) and assessed current and historical community demand and non-revenue water trends. It also set out several recommendations to add to existing conservation measures between 2014 and 2016. Finally, it set two targets for the WSAs:

- reduce average residential water use by 33% between 2004 and 2018 (a target first set in HB Lanarc, 2008); and,
- maintain maximum month water production at or below 2004 levels until 2018.

An internal assessment of progress specially on the WSA Water Conservation Plan was completed in 2018. This report examined historical trends in water use and production in each WSA and summarized attainment of program milestones. It found that, across all nine WSAs, average annual daily use per connection decreased steadily from 2004 to 2017 and that maximum month production remained below the 2004 reference level from 2011 to 2017 (McSorley, 2018b).

Also in 2018, Econics completed a comprehensive third party review of progress toward implementation of the DWWP Action Plan generally, including work on education and outreach. The report found that, overall, the program had been "remarkable and highly successful" at pursuing its goals (Econics, 2019). With respect to outreach and education specifically, major accomplishments over the past decade include the following:

- the program has created and disseminated an impressive array of water conservation and sustainability resources;
- there has been innovation in developing unique and regionally relevant education programs; and,
- partnerships for regional service delivery have been highly successful.

This 2018 review also identified a number of areas for potential enhancements, including improving branding and design, reducing the information intensity of campaigns to focus more on key messages, and innovation in how demand management programs are delivered (for example by using community-based social marketing techniques).

Today, RDN continues to deliver water conservation outreach to all residents in the region, including to its own customers in WSAs. This service is functionally administered by RDN's Regional and Community Utilities division, although several other departments are also involved. The RDN Board is ultimately responsible for program governance, supported by a community and stakeholder Technical Advisory Committee that advises on implementation.

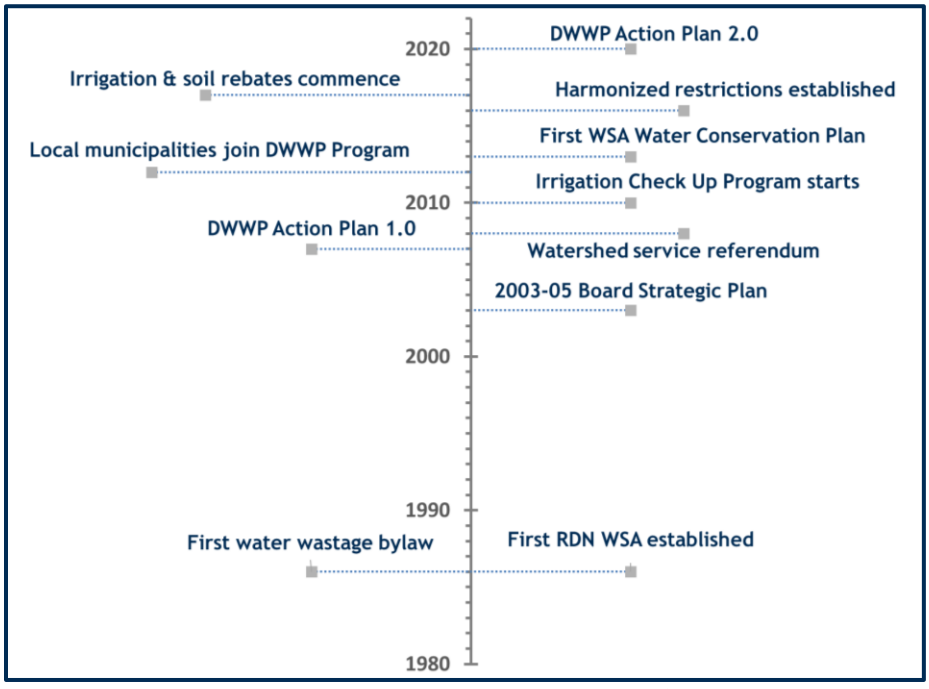


Figure 2: RDN Water Conservation Milestones

In 2019, RDN commenced an update, renew and refresh of the DWWP Action Plan, concluding in early 2020. This was driven by a multi-stakeholder structured decision making process, a resident survey and other public input, feedback from RDN departments and consultation with technical experts.

The DWWP Action Plan 2.0 retains alignment with the original objectives of the 2007 plan with increased focus on emerging challenges and priorities such as climate change. It is organized under three themes:

- Water Awareness & Stewardship;
- Water Information & Science; and,
- Water-Centric Planning & Policy Support.

Actions pertaining to water conservation are generally categorized under the Water Awareness & Stewardship theme. Ones particularly relevant to this Water Conservation Plan are summarized in Table 2.

Table 2: Select Relevant Actions and Sub-Actions from DWWP Action Plan 2.0

#	Action	Continuing Sub-Actions	New Sub-Actions
5.1.1	Enhance Water Awareness Through Community-Based Team WaterSmart Outreach	• Tours • Community events • Curriculum-connected school materials • Irrigation Check-ups • Workshops	• Community-based Social Marketing program design • Multi-media engagement • Interpretive signage and demonstration sites • Youth water leadership projects • Public surveys
5.1.2	Incentivize Sustainable Practices (Rebates)	• All current rebates	• Explore new rebate options (e.g. water flow meters for wells)
5.1.3	Create Team WaterSmart Campaigns to Target Strategic Sectors	• N /A	• Agricultural water stewardship • Commercial, institutional, industrial water stewardship
5.1.5	Coordinate with Water Service Providers	• Support small water systems • Coordinate regional watering restrictions communications	• Support regional water conservation plans

Source: Excerpted from RDN (2020b, p. 39)

The DWWP Action Plan 2.0 will guide implementation of the conservation program described in this document from 2020 to 2030 and beyond.

4.0 Water Service Areas Overview and Water Use Profile

This section provides a brief overview of RDN's nine WSAs and a summary of recent water production and consumption trends.

4.1 Systems Overview

The nine WSAs within the scope of this plan are listed below. For more information on their history and infrastructure configuration see RDN (2020c) or AquaVic (2013).

- **Decourcey** – RDN's smallest WSA with only 5 residential connections, established in 1998 in the rural area south of Nanaimo.
- **Englishman River** – established in 2003, situated in the area near the southern boundary of Parksville between the Island Highway and the Englishman River.
- **French Creek** – RDN's third largest system with 288 connections, established in 1980, and located south of the Island Highway between Parksville and Qualicum Beach.
- **Melrose Terrace** – another small system with 28 connections, established in 2005, and located near the Alberni Highway southwest of Coombs.
- **Nanoose Bay** – the largest system by far under RDN's administration with about three quarters of total connections, covering much of the Nanoose Bay Peninsula.
- **San Pareil** – established in 1999, the second largest system by number of connections, and located northeast of Parksville.
- **Surfside** – established in 1986 making it the longest managed system for RDN, located in the area north of Qualicum Beach.
- **Westurne Heights** – established in 2016 making it RDN's newest system, located two kilometers south of the Highway 4/Chatsworth Road intersection.
- **Whiskey Creek** – established in 2011, serving the Westerlea Estates subdivision located eight kilometers southwest of Qualicum Beach

Table 3: RDN's Water Service Areas

Water Service Area	Year Established	Water Source	Number of Connections
Decourcey	1998	Groundwater (1 well)	5
Englishman River	2003	Groundwater (well series)	151
French Creek	1980	Groundwater (well series)	238
Melrose Terrace	2005	Groundwater (1 well)	28
Nanoose Bay	2005	Groundwater supplemented from Englishman River	2205*
San Pareil	1999	Groundwater (well series)	288
Surfside	1986	Groundwater (2 wells)	39
Westurne Heights	2016	Groundwater (1 well)	17
Whiskey Creek	2011	Surface water (Crocker Creek)	125

* Nanoose Bay also has 64 commercial, institutional and multi-family residential connections

4.2 Water Production and Consumption

This summary of very recent water production trends builds on previous work covering earlier years. Consistent with that work, production is defined as "the total inputs of water that enters a WSA distribution system including groundwater and surface water" (McSorley, 2018b, p. 4). More details on this analysis can be found in Technical Memo #2 (Demand Analysis and Forecasting).

Per connection water production curves for the combined total of all nine WSAs are shown below in Figure 3. Values are shown in Table 4.

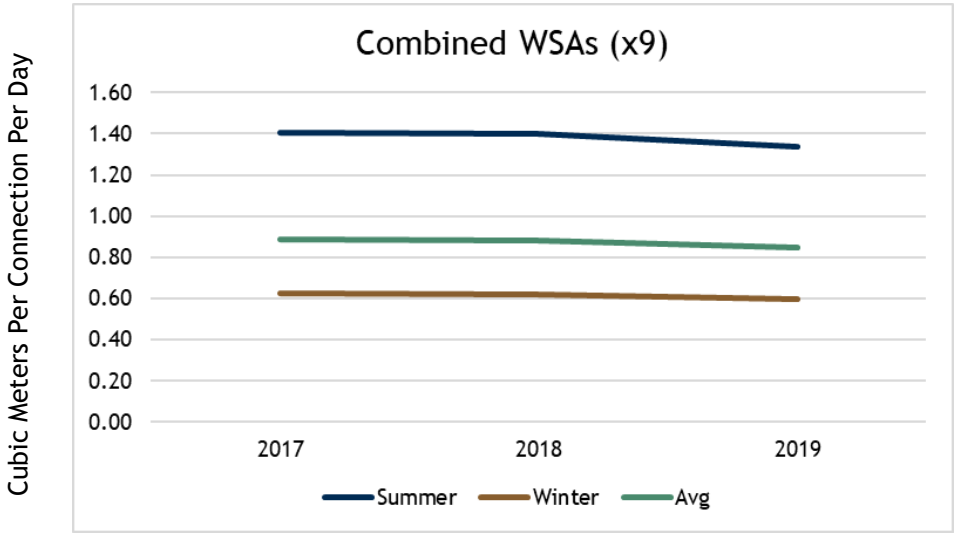


Figure 3: Per Connection Combined Water Production for All RDN WSAs, 2017 to 2019
* Includes commercial connections

No discernable trends can be detected in the production curves. This is expected when only looking at a few years of data, where structural trends in water use will be over-ridden by short term variation in seasonal weather. However, previous analysis (McSorley, 2018b; AquaVic 2013) does indicate consistent reductions in production and demand over time, which is not surprising given RDN's efforts through Team WaterSmart and trends across North America over the past decade.

Table 4: Per Connection Water Production for RDN Water Service Areas, 2017 to 2019

Water Service Area	Season	m^3/Connection/Day		
		2017	2018	2019
Decourcey	Summer	0.69	0.99	1.28
	Winter	0.29	0.34	0.31
	Average	0.43	0.56	0.64
Englishman River	Summer	2.16	2.33	2.26
	Winter	0.65	0.58	0.68
	Average	1.16	1.17	1.21
French Creek	Summer	1.08	1.04	1.07
	Winter	0.59	0.50	0.48
	Average	0.75	0.68	0.68
Melrose	Summer	0.69	0.52	0.59
	Winter	0.59	0.46	0.48
	Average	0.63	0.48	0.52
Nanoose Bay (Combined)	Summer	1.40	1.40	1.32
	Winter	0.59	0.62	0.57
	Average	0.86	0.89	0.82
San Pareil	Summer	1.56	1.49	1.44
	Winter	0.84	0.68	0.71
	Average	1.08	0.95	0.95
Surfside	Summer	1.23	1.48	1.42
	Winter	0.45	0.41	0.48
	Average	0.71	0.77	0.80
Westurne Heights	Summer	0.58	0.44	0.47
	Winter	0.40	0.41	0.34
	Average	0.46	0.42	0.38
Whiskey Creek	Summer	1.23	1.08	1.14
	Winter	0.86	0.85	0.98
	Average	0.99	0.93	1.03
Combined WSAs (x9)	Summer	1.41	1.40	1.34
	Winter	0.62	0.62	0.60
	Average	0.89	0.88	0.85

Peaking factors for both Nanoose Bay Peninsula and for the combined total of all nine WSAs can be found in Figure 4. As discussed in Technical Memo #2, note that peaking factor was calculated using the somewhat unorthodox formula set out in the figure.

Also consistent with previous analysis, both comparison of summer to base (winter) demand in Table 4 and looking at peaking in Figure 4 demonstrate that summer use in the WSAs tends to be high, without doubt driven by residential lawn and garden irrigation. This bolsters the case for continued demand management efforts targeting this end use.

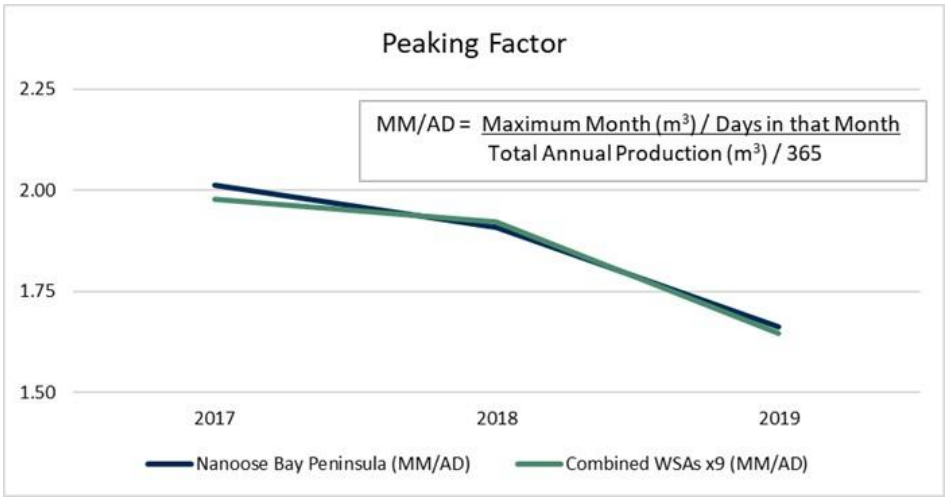


Figure 4: Peaking Factor in RDN's Nanoose Bay WSA and Combined WSAs, 2017 to 2019

In depth examination of metered residential customer consumption was not part of the scope of preparing this plan, as this was unnecessary because it was undertaken very recently under a separate project (see McSorley, 2018b). However, annual totals for the 2018/19 billing year are set out in Table 5.[1]

Table 5: Single Family Residential Metered Water Consumption, 2018/19 Billing Year

Water Service Area	2018/19 Total m^3	Connections	Liters/connection/day	Liters/capita/day
Decourcey	992	5	544	247
Englishman River	57,336	151	1040	473
French Creek	48,306	238	556	253
Melrose	4,082	28	399	182
Nanoose Bay	580,721	2205	722	328
San Pareil	71,632	288	681	310
Surfside	10,030	39	705	320
Westurne Heights	1,847	17	298	135
Whiskey Creek	27,561	125	604	275
Combined WSAs x9	**802,508**	**3,096**	**710**	**323**

[1] Liters per connection per day results in Table 5 are generally in line with findings in previous RDN analysis by (McSorley 2018b, p. 20). However, note that in three instances (Decourcey, Melrose and San Pariel) variation exceeds 30%. Resolving this was outside the scope of preparing this plan, but in the cases of Decourcey and Melrose, this could be explained by data skewing due to the very small size of these systems (e.g., just a few customers making changes to consumption, large leaks inside private properties, or meter errors can make a large difference in results). Note that no validation of this data was completed by Econics.

4.3 Commercial, Institutional and Multi-Family Residential Demand

Most consumption in the WSAs occurs in single family homes. However, there is a small group of commercial, institutional, multi-family residential, strata residential and other residential users. The breakdown of consumption by customer category can be found in Figure 5.

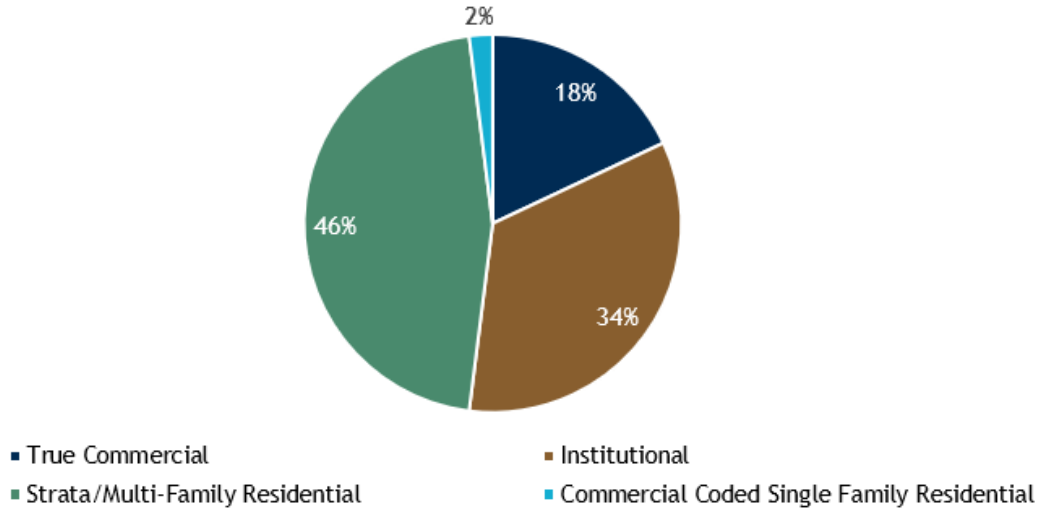


Figure 5: Commercial, Institutional and Multi-Family Residential Water Consumption, 2019 (n=66)

In total, there are 66 accounts in this group, 64 of which (and virtually all consumption) are located in Nanoose Bay Peninsula WSA. These accounts are held by an even small number of customer entities, 30 in total (i.e., some customers have multiple accounts).

New measures intended to help customer classes other than single family residential manage their water use are discussed further in Section 7.

4.4 Water Balance

Analysis of production and consumption trends yields the water balance set out in Figure 6 for the combined nine WSAs.[2]

[2] Note that water production totals used in the calculation of this water balance are slightly different than those discussed in Section 4.2, as production data used here are for the 2018/19 billing year as opposed to the 2019 calendar year in order to align with the single family residential consumption data in Table 5 (which also cover the 2018/19 billing year).

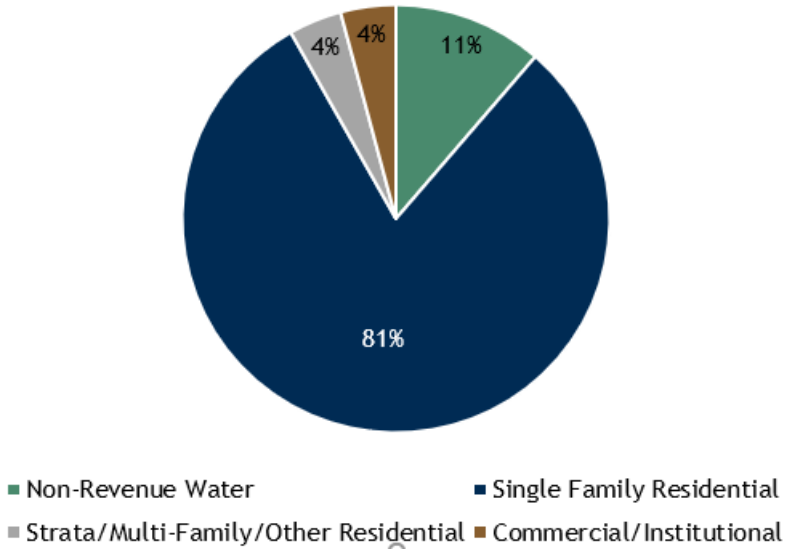


Figure 6: Estimated Water Balance for Combined RDN Water Service Areas, 2018/19

Note that there is some uncertainty around non-revenue water estimates. The analysis presented here yields an estimate of 11% of total production for 2018/19. However, other recent analysis has estimates that range from 2.4% in Surfside to as high as 44% in San Pareil (see RDN, 2020d). The estimated weighted average for these results is approximately 25%, noting that there are known operational explanations for some of this in some WSAs. Further analysis will be required to reconcile this gap. Section 7 discusses opportunities to improve water use accounting and improve management of non-revenue water as a key early priority of this plan.

5.0 Water Conservation Plan Objectives

Drinking Water and Watershed Protection Action Plan 2.0 Vision and Mission

Our vision is for healthy, safe, and resilient water resources in the region, enabled through strong partnerships.

Our mission is to provide regional leadership at the watershed scale to support water management, land-use planning, and community outreach and advance drinking water sustainability, climate adaptation, and healthy ecosystems.

Source: RDN, 2020b, p. 17

While the scope of this plan focuses narrowly on water conservation within the boundaries of RDN's WSAs, its objectives are nested within the broader vision and mission of the regional DWWP Action Plan (see Text Box).

The DWWP Action Plan 2.0 also articulates more specific goals and objectives that frame the conservation activities under this plan. These are listed in Table 6 below. Note that the second, third and fifth goals are all particularly relevant.

Table 6: Drinking Water and Watershed Protection Action Plan 2.0 Goals

1. Protect, manage and restore ecosystems and the overall health and functioning of our watersheds and aquifers.
2. Safeguard and manage source waters to secure a sustainable drinking water supply.
3. Increase water-use efficiency and optimize infrastructure investments for water and wastewater systems.
4. Foster the enjoyment and protection of social, cultural, and recreational values and amenities in our watersheds to maintain well-being and quality of life.
5. Mitigate and better prepare for climate change impacts on the region's water resources.

Source: RDN, 2020b, p. 18

In addition to these important linkages with the DWWP Action Plan 2.0, the following supplemental and supporting objectives pertain specifically to the plan in this document:

- continue to reduce per capita production and consumption in all WSAs year round;
- continue to reduce peak demand in the summer in order to better prepare for climate change impacts and improve resiliency to drought and other water shortages;
- focus resources to provide additional support to residents or WSAs with above average demand;
- improve understanding of non-revenue water and better manage system losses from leakage and other sources;
- support RDN's asset management program; and,
- foster a water stewardship ethic and ensure we collectively act as good neighbours to surrounding communities who share use of our aquifers and streams.

The vision, mission and goals of the DWWP Action Plan 2.0 and the additional supplemental objectives articulated above will continue to shape implementation over the decade to come.

6.0 Overview of Current Water Conservation Programs

The actions set out in the next section do not start from scratch. Rather, they build on years of work by RDN, partners and residents under the 2013 Water Conservation Plan and DWWP Program. This section provides a very brief inventory of current measures, many of which will continue under the updated plan. Readers wanting more information can consult Technical Memo #1 (Existing Program Review).

It is also important to note that RDN offers many other water-related programs and services not tied directly to conservation, such as Septic Smart rebates and subsidized well water quality testing (see, for example, www.rdn.bc.ca/wellsmart).

RDN's program is mainly delivered to residents across the region under the Team WaterSmart brand (see Figure 7) and have been for many years. This includes both education measures and incentives.

Figure 7: Team WaterSmart Wordmark

Relevant education measures include:

- **Community Events:** Team WaterSmart hosts staffed booths at a variety of community events across the region;
- **Youth Resources:** curriculum resources are readily available for teachers, complimented by Team WaterSmart classroom visits and watershed field trips for students in grades 4 and 5.
- **Print Resources and Online Tools:** RDN distributes guidebooks and brochures on topics such as lawn and garden best practices, with many additional resources available online at www.rdn.bc.ca/team-watersmart.

Relevant incentives Include:

- **Residential Irrigation System Check-Ups**: free home visits by qualified technicians that help residents operate their irrigation systems more efficiently.
- **Irrigation Upgrades and Soil Improvements Rebate**: rebates to help residents retrofit systems with more efficient components and improve soil structure and water retention capabilities.
- **Rainwater Harvesting Rebate:** Up to $750 in rebates are available to homeowners who install a system with 1,000 imperial gallons of storage or more.

RDN also coordinates regionally harmonized outdoor watering restrictions that specify days of the week and times that residents can irrigate lawns and gardens, staged to escalate requirements in the event of drought or other shortages.

In addition to these programs, RDN's Water Services Department helps residents manage their use by using a volume-based water services pricing structure. It also strives to ensure its own operations are efficient by promptly fixing leaks and addressing other sources of loss.

More information on these successful programs and how they will continue under this plan is provided in the next section.

7.0 2020 - 2030 Water Conservation Program

This section sets out the new and continuing measures RDN will implement over the next decade to attain the objectives set out in Section 5.

The new program places strong emphasis on helping residents becoming more efficient and positioning RDN to make better-informed decisions around water management in the future. In some cases, the measures are enhancements of tools that are already in place. In other cases, new programs will be developed and implemented.

The actions in this strategy are organized around five themes:

1. **Reduce Outdoor Water Use**: enhance effectiveness of existing incentives and regulations that help residents reduce outdoor irrigation of lawns and gardens.

2. **Implement a Commercial, Institutional and Multi-Family Residential Pilot Project:** help the small group of WSA customers that do not fall into the single family residential category control their consumption.

3. **Review Water Service Rates to Optimize Conservation-Orientation:** as part of a planned review aimed primarily at ensuring revenue sufficiency, review rates and the rate structure to ensure they provide incentives to conserve.

4. **Improve Water Use Accounting and Management of Non-Revenue Water:** Sequentially improve data on consumption and production, identify sources of non-revenue water including leakage, and implement appropriate measures to control losses.

5. **Continue Team WaterSmart Outreach Implementation:** raise awareness of the importance of water conservation, assist residents to reduce use indoors, continue outreach to youth, and foster a community stewardship ethic.

Elaboration is provided in the following pages.

7.1 Theme 1 - Reduce Outdoor Water Use

As discussed in Section 4, water use in the WSAs grows dramatically in the summer, typically more than doubling the base use in the winter. The great majority of this is due to residents irrigating lawns and gardens.

Residents enjoy working in their yards and the lifestyle benefits these green spaces provide. RDN will support them to continue to do so while also using our finite water resources in the most efficient way possible.

RDN will continue to implement and enhance the following current measures as a top priority under this updated plan:

- **Residential Irrigation System Check-Ups:** Team WaterSmart will continue to offer irrigation system check-ups. These will remain a free, voluntary, seasonal service. For those who cannot participate in check-ups, RDN will also continue to offer periodic workshops, hosted at community centres and through webinars online. More information on the program can be found at www.rdn.bc.ca/irrigation-initiatives.

- **Irrigation Upgrades and Soil Improvements Rebate:** Building on the irrigation check-ups, these rebates help residents retrofit systems with more efficient components and improve soil water retention capabilities. Up to $675 in rebates are available, and applicants who complete both irrigation upgrades and soil amendments may be eligible for a bonus of up to $100. More information can be found at www.rdn.bc.ca/irrigation-upgrades-and-soil-improvements.

- **Watering Restrictions:** regulatory approaches like watering restrictions are highly cost effective because they can make significant contributions to cutting demand without requiring large operational budgets (excepting enforcement costs). In 2015, RDN spearheaded implementation of a harmonized, region-wide restriction program after an unprecedented hot and dry summer. The schedule is divided into four stages (see Figure 8, note that Surfside and Decourcey WSAs have slightly different requirements). More detail can be found at www.rdn.bc.ca/watering-restriction-map.

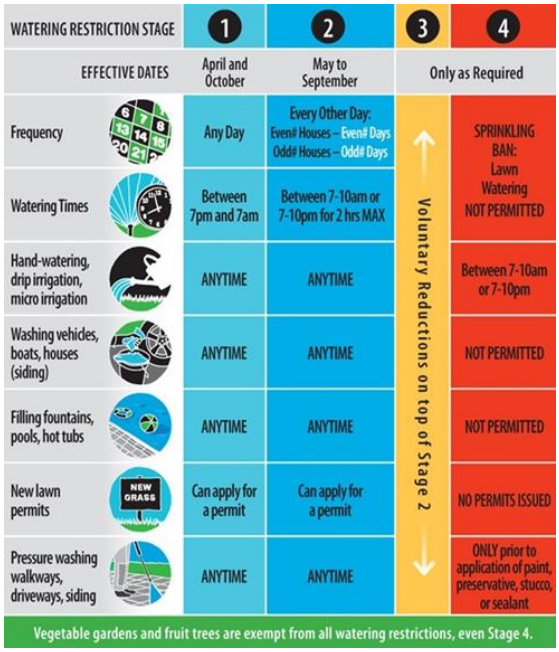


Figure 8: Regional Watering Restrictions Schedule

RDN will build on the success of these ongoing measures with the following enhancements:

- increase the number of irrigation system check ups taking place in WSAs by setting an annual target of at least fifteen (over the past decade, between five or ten of these typically happen per year in the WSAs);
- target check ups in WSAs with above average summer per connection use, particularly Englishman River;
- continuously improve how audits are done by building on international best practices and employing community based social marketing techniques (see, for example, McKenzie-Mohr, 2011);
- implement targeted and escalating enforcement of watering restrictions in WSAs and properties with known instances of repeat non-compliance;
- increase promotion of efficient outdoor use through increased Team WaterSmart outreach (see Theme #5, below).

Table 7 summarizes the core actions under this theme, expected outcomes and linkages to the plan objectives set out in Section 5.

Table 7: Theme #1 Summary

Theme 1: Reduce Outdoor Water Use		
1.1	Residential Irrigation System Check-Ups	Enhance
1.2	Irrigation Upgrades and Soil Improvements Rebate	Continuing
1.3	Outdoor Watering Restrictions	Continuing
Expected Outcome	Maintain maximum month average daily water production	
Links to Plan Objectives	• continue to reduce peak demand in the summer • focus resources to provide additional support to residents or WSAs with above average demand	

7.2 Theme 2 - Commercial, Institutional & Multi-Family Residential Pilot Project

As noted in Section 4.3, Nanoose Bay WSA has a small number of commercial, institutional and multi-family accounts (64 in total in Nanoose alone, held by only 30 unique customer entities). Altogether, they consume 8% of total water produced across all WSAs. Within, this group, most demand is concentrated in an even smaller number of accounts. The Top 10 highest volume customers (by entity, not account) make up 92% of all demand in these sectors; the Top 5 customers make up 79%.

See Technical Memo #2 (Demand Analysis and Forecasting) Section 3.0 for more information on demand in the commercial, institutional and multi-family residential sectors.

The limited amount of commercial and institutional use is tightly concentrated in a small number of locations and use types (primarily strip mall, golf course and marina), making it relatively simple to reach these customers with targeted advice.

There are also a number multi-family, bare land strata and mobile home accounts, some of which have quite high demand. RDN will work with strata councils and property managers to help these customers manage their consumption. This may include irrigation system check ups, targeted education, help with locating leaks on the customer side of the water meter, and potentially targeted incentives to replace inefficient fixtures indoors.

This theme has an important linkage with the DWWP Action Plan 2.0, which intends Team WaterSmart campaigns for new sectors including industrial, commercial and institutional (RDN, 2020b, p. 24). A successful pilot project in the WSAs can provide learnings that may inform development of a program that can later be rolled out region wide.

Table 8 summarizes the core actions under this theme, expected outcomes and linkages to the plan objectives set out in Section 5.

Table 8: Theme #2 Summary

Theme 2: Commercial, Institutional and Multi-Family Residential Pilot Project		
2.1	Commercial, Institutional and Multi-Family Pilot Project	New
Expected Outcome	Reduce per capita water demand	
Links to Plan Objectives	• continue to reduce per capita demand in all WSAs year round • continue to reduce peak demand in the summer • foster a water stewardship ethic	

7.3 Theme 3 - Review Water Service Rates to Optimize Conservation-Orientation

While the primary purpose of water rates is to ensure that there is sufficient revenue to fund continued operation of the water systems, effective volume-based pricing is a financial tool that can be used to encourage conservation. When rates are structured so that customers pay more if they use more, they will have an incentive to do so wisely and to purchase efficient fixtures and appliances for their homes and businesses.

RDN has one water user fee rate structure for all WSAs. The structure is designed with fees increasing as customers exceed established volumetric thresholds (a 'tiered' or 'inclining block' structure). Customers pay a minimum daily rate of $0.35 and then charges at different prices as consumption thresholds are passed. Table 9 shows current rates.[3]

Table 9: Regional District of Nanaimo Residential Water Service Rates

Rate per Cubic Meter per Day						
Minimum Daily Rate	**Up to 0.7**	**0.71 to 1.4**	**1.41 to 2.1**	**2.11 to 2.8**	**2.81 to 3.5**	**Over 3.51**
$0.35	$1.08	$1.23	$1.58	$1.86	$2.50	$3.75

* Displayed water and wastewater charge assumes non-discounted residential consumption rates, paid on or before bill due date, and does not include any additional surcharges or parcel taxes. See https://www.rdn.bc.ca/water-user-rates.

RDN plans to conduct a review of water rates fees and charges during the period of this plan. The primary goal of this review is to ensure that revenue is stable and sufficient enough to cover the long-term costs of running systems. However, it will also consider other objectives including affordability, fairness, and communication simplicity. The scope will also explore whether rates and the rate structure can be further optimized to encourage conservation. For example, this may include:

- shifting more of the total revenue collected from fixed charges to the volumetric portion of the rate structure, including revenue currently collected through parcel taxes;
- making the rate structure simpler by reducing the number of tiers so residents can easily understand it and better respond to the conservation price signal;
- increasing the per unit charge at the highest tiers so residents who consume lots of water (and therefore impose higher costs on the system) pay their fair share;
- consider introduction of seasonal surcharges designed to reduce summer demand.[4]

The review will follow industry best practices, including the procedures and principles set out the American Water Works Association Manual M1, Principles of Water Rates, Fees, and Charges (AWWA, 2017).

[3] In addition, properties are charged annual parcel taxes which are used to offset capital costs. These vary from one WSA to another. However, because these charges do not vary for any particular property based on the volume it consumes, the parcel taxes are not likely to significantly influence consumption decisions.

[4] See AWWA (2017) Chapter IV.5 for more information on seasonal surcharges.

Table 10 summarizes the core actions under this theme, expected outcomes and linkages to the plan objectives set out in Section 5.

Table 10: Theme #3 Summary

Theme 3: Review Water Service Rates to Optimize Conservation-Orientation		
3.1	Water service rate review	Enhance
Expected Outcome	Reduce per capita water demand	
Links to Plan Objectives	• continue to reduce per capita demand in all WSAs year round • continue to reduce peak demand in the summer • foster a water stewardship ethic	

7.4 Theme 4 - Improve Water Use Accounting & Non-Revenue Water Management

Managing non-revenue water, including system losses through leaks, is often one of the most effective and low cost ways to conserve. There are many components of non-revenue water. Some are legitimate uses, such as main flushing and fire hydrant testing. Others are sources of waste, such as easily repairable leaks and overflows. The Region strives to operate its WSAs as efficiently as possible and will invest greater effort in this over the next decade. This approach has the added benefit that, when implemented carefully, it requires no behavior change by residents and has little or no impact on people's lifestyles.

Most efforts on water loss in recent years have focused on reactive response to main breaks and leaks that surface above ground. However, there is increasing awareness within RDN of opportunities to improve non-revenue water management.

As noted above in Section 4.4, there is currently some uncertainty about current levels of non-revenue water and system losses. As a result, the first task under this theme will be to improve water use accounting and conduct a formal water audit following the procedures set out in American Water Works Association Manual of Water Supply Practices M36 (Water Audits and Loss Control Programs). This may involve conducting night flow analysis, adding additional system metering, or other system enhancements as required.[5]

Concurrently, the Region will also tighten water production and use data management. It will standardize and document tracking and reporting methods in the Water Services procedures manual. Technical Memo #2 (Demand Analysis and Forecasting, p. 32) provides preliminary guidance on required steps.

Based on results of the water audit and data management improvements, the Region will implement standard industry best practices for managing system loss as appropriate. As a starting point, these efforts will be targeted as WSAs with higher reported non-revenue water figures (i.e., San Pareil, Whiskey Creek, Nanoose Bay and Melrose Terrace).

Results of the water audit will also be used to establish measurable loss reduction targets for the next decade. See Section 8, below, for more on targets under this plan.

Looking to the future, RDN may also pilot pressure management and other more advanced system loss management techniques, both to reduce real losses in RDN WSAs and to develop learning and experience for the benefit of other service providers in the region.

Table 11 summarizes the core actions under this theme, expected outcomes and linkages to the plan objectives set out in Section 5.

[5] See AWWA (2016) Chapter 7 for further guidance on procedures and issues for water use accounting and non-revenue water management for small systems.

Table 11: Theme #4 Summary

Theme 4: Improve Water Use Accounting and Management of Non-Revenue Water		
4.1	Water use accounting and water auditing	Enhance
4.2	Non-revenue management water and reduced system losses	Enhance
Expected Outcome	• Reduce system losses	
Links to Plan Objectives	• continue to reduce per capita production and demand in all WSAs year round • improve understanding of non-revenue water and management of system losses	

7.5 Theme 5 - Continue Team WaterSmart Outreach Implementation

- **Community Events** - Team WaterSmart hosts a variety of staffed booths across the region at fairs, festivals and environmental stewardship events (see Figure 9). Booths typically utilize educational visuals and information display boards, often including giveaways such as native plants. These events provide opportunities for staff to reach many people quickly to promote programs. Opportunities to host events in the WSAs are limited, but residents can still participate when they take place in nearby communities.[6]

Figure 9: Team WaterSmart Booths at Community

- **Publications and Online Resources** - Team WaterSmart publishes a series of guidebooks and brochures on topics such as lawn and garden best practice including irrigation system management. They are attractively designed and include thorough detail for residents who are interested in applying water conservation techniques and strategies both outdoors and indoors (see Figure 10). There are also a host of resources available online.

Figure 10: Team WaterSmart Brochures

[6] Note that in 2019, Team WaterSmart hosted a 'Meet Your Neighbours' event in the Rivers Edge subdivision of the Englishman River WSA.

- **Youth Resources:** RDN delivers curriculum resources for teachers in the region that aim to engage students in ongoing learning about water sustainability, complimented by Team WaterSmart classroom visits. Field trips are also offered to students in grades 4 and 5 to the Englishman and Nanaimo River watersheds. Additional youth resources are available online.

- **Rainwater Harvesting Rebate**: Up to $750 in rebates are available to homeowners who install a rainwater collection system with 1,000 imperial gallons of storage or more. Since the program began in 2011, 15 rebates have been issued in the WSAs, averaging 1.7 per year. About half of these have been issued in Nanoose. More information can be found at www.rdn.bc.ca/rainwater-harvesting.

RDN will build on the success of these ongoing measures with the following enhancements:

- ensure that Team WaterSmart events occur regularly either within WSAs or within a short drive;
- continue to push Team WaterSmart best practice guidance into the WSA communities through events, direct mail, social media and other online channels;
- ensure that Nanoose Bay Elementary School students receive their share of water conservation youth outreach proportional to the rest of the region;
- continue to offer and promote rainwater harvesting rebates to WSA residents;
- continue to build a water stewardship ethic in the WSA communities; promote awareness of the DWWP Program and its vision, mission and goals.

Table 12 summarizes the core actions under this theme, expected outcomes and linkages to the plan objectives set out in Section 5.

Table 12: Theme #5 Summary

Theme 5: Continue Team WaterSmart Outreach Implementation		
5.1	Team WaterSmart publications, events and online resources	Continuing
5.2	Team WaterSmart youth outreach	Continuing
5.3	Rainwater harvesting rebate	Continuing
Expected Outcome	Reduce per capita demand	
Links to Plan Objectives	• reduce per capita production and consumption in all WSAs year round • continue to reduce peak demand in the summer • foster a water stewardship ethic	

8.0 Implementation

This section describes how the water conservation program will be implemented. It also provides a framework for monitoring, evaluation and continuous improvement.

Table 13 provides a summary of the program measures, their current status, and the sectors they target.

Table 13: 2020-2030 Water Conservation Plan Program Summary

Theme	Code	Measure	Status	Sector
#1 Reduce Outdoor Water Use	1.1	Residential irrigation system check-ups	Enhance	Residential
	1.2	Irrigation upgrades and soil improvements rebate	Continuing	Residential
	1.3	Outdoor watering restrictions	Continuing	All
#2 Commercial, Institutional and Multi-Family Residential Pilot Project	2.1	Commercial, institutional and multi-family pilot project	New	Commercial, Institutional and Multi-Family
#3 Review Water Service Rates	3.1	Water service rate review	Enhance	All
#4 Improve Water Use Accounting and Management of Non-Revenue Water	4.1	Water use accounting improvement and water audit	Enhance	Water Utility
	4.2	Non-revenue management water and reduced system losses	Enhance	Water Utility
#5 Continue Team WaterSmart Outreach Implementation	5.1	Team WaterSmart publications, events and online resources	Continuing	Residential
	5.2	Team WaterSmart youth outreach	Continuing	Residential
	5.3	Rainwater harvesting rebate	Continuing	Residential

8.1 Water Conservation Plan Targets

RDN will pursue realistic water production and use targets to measure success towards implementation of this plan.

Target 1: Residential Consumption

For the residential sector, RDN aims to reduce consumption by 1.5% each year for the next ten years. Much of this will occur naturally as people replace inefficient fixtures and appliances over time. The remainder will be driven by this plan. As such, RDN's targets for the WSAs (as shown in Figure 11) are:

- Reduce single family residential consumption by 15% to 275 liters per capita (LCD) by 2030, benchmarked against 323 LCD in 2018/19.

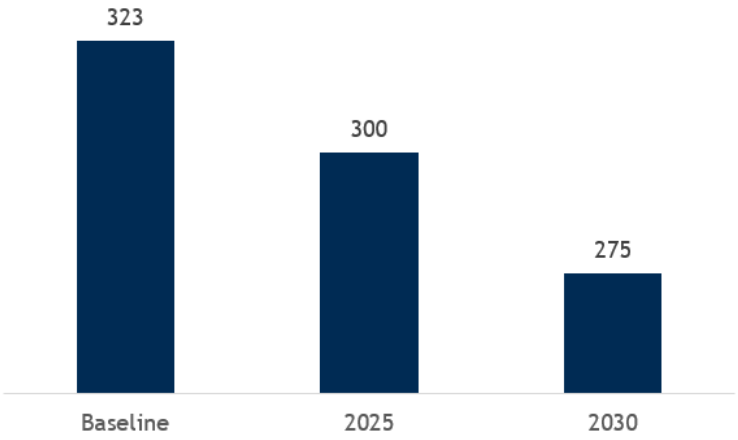


Figure 11: RDN WSA Single Family Residential Water Use Targets (Liters/Capita/Day)

Target 2: Peak Season Demand

With respect to peak demand, the target for the 2020 to 2030 operational period is aligned with the one set in the 2013 plan (AquaVic, 2013, p. 23) and aims to manage the amount of water withdrawn from streams and aquifers during the summer. Over the past five years, average production per day during the highest use month has consistently remained below 5,500 cubic meters per day (m^3/day) with an average of about 4,800 m^3/day. This is well below the 2013 target of keeping production below the 2004 level, which was about 6,270 m^3/day

Maximum month production is highly variable and heavily influenced by summer weather conditions. As well, summers are expected to become drier over the coming years. It will be challenging for RDN to reduce this figure by much going forward, notwithstanding the effort that will go towards helping residents reduce outdoor use under this plan. In light of this, the target for the next operational period is set to align with recent trends, as follows:

- Maintain maximum month average day total water production at or below 5,300 m^3/day, benchmarked against the July 2018 daily average.[7]

Target 3: Non-Revenue Water

As discussed in Section 5 (Theme #4), improving management of non-revenue water and system loss is a priority under this plan; however, there remains some uncertainty about the current situation. This will be investigated as an early implementation priority. Once these investigations have been completed and uncertainty has been narrowed, the Region will set quantified targets in this area. These will be expressed as a target reduction of non-revenue water as a percentage of total production across all WSA. Alternatively, it may be possible to express this as an infrastructure leakage index (ILI) target based on the American Water Works Association methodology.[8]

[7] Note that this is measured as the highest total combined (all WSAs) water production month in a billing year divided by number of days in that month, expressed in cubic meters per day (m^3/day).
[8] It is noted that there are limitations to the use of the ILI metric for small systems. However, it may be possible to develop a reliable ILI specifically for Nanoose Bay Peninsula WSA. AWWA (2016), Chapter 7 provides further guidance on this issue.

8.2 Monitoring and Evaluation

Indicators from each program theme are compiled in Table 14. These are intended to support the strategic targets set out above. Performance will primarily be measured through staff tracking.

Table 14: Program Indicators and Metrics

Theme	Indicators	Metrics
#1: Reduce Outdoor Water Use	Peak season demand	Maximum month production
	Compliance with the watering bylaw	Number of watering bylaw warnings issued
	Irrigation Check Up Uptake	Check ups in WSAs per year
	Irrigation and soil rebates	Rebates in WSAs per year
#2: Commercial, Institutional and Multi-Family Residential Pilot Project	Site audits or visits completed	Number of facilities audited
	Reduced water use in target sectors	Percent change in average non-single family residential metered consumption
#3: Review Water Service Rates	Review completed	Board approves new rates and/or rate structure post review
#4 - Improve Water Use Accounting and Management of Non-Revenue Water	Water audit completed	Result approved by RDN senior management
	Volume of water losses (real and apparent)	m^3/service connection/year
	Volume of non-revenue water	Percent of total system production
#5 - Continue Team WaterSmart Outreach Implementation	Per capita demand	Percent change in single family residential per capita consumption (LCD)
	Event delivery	Number of events delivered within 10 minute drive of a WSA annually
	Rainwater harvesting rebate uptake	Number of rebates issued in WSAs per year

8.3 Implementation Schedule

A summary schedule for implementation is outlined in Table 15 on the next page. This may be modified as requirements are more clearly defined.

Early implementation priorities include the following:

- complete a water audit commencing in 2020 to improve understanding of non-revenue water and sources of loss;
- based on water audit results, develop and commence implementation of an ongoing system loss management program in 2020/21;
- in 2021, identify and implement enhancements to the irrigation system check up program;
- in 2022, conduct a water services rate review that includes investigation of conservation-oriented pricing in its scope; and,
- in 2023, design and implement the commercial, institutional and multi-family residential pilot project.

Table 15: Water Conservation Plan Implementation Schedule

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
#1: Reduce Outdoor Water Use											
Residential irrigation system check-ups											
Irrigation upgrades and soil improvements rebate											
Outdoor watering restrictions											
#2: Implement Commercial, Institutional and Multi-Family Residential Pilot Project											
Commercial, institutional and multi-family pilot project											
#3: Review Water Service Rates											
Water service rate review											
#4: Improve Water Use Accounting and Management of Non-Revenue Water											
Water use accounting improvement and water audit											
Non-revenue management water and reduced system losses											
#5 Continue Team WaterSmart Outreach Implementation											
Team WaterSmart publications, events and online resources											
Team WaterSmart youth outreach											
Rainwater harvesting rebate											

Legend	
	Implementation commencement
	Ongoing continuation

8.4 Adaptive Management

Consistent with the path set out in the DWWP Action Plan 2.0, implementation will follow an adaptive management framework. This means learning from experience and responding as needed to fine-tune delivery in response to feedback and outcomes (RDN, 2020b, p. 46). Progress towards targets set out in Section 8.1 and objectives in Section 5 will guide this. The formal date for updating the plan is 2030, but it may be reviewed before then if appropriate.

Plan implementation will be led by RDN's Water Services Department. Regular progress reports will be provided to the RDN Board. Staff may also periodically seek advice from WSA residents, the DWWP Technical Advisory Committee, and other stakeholders as appropriate.

9.0 Conclusion

This document sets out RDN's Water Conservation Plan for its Water Service Areas for the period from 2020 to 2030. By continuing to encourage efficient use, this plan will play an integral role in making WSA communities more sustainable. It will help us adapt to future pressures from climate change and provide a range of other social, ecological and financial benefits. It will also support ongoing pursuit of the DWWP Action Plan 2.0's vision for healthy, safe and resilient water resources in the region, enabled through strong partnerships.

10. References

American Water Works Association (2006). Water Conservation Programs – A Planning Manual. Manual of Water Supply Practices M52, Denver CO.

American Water Works Association (2013). Water Conservation Program Operation and Management. Manual G480-13. Denver CO.

American Water Works Association (2016). Water Audits and Loss Control Programs, Manual of Water Supply Practices M36, 4th ed., Denver.

American Water Works Association (2017). Principles of Water Rates, Fees and Charges. Manual of Water Supply Practices M1, Denver CO.

Aquavic Water Solutions (2013). Water Conservation Plan. Prepared for RDN, October 2013.

Brandes, O., Renzetti, S., Stinchcombe, K. (2010). Worth Every Penny: A Primer on Conservation-Oriented Water Pricing. Accessed 17 November 2019. Accessed at https://poliswaterproject.org/polis-research-publication/worth-every-penny-primer-conservation-oriented-water-pricing/.

Econics (2018). Regional District of Nanaimo Drinking Water & Watershed Protection Program: 10 Year Action Plan Implementation Review. Prepared for Regional District of Nanaimo, September 2018.

HB Lanarc Consultants Ltd. (2008). Innovative Options and Opportunities for Sustainable Water Use. Prepared for Regional District of Nanaimo, 22 May 2008.

International Water Association (IWA) (2000). Losses from Water Supply Systems: Standard Terminology and Recommended Performance Measures. The Blue Pages.

Lanarc (2007). Drinking Water and Watershed Protection Action Plan. Prepared for the Drinking Water-Watershed Protection Stewardship Committee, Nanaimo BC, October 2007.

Maddaus, L., Maddaus, W., Maddaus, M. (2014). Preparing Urban Water Use Efficiency Plans: A Best Practice Guide. IWA Publishing, London, UK.

McKenzie-Mohr, D. (2011). Fostering Sustainable Behavior: An Introduction to Community-Based Social Marketing. 3rd ed. New Society, Gabriola Island.

McSorely, H. (2018a). Team WaterSmart Free Irrigation Check-Up Service: Conservation Program Impact Evaluation. Report prepared for Team WaterSmart, Drinking Water & Watershed Protection Program, Regional District of Nanaimo, March 2018.

McSorely, H. (2018b). Water Conservation Evaluation: Targets, Trends and Trajectories. Report prepared for Regional District of Nanaimo, June 2018.

Province of British Columbia, POLIS Project on Ecological Governance, and Okanagan Basin Water Board (2013). Water Conservation Guide for British Columbia, Victoria, December 2013.

Regional District of Nanaimo (2008). A Bylaw to Establish A Drinking Water and Watershed Protection Service. Bylaw No.1556. Accessed online at www.rdn.bc.ca/cms/wpattachments/wpID2501atID7171.pdf. Accessed on 7 May 2020.

Regional District of Nanaimo (2019). Team WaterSmart. Retrieved February 20, 2020, from www.rdn.bc.ca/team-watersmart.

Regional District of Nanaimo (2020a). Action on Climate Change. Website. Accessed at www.rdn.bc.ca/action-on-climate-change. Accessed on 26 April 2020.

Regional District of Nanaimo (2020b). Drinking Water and Watershed Protection Action Plan 2.0 (2020 – 2030+) Nanaimo BC.

Regional District of Nanaimo (2020c). WaterSmart Communities. Website. Accessed at www.rdn.bc.ca/watersmart-communities. Accessed on 27 April 2020.

Regional District of Nanaimo (2020d). mw-RDN Nonrevenue water summary. Microsoft Excel Spreadsheet.

Vickers, Amy (2001). Water Use and Conservation. WaterPlow Press, Amherst, MA.

10.1 Resources

The following list provides various resources from leading jurisdictions, non-governmental organizations and other agencies that may assist with implementation of the themes and measures in this plan.

Theme 1: Reduce Outdoor Water Use

Water Smart Irrigation Professionals (York and Peel Regions and Landscape Ontario)
https://www.watersmartirrigationprofessional.ca/

Fusion Landscape Professional (York and Peel Regions and Landscape Ontario)
https://www.fusionlandscapeprofessional.ca/

Sustainable Landscapes: A Utility Program Guide (Alliance for Water Efficiency)
https://www.allianceforwaterefficiency.org/impact/our-work/sustainable-landscapes-utility-program-guide (note this is a "members only" benefit)

Theme 2: Commercial, Institutional & Multi-Family Residential Pilot Project

Canadian Best Practice Jurisdictions

York Region, Ontario
https://tinyurl.com/y8m5gxmn
Region of Peel, Ontario
https://www.peelregion.ca/watersmartpeel/businesses/indoorwater.htm
Waterloo Region, Ontario
https://www.regionofwaterloo.ca/en/doing-business/water-programs-and-funding.aspx
City of Guelph, Ontario
https://guelph.ca/living/environment/water/rebates/watersmartbusiness/

Seneviratne, M. (2007). A Practical Approach to Water Conservation at Commercial and Industrial Facilities. ISBN: 9781856174893

Resource Library (Alliance for Water Efficiency)

Theme 3: Review Water Service Rates to Optimize Conservation-Orientation

AWWA (2017). M1 Principles of Water Rates, Fees and Charges, 7th Edition. ISBN 9781625761910.

Financing Sustainable Water (Alliance for Water Efficiency)
https://www.financingsustainablewater.org/

Brandes, Renzetti and Stinchcombe (2010). Worth Every Penny: A Primer on Conservation-Oriented Water Pricing. Prepared for the POLIS Water Sustainability Project https://poliswaterproject.org/polis-research-publication/worth-every-penny-primer-conservation-oriented-water-pricing/

Waterworth Blog
https://waterworth.net/blog/

Value of Water Campaign
http://thevalueofwater.org/

Water Research Foundation (2016). Rate Approval Process Communication Strategy and Toolkit.
https://icma.org/sites/default/files/308295_Rate%20Approval%20Process%20Comm%20Strategy%20Toolkit.pdf

Theme 4: Improve Water Use Accounting & Non-Revenue Water Management

AWWA (2016). M36 Water Audits and Loss Control Programs, Fourth Edition. ISBN 9781625761002

AWWA Water Audit Software and Other Resources
https://www.awwa.org/Resources-Tools/Resource-Topics/Water-Loss-Control

econics

To: Joe McCallum
Engineering Technician, Water Services
Regional District of Nanaimo

From: Kirk Stinchcombe, Econics

cc: Julie Pisani
Drinking Water and Watershed Protection Program Coordinator
Regional District of Nanaimo

Date 9 May 2020

Re: Technical Memo #1 (Existing Program Review)

Regional District of Nanaimo
Water Efficiency Plan Update

Technical Memo #1
Existing Program Review

Table of Contents

List of Figures

List of Tables

1.0 Introduction

In 2019, the Regional District of Nanaimo (RDN) commenced an update of its Water Conservation Plan. This update will outline data-based targets, goals, implementation strategies, and provide guidance on community engagement for water use within the RDN Water Services Department's nine Water Service Areas (WSAs).

Based from the axiom that "if it isn't broke, don't fix it", the update will, in the first place, be driven by RDN's various ongoing and successful programs and recent performance. It will then be refined by drawing on emerging and current best practice around Canada and the world, as well as other Regional plans and targets. As such, looking at the current program, its strengths, and the opportunities for improvement is an obvious starting point.

This technical memo, the Existing Program Review, provides an inventory and assessment of RDN's current water efficiency program specifically in the WSAs and is intended to inform the plan update. The goal is to provide a foundation for evaluating how the program might be further developed and improved going forward.

The memo has four parts. First, it provides the methodology. Second, it gives a general overview of the program and brief assessment of its branding. Third, it inventories elements of the current program. Finally, it looks at program strengths, opportunities and challenges.

1.1 Limitations

The reader should be aware of several limitations. First, due to scope constraints this work is not a formal or comprehensive audit of the current water efficiency program. That is, we did not conduct a systematic examination of books, accounts, statutory records, and vouchers related to RDN's program. Rather, it is a general review informed by examination of documents, marketing collateral and other resources largely directed to us by RDN staff. Nevertheless, we are confident the report provides an objective and well-informed assessment of the current status of implementation.

Second, this summary focuses on recent program highlights – major initiatives, achievements and identified challenges. It should be noted that a great deal of additional work has been completed in support of the goal of reduced water demand over the past decade and beyond by RDN staff and partners, far more than what can be detailed here.

Third, this report is not a review of water conservation measures more broadly across the region under the Drinking Water and Watershed Protection (DWWP) Program or Team WaterSmart. It does provide some advice on implementation of Team WaterSmart measures that specifically pertain to demand management in the WSAs. However, it does not purport to assess these programs and measures at a regional scale. For further discussion of this regional program, including communication and outreach components, see Econics (2018).

Finally, no quantitative analysis of past or future water demand is included in this report. For this, please refer to the companion document, *Demand Forecasts* (Econics 2020), prepared in parallel to this work.

2.0 Methodology

Preliminary information and data for this report was gathered from three sources as follows:

- review of any available print reports and past strategies on RDN's water efficiency programs;
- online sources (e.g., at www.rdn.bc.ca/team-watersmart); and,
- hard copies of brochures, educational print materials and other communication collateral.

Based on an instruction sheet provided ahead of time, hard copy material was sent by RDN staff to Econics. As well, extensive amounts of electronic material were loaded to a project FTP site. These provided wide-ranging information about goals, target markets, history, promotion, outcomes and challenges associated with all major components of the current water efficiency program. This commenced with looking at information previously provided to Econics by RDN during an earlier project, moving on to additional information provided in 2020.

Once this data was collected and reviewed, it was compiled and summarized in Econics' proprietary Measures Assessment Tool. This tool inventories 154 unique water conservation measures that have been assembled based on examination of programs across North America, as well as reviews of leading best practices manuals and guidelines. It is used to take stock of current demand management programs, evaluate potential future measures, and inform the design of updated water conservation strategies. This helped us understand how RDN's program fits together, its history, and begin to identify possible future directions.

A meeting was held via teleconference and webinar with key RDN staff in early 2020. Results of the analysis were reviewed, and staff provided additional insights into the workings of current and past initiatives and identified some missing elements.

The various program components were then organized according to the "5E" categories, as described in Section 4, below.

3.0 Program Overview

3.1 Program Background

In 2013, RDN approved its first Water Conservation Plan, developed by Aquavic. Primary targets included reducing average residential use by 33% and maintaining a maximum monthly production to match 2004 levels by 2018. In 2018, RDN conducted a program evaluation, which found that both targets were successfully met (McSorely, 2018a).

3.2 Geographic Scope

The RDN manages a total of nine separate WSAs located throughout the region, spanning from Cedar to Qualicum Beach. The 9 WSAs are:

- Decourcey;
- Nanoose Bay Peninsula;
- Englishman River Estates;
- San Pareil;
- French Creek;
- Surfside;
- Whiskey Creek;
- Westurne Heights; and,
- Melrose Terrace.

The great majority of water supplied within the WSAs is delivered to single family residential accounts. The largest WSA operated by RDN is the Nanoose Bay Peninsula with just over 2,000 residential connections, while Decourcey has only 5 connections (McSorley, 2018).

As for commercial/institutional/industrial (CII) accounts, there are only 66 such accounts in the WSAs. However, further analysis found that most of these are strata accounts with single family residential landform or townhouse type developments. There are a handful of true CII customers, mostly commercial accounts in central Nanoose as well as a golf course (for non-irrigation purposes), school (Nanoose Bay Elementary) and several other institutions (volunteer fire department, churches, community center, etc.).

Each service area is dependent on groundwater as a drinking water source except for Whiskey Creek and Nanoose, which use a combination of ground and surface water. As of 2020, Nanoose will be serviced by a year-round surface water supply, with the opening of the new intake and treatment facility on the Englishman River. This was designed to provide increased flow and to take stress off local aquifers as communities continue to grow.

3.3 Program Branding

Figure 1: RDN Water Conservation Online Branding

Most water conservation communication and outreach are branded under the RDN and Team WaterSmart logos as shown in Figure 1.

The Team WaterSmart brand is seen in print material, web resources, community events, rebates, workshops, school education and more. Dozens of different resources are available, some features having sophisticated user interfaces (for example the regional watering restrictions map and the Our Watershed map tool).

Detailed investigation of branding and design is not part of the scope of this work. However, this was investigated at a high level as part of an earlier project (see Econics, 2018). This found that, while design is generally clean and contemporary, there are some opportunities for improvement, notably around making communication less information intensive and more focused on simple key messages. This earlier work also commented on the tendency to use of many different brand marks, which can sometimes distract from recognition of the main sponsors (being RDN and partner local governments). These observations remain relevant today.

4.0 Water Conservation Program Inventory

In this section, RDN's water conservation program elements are inventoried using Econics' 5E Framework, which is a convenient way of organizing components to understand how they work together as parts of a complete package. Each 5E theme deals with a different facet of water efficiency design, and each complements the others. A water service provider that invests in effort under each theme is more likely to have a comprehensive approach that will achieve sustained water use reductions in a community. The 5Es are as follows:

1. **Education tools** involve giving information to customers to help them understand how they use water and make changes.
2. **Encouragement tools** provide customers with incentives like product rebates, home audits, low cost access to plumbers or giveaways such as lawn watering gauges.
3. **Enforcement tools** involve judicious use of regulatory instruments like watering restrictions, building and plumbing codes, Provincial regulations and product performance standards.
4. **Economic tools** focus on providing financial incentives through effective water and wastewater pricing and similar mechanisms.
5. **Engineering approaches** encourage use of emerging technology and techniques, either by customers or by the water service provider itself (for example, in the case of system loss management).

4.1 Education

Education tools provide information to residents about water efficiency through various channels "from the classroom to the family room to the boardroom". This category includes traditional education, marketing and advertising, and direct communication through customer service staff, elected officials and other spokespeople. Poorly executed education and marketing efforts often have little or no impact on changing sustainable behavior. However, well-executed campaigns that employ carefully constructed messages, target specific behaviors and emphasize personal contact can be tremendously successful. Moreover, these methods lay a foundation for effective implementation of other types of tools.

Event Booths

Team WaterSmart hosts a variety of staffed booths across the region at fairs, festivals and environmental stewardship events. Booths typically utilize educational visuals and information display boards, often including giveaways (e.g., toilet leak dye tabs; native plant seeds and seedlings), contests and interactive activities (see Figure 2).

Booths provide opportunities for staff to reach a large number of people in a short amount of time and can be used as a channel to promote current programs and future events. Staffed booths also have benefits beyond conservation including raising the profile of RDN and the DWWP Program and connecting people to their drinking water.

In 2019, Team WaterSmart hosted a 'Meet Your Neighbours' event in the Rivers Edge subdivision of the Englishman River WSA. However, staff note that there are few community events within the service areas compared to the rest of the region due to their small sizes and scarcity of community hubs.

Figure 2: Team WaterSmart Booths at Community Events in the RDN

Youth Resources

The DWWP team delivers a curriculum resource for teachers in the region that aims to engage students in ongoing learning in water sustainability, complimented by classroom visits. The curriculum activity guide provides guidance on water education sessions and prepares students for watershed field trips. Field trips are also offered to students in grades 4 and 5 and run to the Englishman River and the Nanaimo River in May, June, September and October.

Figure 3: RDN Online Youth Outreach Design

As well, the Team WaterSmart webpage includes a 'KidsZone' interactive page for youth that includes quizzes and info on conservation (see Figure 3). This page provides youth with the opportunity to learn how water is used in our every day lives and ways to reduce use both at home and outdoors. The RDN 'WaterMap' is also available online through an interactive mapping page that provides youth (and people of all ages) access to an in-depth spatial analysis of watersheds and aquifers, supply areas, and monitoring locations.

Guide Books

Team WaterSmart publishes a series of guidebooks and brochures on lawn and garden best practice including irrigation system management. They are attractively designed and include thorough detail for residents who are interested in applying water conservation techniques and strategies for both outdoor indoor use (see Figure 4). Additional resources can be found on the website.

A notable example is *The Landscape Guide to Water Efficiency*, designed for residents to learn about sustainable landscape irrigation design, installation and on-going maintenance.

Figure 4: Team WaterSmart Brochures

4.2 Encouragement

Encouragement tools include incentives like product rebates, home audits, low cost access to plumbers or giveaways such as lawn watering gauges. These are provided to customers of all kinds in both residential and non-residential settings. Research from the fields of environmental psychology and community-based social marketing shows that such instruments can have a substantial impact on changing water use behavior or purchases of efficient appliances and fixtures.

Residential Irrigation System Check-Ups

During the summer months, water use in the region can double or sometimes triple due to the outdoor water use demand. Over the past decade, Team WaterSmart has performed hundreds of residential irrigation system check-ups to encourage residents to get familiar with their own systems and operate them more efficiently. This program incorporates elements of water conservation best practices because it is highly targeted at both high-volume residential customers and at outdoor irrigation via in-ground automatic systems.

Check-ups are offered as a free service to residents seasonally. They target top 100 users across the region. Participation is voluntary. The response rate varies with anywhere from 12 to 140 audits per year, primarily in newly developed residential areas.

Figure 5 illustrates uptake of check-ups specifically within the WSAs. This shows a spike in participation in early years, likely due to promotion of a pilot project in Nanoose at the outset of the program. In more recent years, participation has leveled off to about five check ups per year, with staff availability as a primary limiting factor. Staff indicate that they believe that there could be more uptake if additional resources were allocated and greater promotion were to occur. Most check ups (about 80% overall) have taken place in Nanoose, as expected.

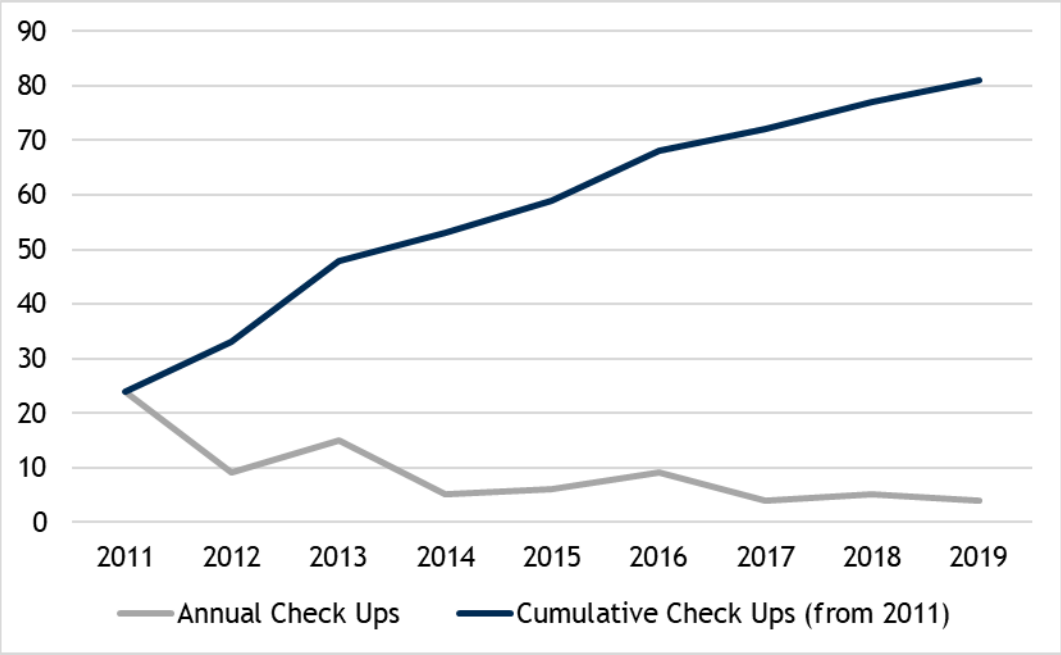


Figure 5: Annual and Cumulative Irrigation Check-Ups in RDN WSAs (2011 to 2019)

For those who cannot participate in check-ups, RDN also offers workshops multiple times a year, hosted at community centres. Overall, the program has been successful in catching leaks and lowering water usage through irrigation systems and has been popular for residents.

Irrigation Upgrades and Soil Improvements Rebate

Building off the free irrigation check-ups program, this rebate allows residents to retrofit irrigation systems with more efficient components and to improve soil structure and water retention capabilities.

This program offers residents up to $675 in rebates (see Table 1). Applicants who are pre-approved for both irrigation upgrades and soil amendments may be eligible for a bonus of up to $100 upon completion. Properties must have a garden or landscape area of 37 square meters (m^2) or more to be eligible.

Table 1: Irrigation Upgrades & Soil Improvement 2020 Rebates

Category		Maximum Rebate
Add a:	Smart Controller	$100
	Rain Sensor **OR**	$75
	Weather or Soil Moisture Sensor	$125
Convert to:	Drip Irrigation	$200
	Matched Precipitation (MP) Rotators	$50
Add:	Quality Top Soil, Compost or other Organic Mulch	50% off (up to $100)
Bonus:	Complete Both Irrigation System Upgrades & Soil Amendment	$100
	Maximum Total Rebate	**$750**

In order to qualify for this program, upgrades must be completed by a professional certified by the Irrigation Industry Association of BC (IIAC) (see Figure 6). The certification standards and guidelines promote water, soil, and energy conservation practices through efficient system design, installation and management. Irrigation technician, design and training courses are available through the IIABC website, and subsidies have been provided by RDN for about dozen participants per year.

Figure 6: IIABC logo

Figure 7 shows annual and cumulative uptake of irrigation and soil improvement rebates of all types since the offer began in 2016. WSAs have averaged 3.3 rebates per year, with the majority (about 70%) again taken up in Nanoose. Consistent with discussion about irrigation check-ups, staff believe that greater uptake could occur with more resources and advertising.

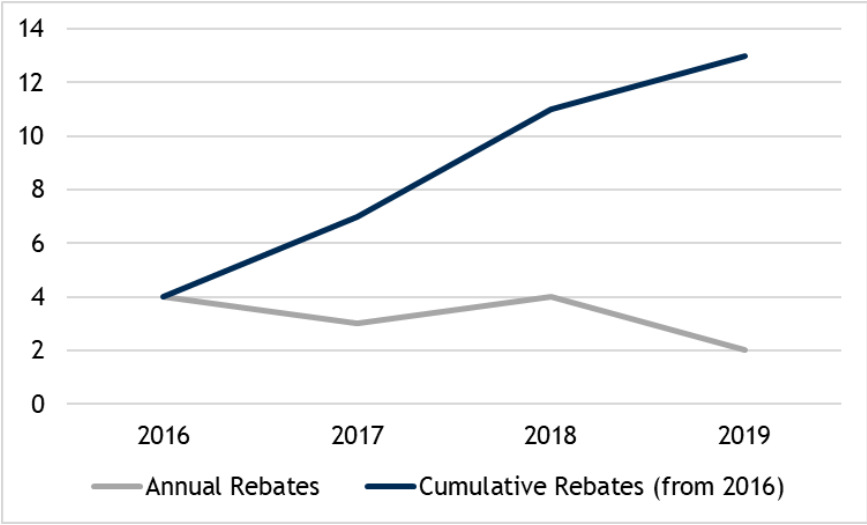


Figure 7: Annual and Cumulative Irrigation and Soil Improvement Rebates (2016 to 2019)

Overall, the existing irrigation program elements continue to be effective and well suited for the WSAs given the nature of the residential land use and demographics. This is discussed further in Section 5.

Rainwater Harvesting Rebate

Up to $750 in rebates are available to homeowners who install a rainwater harvesting system with 1,000 imperial gallons of storage or more. Since the program began in 2011, 15 rebates have been issued in the WSAs, averaging 1.7 per year, peaking in 2016 at five. About half of these have been issued in Nanoose.

Cost will prohibit many residents from taking part in this promotion. However, as the historic trend illustrates, there is certainly a niche market for rainwater harvesting in the WSAs, particularly in areas with higher income demographics and higher value properties.

Other Residential Rebates

RDN provides other incentives and rebates to residents including:

- Septic Smart Rebate: covers 75% of the cost, to a maximum amount, to install a distribution box, risers or effluent filter. A rebate is also available for system repair or replacement with a value over $5,000;
- Wellhead Upgrades: up to $650 for upgrades completed on private domestic wells that bring the well cap, casing tick-up, and/or surface seal; and,
- Well Water Testing: covers 50% (up to $150) for full spectrum well water quality tests for residential landowners with private domestic wells.

Given the absence of private wells, by definition these offers have limited or no application in the WSAs and are primarily intended for non-serviced properties in electoral areas.

4.3 Enforcement

Enforcement tools involve judicious use of regulatory instruments such as watering restrictions, plumbing codes, and product performance standards. Regulatory approaches are often highly cost effective because they can make significant contributions to cutting demand without requiring large operational budgets for water service providers (excepting enforcement costs).

Water Restrictions

In 2015, an updated seasonal lawn watering restriction program was introduced after an unprecedented hot and dry summer. The Water Restriction Schedule is divided into four Stages (see Figure 8). Restrictions have been harmonized across water service providers for consistency and communication ease.

Restriction times are set to balance the needs of several major water suppliers in the region, some large systems on surface water sources, other smaller systems on groundwater. Under ordinary conditions, “Stage 1” restricts lawn watering to between 7pm to 7am beginning in April. “Stage 2” follows in May through September with lawn watering restricted to even or odd days for a 2 hour maximum in a morning or evening time window.

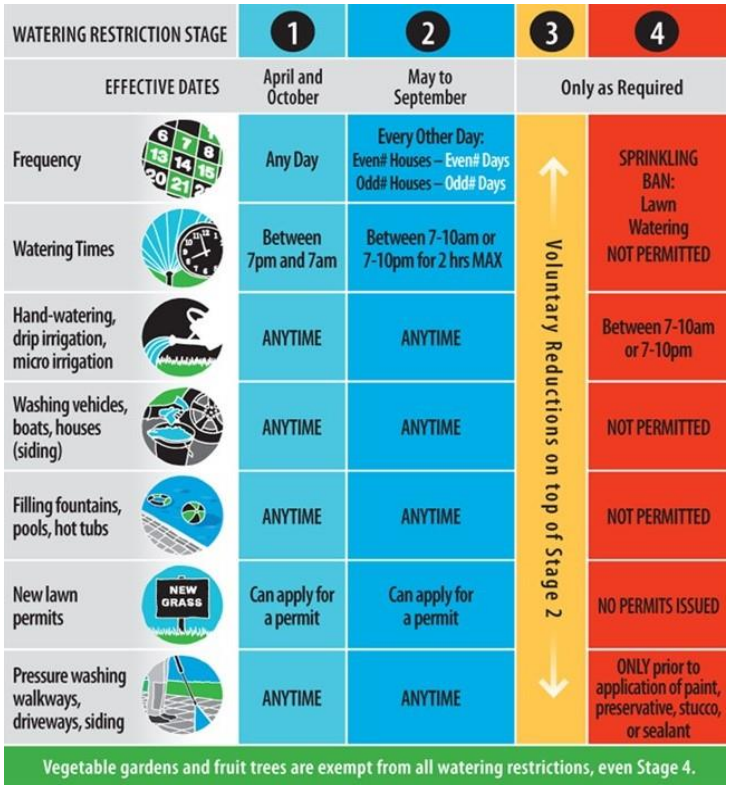


Figure 8: 2019 Regional Water Restrictions Schedule

Awareness is promoted on the RDN website and on social media. Each municipality and water purveyor has bylaws and/or policies pertaining to enforcement. Residents are able to track the current status online through the watering restriction map. Municipalities have ticketing bylaws that could be utilized if there are infractions, as does RDN.

RDN staff note that there are rare and isolated incidences of serial non-compliance with restrictions in some WSAs and intends to follow up on this with additional enforcement effort in the future.

Surfside and Decourcey are subject to separate restrictions, as seen in Table 2. These are similar to the rest of the region, except for more stringent watering times at all stages and more prescriptive delineation of property addresses.

Table 2: Surfside and Decourcey Water Restrictions Schedule

Addresses	Stage 1 April and October	Stage 2 May, June, July, Aug & Sept	Stage 3 As Required	As Required
Surfside Drive Odd numbers from 1027 to 1117 **McFeely Drive** Odd numbers from 927 to 935	Daily 7pm-7am (Night time watering only)	Tuesday, Friday & Sunday 7-10am or 7-10pm, for max. 2 hrs/day	Voluntary Reductions on top of Stage 2	Sprinkling Ban: Lawn Watering Not Permitted
Surfside Drive Odd numbers from 985 to 1021 Even numbers from 982 to 1010	Daily 7pm-7am (Night time watering only)	Monday, Wednesday & Saturday 7-10am or 7-10pm, for max. 2 hrs/day	Voluntary Reductions on top of Stage 2	
Surfside Drive Odd numbers from 965 to 977 Even numbers from 954 to 976 **McFeely Drive** Odd numbers from 939 to 959	Daily 7pm-7am (Night time watering only)	Tuesday, Thursday & Sunday 7-10am or 7-10pm, for max. 2 hrs/day	Voluntary Reductions on top of Stage 2	
Decourcey Houses on Bissel Road and Ingram Road	Daily 7am-7pm (Night time watering only)	Odd# Days 7-10am or 7-10pm, for max. 2 hrs/day	Voluntary Reductions on top of Stage 2	
Houses on Pylades Drive	Daily 7pm-7am (Night time watering only)	Even# Days 7-10am or 7-10pm, for max. 2 hrs/day	Voluntary Reductions on top of Stage 2	

4.4 Economics

Effective volume-based water and wastewater pricing are economic tools that can be used to encourage water use efficiency through the incentive of saving money. Other economic tools include senior government tax incentives, low interest loans, and targeted investment by public agencies.

RDN has one water user fee rate structure for all of the systems it serves. The structure is designed with fees increasing as consumption increases (a 'tiered' or 'inclining block' structure). This service falls under bylaw 1655.09. Customers pay a minimum daily rate of $0.35 then charges at different prices as various consumption thresholds are passed. Table 3 shows current rates.

Table 3: Regional District of Nanaimo Residential Water Service Rates

Rate per Cubic Meter per Day						
Minimum Daily Rate	**Up to 0.7**	**0.71 to 1.4**	**1.41 to 2.1**	**2.11 to 2.8**	**2.81 to 3.5**	**Over 3.51**
$0.35	$1.06	$1.20	$1.55	$1.83	$2.45	$3.67

* Displayed water and wastewater charge assumes non-discounted residential consumption rates, paid on or before bill due date, and does not include any additional surcharges. See https://www.rdn.bc.ca/water-user-rates.

Detailed investigation of the water efficiency potential of conservation-oriented pricing is not part of the scope of this review. We are also unable to comment on the extent to which the RDN's current rate structure meets the long-term costs of sustainably funding the systems. This is a question that would be answered through a rate update based on best practices as described in American Water Works Association (2017).

However, we did complete some basic comparison of RDN's rates with comparable nearby municipalities. This indicates that when parcel taxes are factored in, WSA residents' costs for water services are comparable if not somewhat higher than these reference communities. However, when parcel taxes are factored out, rates appear lower. This is important because parcel taxes are charged on a lot-by-lot basis, so do not vary with the amount of water people consume. As such, there may be an opportunity to shift some of the revenue collected to the volumetric component of the rate structure, thereby providing people with more incentive to conserve and to purchase efficient fixtures and appliances.

4.5 Engineering

Engineering approaches use emerging technology and techniques to reduce total system demand. Examples include advanced pressure and leakage management, water reuse, rainwater harvesting, smart metering, and various in-home or business technologies, sometimes involving retrofit projects for existing facilities. Such technology can have dramatic impact on demand – in some cases eliminating use of potable supplies entirely for specific end uses.

Most of these measures are best suited for larger communities, for example, broad scale roll-out of water recycling or industrial technology. Similarly, smart metering is not a short term priority as there are no immediate plans to replace existing customer meters.

System loss management is, however, a real option. Detailed analysis of the demand management potential of non-revenue water management and system loss is outside of the

scope of this investigation. However, it is well established that attention to these areas can often be very cost-effective conservation measures. They also provide the additional benefit that they do not require behavior change by residents, nor do they significantly affect their lifestyles.

Preliminary information provided by RDN indicates that non-revenue water levels in some service areas are quite high by national standards. In at least four WSAs, the difference between water production and metered use is in excess of 20%, including in Nanoose. However, staff emphasize that these findings require further validation.

Staff also report that most efforts on water loss in recent years have focused on reactive response to main breaks and leaks that surface above ground. Little work has been done in active leak detection and repair or pressure management. Similarly, no night flow analysis has been conducted recently to better quantify system loss. American Water Works Association/International Water Association methodologies to benchmark infrastructure leakage are not used (see, for example, IWA 2000).

In sum, it appears that further attention to non-revenue water management minimally merits further investigation going forward. This option is discussed further in the next section.

5.0 Analysis and Summary

Based on the inventory presented above, this section provides a high-level qualitative assessment of strengths, challenges, and opportunities we see in RDN's current water efficiency program for the WSAs. This is based on our experience working with similar programs across North America as well as best practices as outlined in key industry publications such as AWWA (2006), AWWA (2013), BC Government et. al. (2013), Maddaus (2014), and Vickers (2001).

5.1 Program Strengths

Strengths are internal characteristics of the organization that give it an advantage. RDN can count on a number of these.

- While the WSAs on their own service quite small communities, they are embedded within RDN's regional scale DWWP Program, which works with a much larger population and is well resourced by provincial standards. RDN can continue to leverage the many excellent assets generated by this broader initiative. Specific measures that have particular utility in the WSAs include:

    - irrigation and landscape initiatives including Residential Irrigation System Check-ups, Irrigation Upgrade and Soil Improvement Rebates, and educational resources such as the Landscape Guide to Water Efficiency;
    - Rainwater harvesting rebates;
    - watering restriction promotion (e.g., the online regional watering restrictions map);
    - Team WaterSmart outreach and events; and,
    - youth educational resources (for Nanoose Bay Elementary School).

- The service population is small, relatively homogeneous (consisting mostly of single-family residential development) and directly reachable (e.g., through direct mail, door-to-door, or community centers). This means RDN does not have to spread itself thin with a broad range of program measures targeting different customer classes.

- Most development in the WSAs is relatively new, meaning that indoor technology (toilets, washing machines, etc.) will typically be more efficient than the regional or national average.

- All customers are already metered and paying for water services based on the volumes they use.

- Regionally harmonized watering restrictions are already in place and are well communicated broadly through a variety of channels (print, online, etc.).

- The Drinking Water and Watershed Protection Action Plan has recently been updated following ten years of successful implementation. New and refreshed initiatives flowing from this update will benefit all communities in the region including those in the WSAs.

5.2 Program Challenges

Challenges are either internal features or external elements that place the organization at a disadvantage or can cause difficulties. RDN faces several of these.

- Because most development in the WSAs is residential and relatively new, practical and feasible demand management opportunities are limited and concentrated in a small number of end uses, particularly outdoor irrigation.

- Due to size and lack of prominent community hubs, few community events are hosted directly within the WSAs, meaning that residents must access some Team WaterSmart offers (e.g., staffed booths) at opportunities in neighboring communities;

- Watering restrictions are harmonized with surrounding, much larger communities. This is a positive for communication efficiency but makes it challenging to enhance the current "evens/odds" system to align with international best practice (e.g., mornings only or one-day-per-week). To do so would require bringing the other water service providers along (City of Nanaimo, City of Parksville, etc.).

- A visual scan of residential land use in the areas and anecdotal reports from staff lead us to believe that many of the homes in the WSAs have automatic, in-ground irrigation systems, probably more so than the provincial average. These homes typically use considerably more water for irrigation than comparable homes without such systems.

- Staff report isolated but persistent problems with non-compliance with mandatory watering restrictions, meaning that enforcement effort may need to escalate with a small number of customers.

- Despite the ability to leverage DWWP Program resources, the actual dollars and staff time that can be devoted to demand management within the WSAs specifically is relatively limited.

5.3 Program Opportunities

Opportunities are internal or external factors that might be leveraged to improve program performance. There are a number of very tangible opportunities for new or enhanced conservation measures in the WSAs.

- While residential outdoor irrigation in the WSAs is likely the predominant end use to target going forward, RDN is well positioned to address this with existing program measures (i.e., irrigation check-ups, rebates, educational materials).

- Efforts to address system loss and non-revenue water management have been relatively limited in the WSAs to date. There may be additional cost-effective savings to realize in this area. This merits further investigation.

- Volume based costs for water services in the WSAs appear to be lower than in surrounding communities when fixed charges, particularly parcel taxes, are factored out. As well, with five tiers, the current rate structure is quite complicated. A rate update may indicate potential to further enhance the conservation-oriented pricing approach that is already in place.

- There are only a handful of true commercial and institutional customers in the WSAs (most of whom are concentrated in the central part of Nanoose). While creating a new, major non-residential conservation program for these few accounts would not be recommended, it may be worthwhile targeting these users as part of development of a commercial/institutional program for the region as a whole, in line with the DWWP Action Plan 2.0 goal of targeting strategic sectors (Action 5.1.3).

- There may be additional opportunities to target high volume residential users with more sophisticated, targeted offers. This aligns with DWWP Action Plan 2.0 intentions to enhance Team WaterSmart outreach with community-based social marketing principles (Action 5.1.1).

These insights gained through this program review will be used to guide development of the Updated Water Efficiency Plan in the next stages of the project.

6.0 References

American Water Works Association (2006). Water Conservation Programs – A Planning Manual. Manual of Water Supply Practices M52, Denver CO.

American Water Works Association (2013). Water Conservation Program Operation and Management. Manual G480-13. Denver CO.

American Water Works Association (2017). Principles of Water Rates, Fees and Charges. Manual of Water Supply Practices M1, Denver CO.

Aquavic Water Solutions (2013). Water Conservation Plan. Prepared for RDN, October 2013.

Brandes, O., Renzetti, S., Stinchcombe, K. (2010). Worth Every Penny: A primer on Conservation-Oriented Water Pricing. Accessed 17 November 2019. Accessed at https://poliswaterproject.org/polis-research-publication/worth-every-penny-primer-conservation-oriented-water-pricing/.

Econics (2018). Regional District of Nanaimo Drinking Water & Watershed Protection Program: 10 Year Action Plan Implementation Review. Prepared for Regional District of Nanaimo, September 2018.

International Water Association (IWA) (2000). Losses from Water Supply Systems: Standard Terminology and Recommended Performance Measures. The Blue Pages.

Lanarc (2007). Drinking Water and Watershed Protection Action Plan. Prepared for the Drinking Water-Watershed Protection Stewardship Committee, Nanaimo BC, October 2007.

Maddaus, L., Maddaus, W., Maddaus, M. (2014). Preparing Urban Water Use Efficiency Plans: A Best Practice Guide. IWA Publishing, London, UK.

McSorely, H. (2018a). Team WaterSmart Free Irrigation Check-Up Service: Conservation Program Impact Evaluation. Report prepared for Team WaterSmart, Drinking Water & Watershed Protection Program, Regional District of Nanaimo, March 2018.

McSorely, H. (2018b). Water Conservation Evaluation: Targets, Trends and Trajectories. Report prepared for Regional District of Nanaimo, June 2018.

Province of BC, POLIS Project on Ecological Governance, and Okanagan Basin Water Board (2013). Water Conservation Guide for British Columbia, Victoria, December 2013.

Province of BC (2018). British Columbia Plumbing Code, Section 2.6. (Potable Water Systems). Accessed on 4 November 2019. Accessed at http://free.bcpublications.ca/civix/document/id/public/bcpc2018/bcpc_2018dbp2s26

Regional District of Nanaimo (2020). Drinking Water and Watershed Protection Action Plan 2.0 (2020 – 2030+).

Regional District of Nanaimo (2019). Team WaterSmart. Retrieved February 20, 2020, from https://www.rdn.bc.ca/team-watersmart.

Vickers, Amy (2001). Water Use and Conservation. WaterPlow Press, Amherst, MA.

econics

To: Joe McCallum
Engineering Technician, Water Services, Regional District of Nanaimo

From: Kirk Stinchcombe, Econics

cc: Julie Pisani
Drinking Water and Watershed Protection Program Coordinator, RDN
Colwyn Sunderland, Kerr Wood Leidal
Jessica LeNoble, Kerr Wood Leidal

Date 12 May 2020

Re: Technical Memo #2 (Demand Analysis and Forecasting)

Regional District of Nanaimo
Water Conservation Plan Update

DRAFT V3 - Technical Memo #2
Demand Analysis and Forecasting

Prepared with Support from Kerr Wood Leidal

Table of Contents

Table of Figures

1.0 Introduction

In 2019, the Regional District of Nanaimo (RDN) commenced an update of its Water Conservation Plan. This update will set evidence-based targets, implementation strategies, and guide community engagement on water demand management within the RDN's nine Water Service Areas (WSAs).

Understanding current water use as well as the potential for demand reductions associated with different conservation options is a key step in developing the updated plan. This technical memo, Demand Analysis and Forecasting, summarizes water production in RDN's WSAs and assesses likely future demand scenarios, looking at both current trends and with implementation of a series of conservation measures.

The memo has three main parts. First, it summarizes total water production trends for the years 2017 through 2019. Second, it analyzes "commercial" billing class water consumption data the year 2019. Third, it provides a demand forecast for the WSAs using a proprietary model prepared by Kerr Wood Leidal with support from Econics.

1.1 Limitations

The reader should be aware that, due to scope constraints, analysis of metered residential water consumption was not completed for this project. As well, in most cases this analysis relies on annual or monthly totals of water production and consumption data provided by RDN rather than analysis of source data itself. With the exception of commercial-class billing data (see Section 3), no efforts were made by our team to validate or exercise quality control over data provided to us. We therefore assume that the information provided by RDN is accurate. In several instances, we encountered minor issues with some of the data provided. The implications for the analysis and potential future actions to address this are discussed further in the report, and specifically in Appendix 3. Nevertheless, we believe that the resulting analysis is sufficiently reliable to satisfactorily inform water conservation planning in RDN's WSAs.

2.0 Water Production in Water Service Areas

This section briefly examines recent water production trends in the WSAs.

2.1 Methodology

We examined summary water production data for the years 2017 to 2019 building on previous work completed by RDN. Consistent with that earlier work, production is defined as "the total inputs of water that enters a WSA distribution system including groundwater and surface water… In most RDN WSAs, production is equal to the total volume of water sourced from the local groundwater wells. However, production in the Nanoose Bay Peninsula WSA includes both groundwater and surface water inputs" (McSorley, 2018, p. 4).

Total monthly meter readings for all water sources (surface and groundwater) in all nine WSA were provided by RDN staff (RDN, 2020c). No validation or quality reviews were completed on this data by Econics. The data were analyzed, looking at three trends as follows:

- water production per account over time in order to control for changes in number of accounts over time;[1]
- base demand, defined as the period from September to April; and,
- seasonal demand, defined as the period from May to August.

Note that the months selected to separate base and seasonal demand are established based on RDN's current billing cycle. For consistency, the periods used are also the same as those used in similar previous RDN analysis (McSorley, 2018, p. 14).

We also looked at peaking of demand to further understand seasonality. This was calculated based on the following formula:

$$\text{Maximum Month Average Day} = \frac{\text{Maximum Month } (m^3) \text{ / Days in that Month}}{\text{Total Annual Production } (m^3) \text{ / } 365}$$

Note that this is a somewhat unorthodox method to calculate peak because we did not review daily or hourly production data, but rather only monthly totals. While this approach is more than sufficient to inform development of water conservation programs, we caution against using the results for other infrastructure supply planning purposes.

[1] Note that growth is only of significance in Nanoose Bay, which has experienced some continued addition of new accounts in the past several years; development in other WSAs has been zero or negligible. Also note that the account total in Nanoose Bay includes both residential and non-residential accounts.

2.2 Results

Per capita water production curves for Nanoose Bay Peninsula (surface and groundwater) and the combined total of all nine WSAs are shown below in Figures 1 and 2. Curves for the remaining eight WSAs can be found in Appendix 1. Values are shown in Table 1.

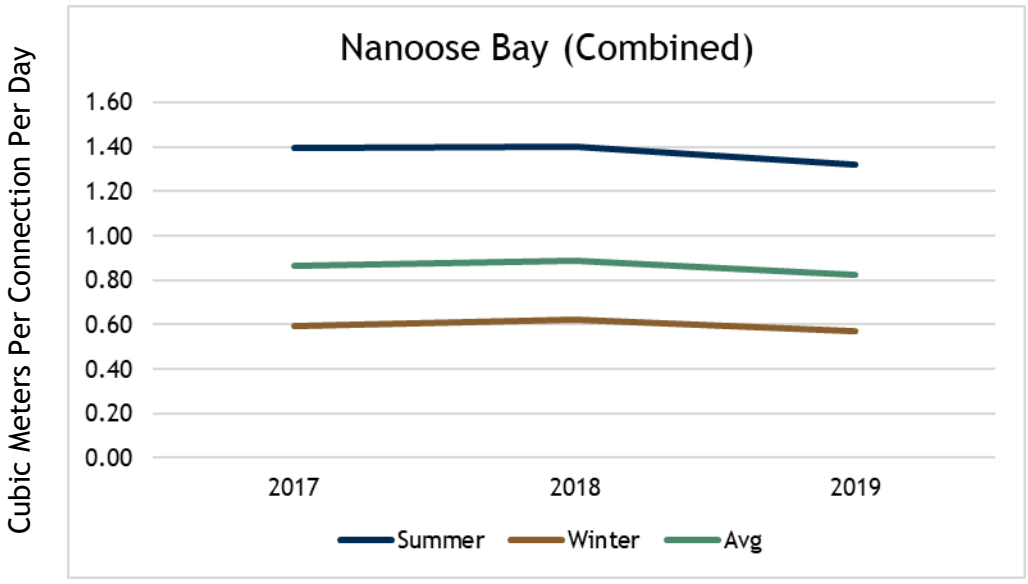


Figure 1: Per Connection Water Production in Nanoose Bay Peninsula, 2017 to 2019 *
* Includes commercial connections

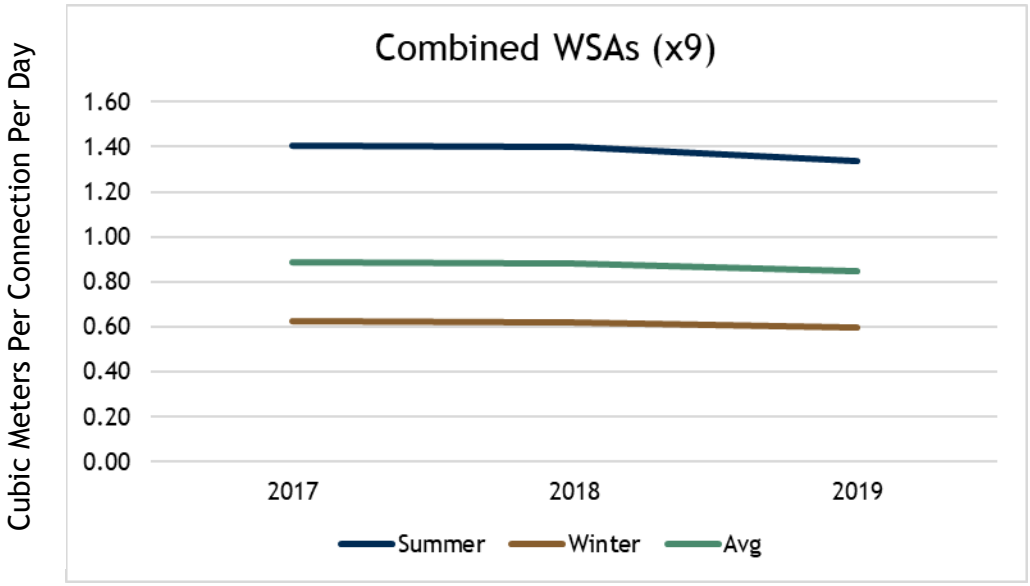


Figure 2: Per Connection Combined Water Production for All RDN WSAs, 2017 to 2019 *
* Includes commercial connections

Table 1: Per Connection Water Production for RDN Water Service Areas (2017 to 2019)

Water Service Area	Season	m^3/Connection/Day		
		2017	2018	2019
Decourcey	Summer	0.69	0.99	1.28
	Winter	0.29	0.34	0.31
	Average	0.43	0.56	0.64
Englishman River	Summer	2.16	2.33	2.26
	Winter	0.65	0.58	0.68
	Average	1.16	1.17	1.21
French Creek	Summer	1.08	1.04	1.07
	Winter	0.59	0.50	0.48
	Average	0.75	0.68	0.68
Melrose	Summer	0.69	0.52	0.59
	Winter	0.59	0.46	0.48
	Average	0.63	0.48	0.52
Nanoose Bay (Combined)	Summer	1.40	1.40	1.32
	Winter	0.59	0.62	0.57
	Average	0.86	0.89	0.82
San Pareil	Summer	1.56	1.49	1.44
	Winter	0.84	0.68	0.71
	Average	1.08	0.95	0.95
Surfside	Summer	1.23	1.48	1.42
	Winter	0.45	0.41	0.48
	Average	0.71	0.77	0.80
Westurne Heights	Summer	0.58	0.44	0.47
	Winter	0.40	0.41	0.34
	Average	0.46	0.42	0.38
Whiskey Creek	Summer	1.23	1.08	1.14
	Winter	0.86	0.85	0.98
	Average	0.99	0.93	1.03
Combined WSAs (x9)	Summer	1.41	1.40	1.34
	Winter	0.62	0.62	0.60
	Average	0.89	0.88	0.85

Peaking factors for both Nanoose Bay Peninsula and for the combined total of all nine WSAs can be found in Figure 3. As discussed in the methodology, note that peaking factor was calculated using the formula set out in the figure.

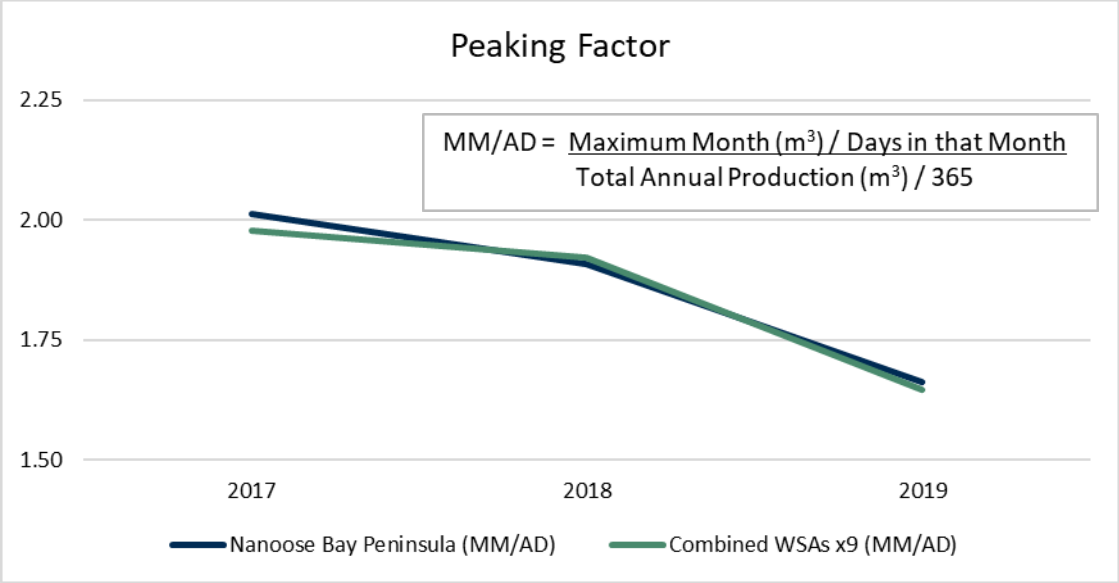


Figure 3: Peaking Factor in RDN's Nanoose Bay WSA and Combined WSAs, 2017 to 2019

No discernable trends in water use can be detected in the production curves. This is expected when only looking at a few years of data, where structural trends in water use will be over-ridden by short term variation in seasonal weather. However, previous analysis (McSorley, 2018; AquaVic 2013) does indicate consistent reductions in water production and demand over time, also as we would expect given RDN's efforts through Team WaterSmart and trends across North America over the past decade.

Also consistent with previous analysis, both comparison of summer to base (winter) demand and looking at peaking demonstrate that summer use in the WSAs tends to be high, without doubt driven by residential lawn and garden irrigation. This bolsters the case for continued demand management efforts targeting this end use.

Finally, we note significant variation in both summer and average water use from one WSA to another, as highlighted in Table 1. Several factors likely explain this including: 1) variations in non-revenue water including leakage; 2) demographic and cultural factors (e.g., some neighbourhoods may irrigate more than others); 3) the fact that results may be skewed by the small populations of some WSAs; and, 4) data accuracy. These factors and the opportunities they present for demand management are discussed further in Section 6.

3.0 "Commercial" Demand in Water Service Areas

RDN's WSAs are primarily made up of single family residential development. However, there are a small number of water accounts classified as "commercial" in RDN's billing system (66 in total). This section provides a brief analysis of consumption trends within this billing group.

3.1 Methodology

To begin with, some clarification on terminology is required. RDN's billing system does not disaggregate accounts other than single family residential into sub-categories. Instead, it groups a number of types of land use, including true commercial, institutional, multi-family residential development (bare land strata development, townhouses, mobile home parks, etc.) and some undeveloped land into a single category referred to generically as "commercial". However, as will be shown below, the term "non-single family residential" is a more accurate descriptor.

This non-single family residential demand was analyzed using a billing data extraction supplied by RDN staff in Microsoft Excel format (RDN, 2020d). This extract provided the meter location and description, billing address, water system, and quarterly consumption for 2019.

Using the information provided combined with a desktop survey of most accounts using Google Maps and Street View, we were able to split all accounts into the following sub-categories: true commercial, institutional, multi-family residential, single family residential, and undeveloped land. Note that this represents a best guess at the appropriate sub-category based on the information available without conducting an on-the-ground survey or speaking directly to customers. However, we believe the result are reasonably accurate.

We also grouped accounts by customer entity (organization, company, strata council, individual, etc.). For example, RDN itself holds 14 separate accounts in the WSAs (associated with lift stations, parks and other municipal operations) but is one customer from a management perspective.

We analyzed trends in the sector by customer entity, account type and consumption. Findings are presented below. All results are for the 2019 calendar year only.

3.2 Results

The great majority of commercial accounts (64 of 66) are located in Nanoose Bay WSA. The remaining two have negligible or zero consumption, so for all intents and purposes we can consider use in this billing group to occur almost exclusively in Nanoose Bay.

There appear to be only 30 unique customer entities holding "commercial" accounts, distributed as follows:

- eight true commercial;
- four institutional (including RDN);
- nine strata or multi-family residential;
- six single family residential homes; and,
- three on undeveloped land.

This is illustrated in Figure 4. RDN itself holds the most accounts for any single entity (14, as noted above). A second customer holds 12 accounts. A number of others hold two to five each.

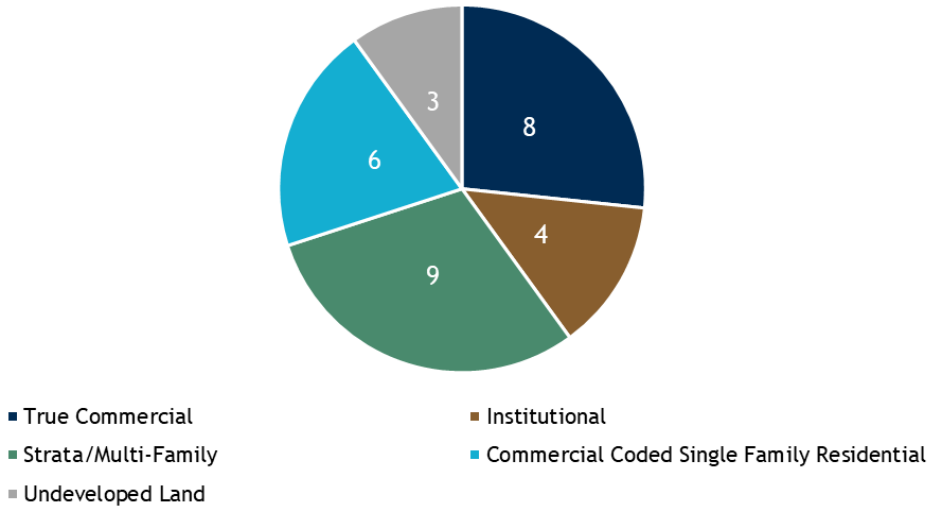


Figure 4: Distribution of "Commercial" Account Holders by Customer Type, 2019 (n=30)

Figure 5 shows the breakdown of consumption within the commercial billing group. This highlights that only about a fifth of actual water use is truly commercial in nature.

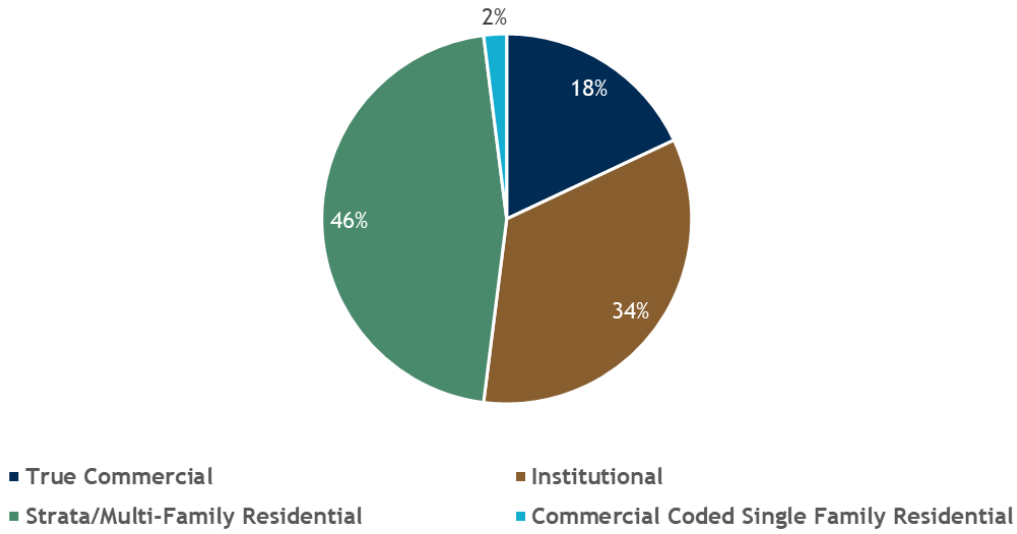


Figure 5: Distribution of "Commercial" Water Consumption by Customer Type, 2019 (n=66)

Twenty three customers consume over 500 liters of water per account per day on average, about the same amount as a single family home. These consume 99% of total used in the sector (spread across 30 accounts). In other words, only 23 customers account for virtually all commercial consumption, distributed as follows:

- seven true commercial;
- four institutional;
- eight strata/multi-family residential; and,
- four single family homes.

The "top 10" customers consume 92% of water in the sector (spread across 27 accounts), broken down as follows:

- three true commercial;
- two institutional; and,
- five multi-family residential.

The "top 5" customers consume 79% of water in the sector (spread across 18 accounts), broken down as follows:

- one true commercial;
- one institutional; and,
- three multi-family residential.

In sum, water consumption trends in the "commercial" sector follow a pattern similar to what we see in many other Canadian jurisdictions: use is concentrated in a small number of entities with many others consuming relatively trivial amounts. This can obviously be used to guide effort should RDN consider targeting these customers with demand management measures.

Three other points merit brief mention. First, with respect to seasonal demand, as expected, a great number of accounts see consumption spike in the summer months, indicating outdoor irrigation.

Second, as noted above, only eight customers across 22 accounts appear to be conducting business that would generally be considered truly commercial in nature. This use is concentrated in a small number of locations and use types (primarily strip mall, golf course, marina). As such, it would be relatively simple to reach these customers with targeted advice.

Third, about a third of accounts in the commercial billing category are better characterized as residential. These consume nearly half (48%) of total water demand in the category. A number of these appear to be bare land strata properties with single family home landform. Some appear to be townhouse-type strata development, and there is also a mobile home park. Six accounts look to be simply single family residential dwellings with no obvious sign of business activity (e.g., signs at front indicating a home-based business). This may indicate that there is a small amount of miscoding in the billing system. Options for addressing these billing data and categorization issues are discussed further in Appendix 3, below. It is also worth mentioning that water demand in many of these residential properties would be managed in much the same way as it is on the rest of the WSAs. That is, it would be treated as residential demand and use methods such as Team WaterSmart outreach and other appropriate tools, albeit with the extra complication of sometimes needing to work with strata councils or property managers.

4.0 Water Demand Forecast

An important step for updating the Water Conservation Plan is to estimate future water demand trends (Province of BC et al, 2013). This will inform assessment of how well existing programs are working and identify possible avenues for adding additional resources or introducing new conservation program measures.

This section summarizes water demand predictions over the next 10 years in RDN's WSAs. Scenarios were developed using a continuation of current programs and conditions (base case) and using alternate or enhanced demand management programs and conditions (conservation cases), developed based on discussions with RDN staff.

4.1 Methodology

Demand projections are technically challenging due to uncertainties inherent with predicting future conditions, especially for population growth, community development and economic conditions.

To overcome these challenges, our methodology creates "bottom up" projections using a proprietary Excel-based tool created by KWL with support from Econics. This model estimates municipal water demands incorporating the following best practices often not incorporated in such forecasts (Pacific Institute, 2016):

1. accounts for conservation and efficiency;
2. accounts for changes in economic activity;
3. accounts for changes in water price;
4. reflects other relevant planning documents;
5. accounts for expected land use changes;
6. accounts for climate change and drought;
7. accounts for uncertainty; and
8. provides transparency and facilitates stakeholder review.

The model uses best practice guidelines for a variety of end uses in combination with user-specified information for the subject community to predict future water use. Current water use is used to calibrate the model for the target community by comparing the modeled and actual demands. Long-term water demand forecasts have inherently high margins of uncertainty arising from the unpredictability of community growth rates and patterns, and of rates of change in how efficiently water is used in households and industry.

The model disaggregates annual water demand into base (primarily indoor) and seasonal (primarily irrigation) components, and further breaks down these categories by sector and end use of water, and accounts independently for distribution system losses. The model also incorporates an estimate of the range of uncertainty in the forecast.

The resulting bottom-up estimate was calibrated for a baseline year (2019) using RDN's water use data. Status quo forecasts were then developed for the WSAs using forecasts of community growth and land use changes (including densification or infill development, which reduces irrigable area while increasing building area and population), climate change (which increases irrigation demand), natural replacement rate estimates for plumbing fixtures and appliances, and the impacts of current demand management programs.

Proposed Conservation Programs

Proposed conservation programs were developed from review of RDN's current efficiency programs (see Technical Memo #1), discussions with staff, best practices, and experiences working with other utilities. From this analysis, a suite of potential measures was identified. In some cases, this involves maintaining or improving current programs, in other cases introducing new programs. The following options were reviewed with RDN staff in February 2020, with resulting consensus that they should be explored further in this quantitative modelling phase.

- Team WaterSmart youth resources;
- Team WaterSmart publications, website and events;
- residential irrigation system check-ups/high user program;
- irrigation upgrades and soil improvements rebate;
- rainwater harvesting rebates;
- water restrictions;
- a commercial and institutional customer pilot project;
- water services pricing adjustments; and,
- system loss management.

A summary of the assumptions used for the projected savings associated with these measures for the demand forecast is provided in Table A1 in Appendix 2.

Assumptions

Assumptions for the water demand forecast were developed using best practices and available reference literature. The literature-based assumptions form the basis for KWL's demand forecasting model and have been successfully calibrated for communities of all sizes in British Columbia.

Local and general assumptions for RDN's forecast assessments are listed in Appendix 2. These assumptions remain constant for the base and conservation cases unless they are modified by the proposed conservation measures.

Scenarios

Due to uncertainty in the water balance (discussed further in Appendix 3), two scenarios were developed for the demand forecast. Scenario 1 has higher relative single family residential demand and Scenario 2 has higher relative non-revenue water. In the forecast, this difference was achieved by attributing additional leakage to either residential sources or distribution sources. Table A2 and A3 in Appendix 2 set out the modelling parameters that establish the baseline for demand forecasting.

4.2 Results

This sub-section provides an overview of the demand forecast results for the base and conservation cases as modeled for RDN.

4.2.1 Scenario 1 (Higher Single Family Residential Demand in Water Balance)

Scenario 1 Base Case

The bottom-up model for Scenario 1 calculated 2020 total water demand of 975 ML compared to 976 ML of total system production estimated based on data provided by RDN as used in Section 2, above. This represents a difference of <1%. In per capita terms, the 2020 demand calculated by the model is equivalent to residential demand of 323 liters per capita per day (LCD) and total demand of 374 LCD day.

The best estimate forecast for 2030 water demand is 1036 ML, representing a 6% increase in total water demand over 10 years. The greatest sources of the increase are residential population growth and increased seasonal demand for irrigation. The best estimate forecast future population is 8,136 people with per capita residential demand of 302 LCD and per capital total system demand of 349 LCD. The lower per capita demand is due to the natural replacement of fixtures and appliances.

The total forecast base case water demand for the nine WSAs are illustrated as total values and per capita values in Figure 6 and Figure 7, respectively.

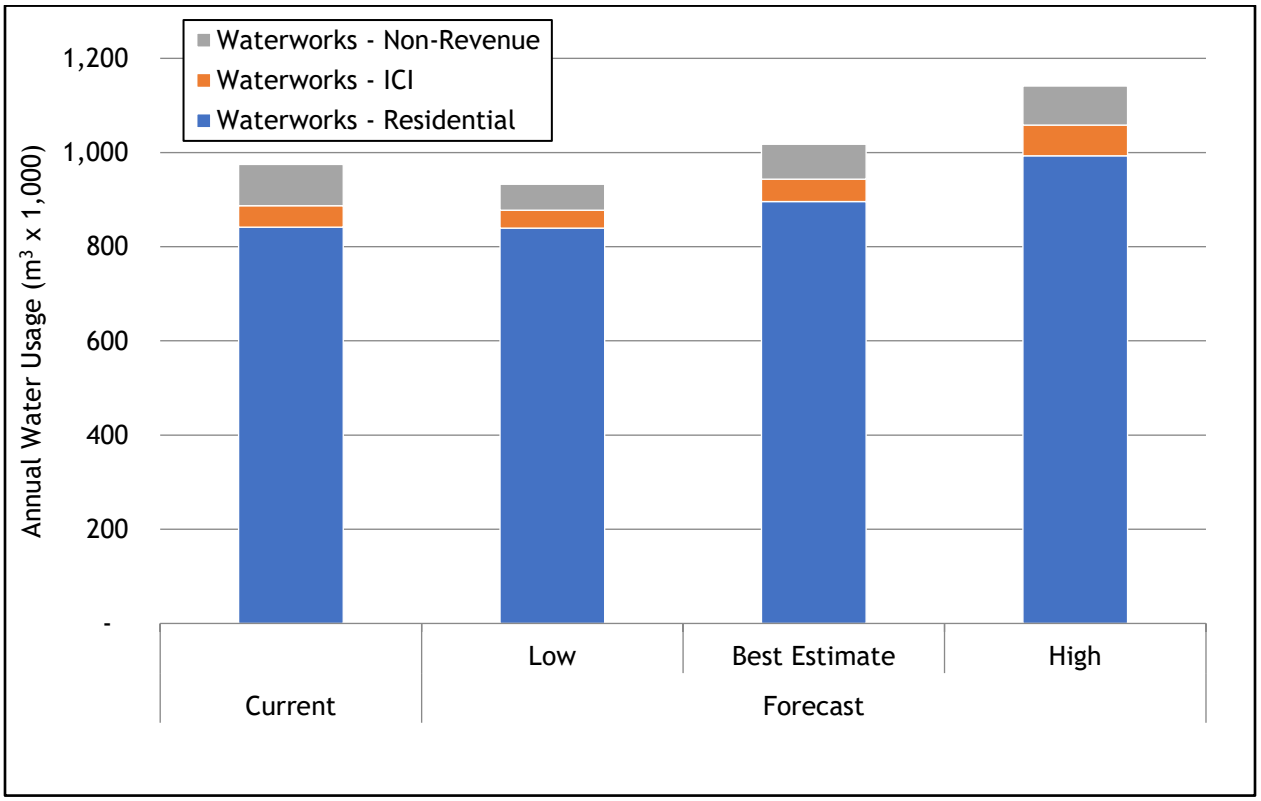


Figure 6: Scenario 1 Current 2020 and Base Case 2030 Forecast Total Water Demand for Nine RDN WSAs

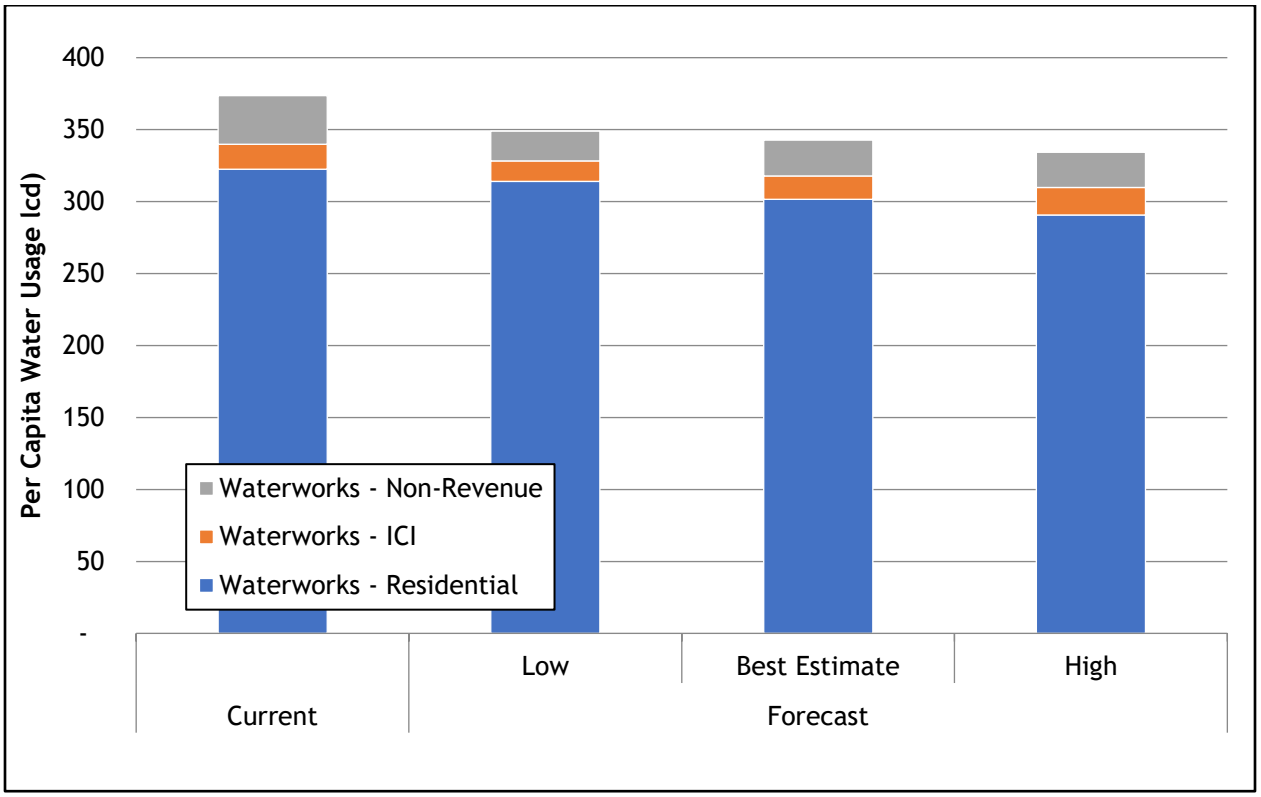


Figure 7: Scenario1 Current 2020 and Base Case 2030 Forecast Per Capita Water Demand for Nine RDN WSAs

Scenario 1 Conservation Cases

The forecast Scenario 1 conservation cases' total water demand for the nine water service areas is illustrated in Figure 8. Compared to the 2030 forecast base case and using the best estimate forecasts, 2030 total water demands are expected to be reduced by 1.9% using a residential irrigation program, by 9.1% using water services pricing adjustments and 1.7% using a system loss management program. However, if all three of these measures were implemented, the total decrease in demand would not add to the sum of each individual program since there would be overlaps in the water demand that is conserved.

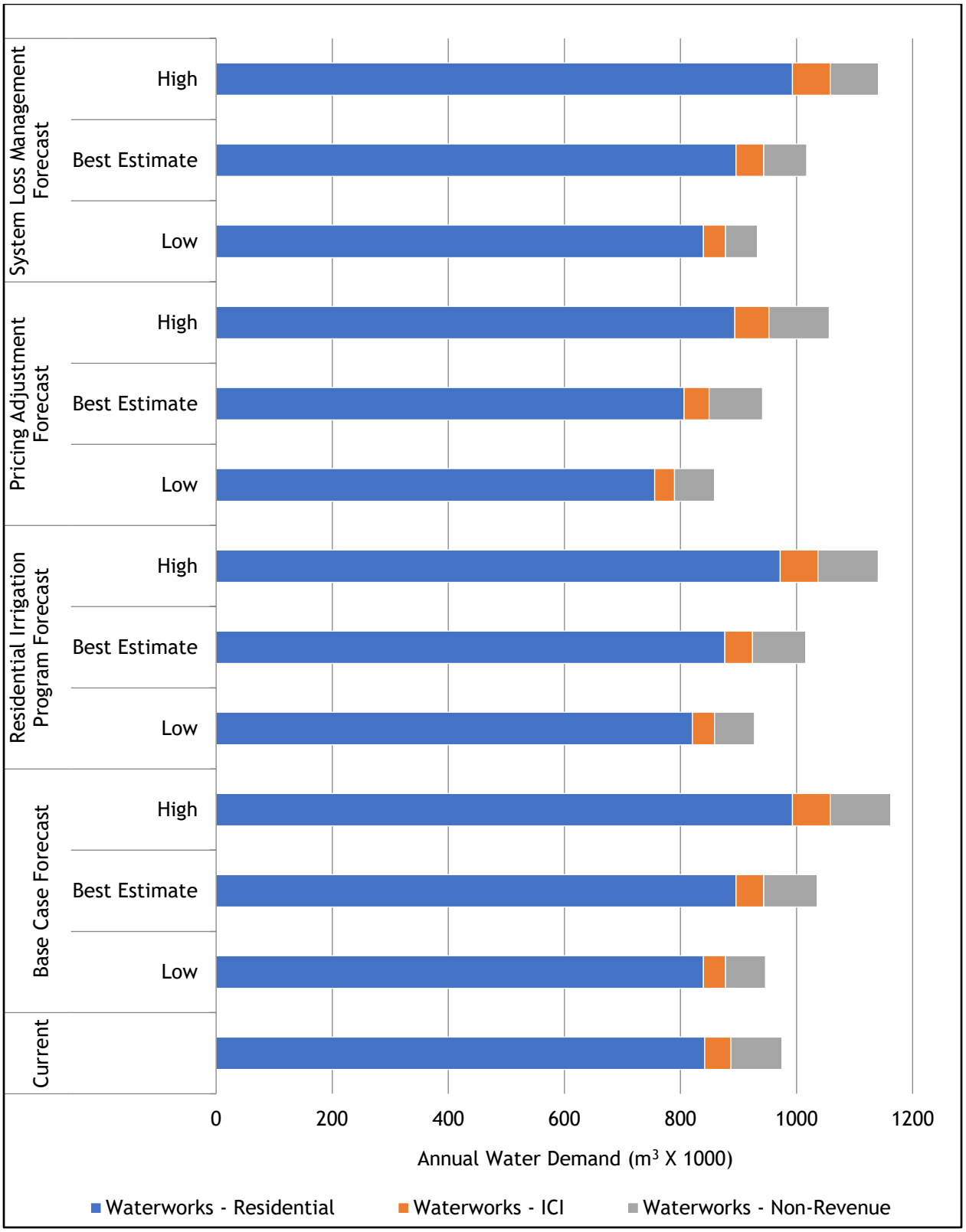


Figure 8: Scenario 1 Current 2020, 2030 Base Case, and 2030 Conservation Cases Total Water Demand Forecast for Nine RDN WSAs

The forecast conservation cases' per capita water demand for the nine water service areas is illustrated in Figure 9 and the following is a breakdown of per capita demands for 2020 and for the 2030 forecast base case and conservation cases. Total water demands are primarily driven by population growth. For newer or denser future developments, it is forecast that higher total demand will be due to a larger population with moderately lower per capita demands. This is reflected in Figure 9.

Scenario 1 Residential Demand

- 2020: 323 LCD
- 2030 Forecast Base case: 302 LCD
- 2030 Forecast System Loss Management Program: 302 LCD
- 2030 Forecast Pricing Adjustment: 272 LCD
- 2030 Forecast Residential Irrigation Program: 295 LCD

Scenario 1 Total System Demand

- 2020: 374 LCD
- 2030 Forecast Base Case: 349 LCD
- 2030 Forecast System Loss Management Program: 343 LCD
- 2030 Forecast Pricing Adjustment: 317 LCD
- 2030 Forecast Residential Irrigation Program: 342 LCD

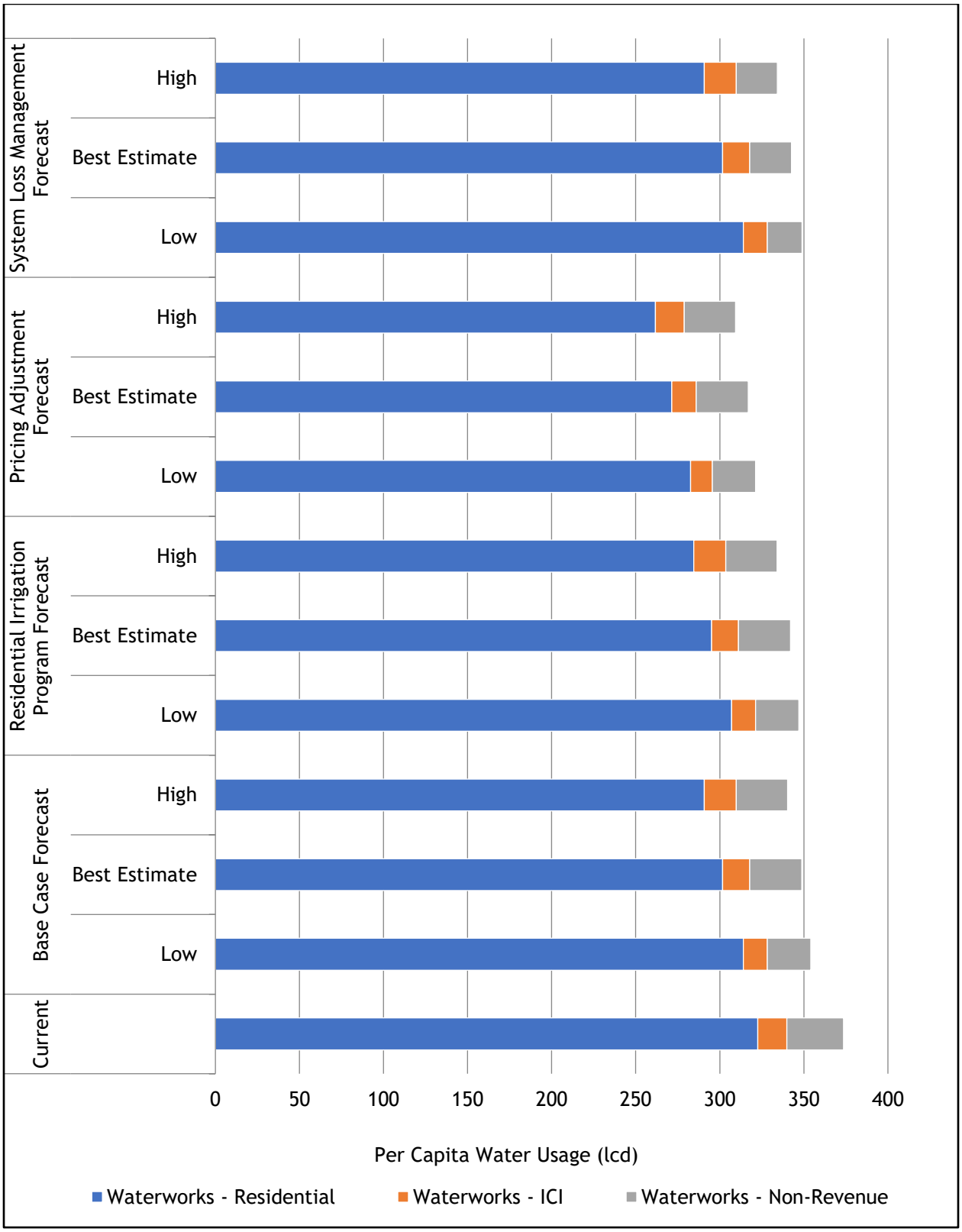


Figure 9: Current 2020, 2030 Base Case, and 2030 Conservation Cases Per Capita Water Demand Forecast for Nine RDN WSAs

4.2.2 Scenario 2 (Higher System Loss in Water Balance)

Base Case

For the purpose of illustrating uncertainty in the demand forecast for a system loss management program, the bottom-up model was also calibrated for a situation with 20% system losses rather than 9% system losses, as is the case under Scenario 1. Under this scenario, residential per capita water demand was decreased by 55 LCD and this demand was instead attributed to losses within the water distribution network. For Scenario 2, the calculated 2020 total water demand was 982 ML compared to 976 ML of total system production based on the data provided by RDN as used in Section 2, above and 975 ML in Scenario 1. In per capita terms, the 2020 demand calculated by the model is equivalent to residential demand of 284 LCD and total demand of 376 LCD day.

The best estimate forecast for 2030 water demand is 1059 ML, representing an 8% increase in total water demand over 10 years. The greatest sources of the increase are residential population growth and increased seasonal demand for irrigation. The best estimate forecast future population is 8,136 people with per capita residential demand of 272 LCD and per capital total system demand of 357 LCD. The lower per capita demand is due to the natural replacement of fixtures and appliances.

The total forecast base case water demand for the nine WSAs under Scenario 2 are illustrated as total values and per capita values in Figure 10 and Figure 11, respectively.

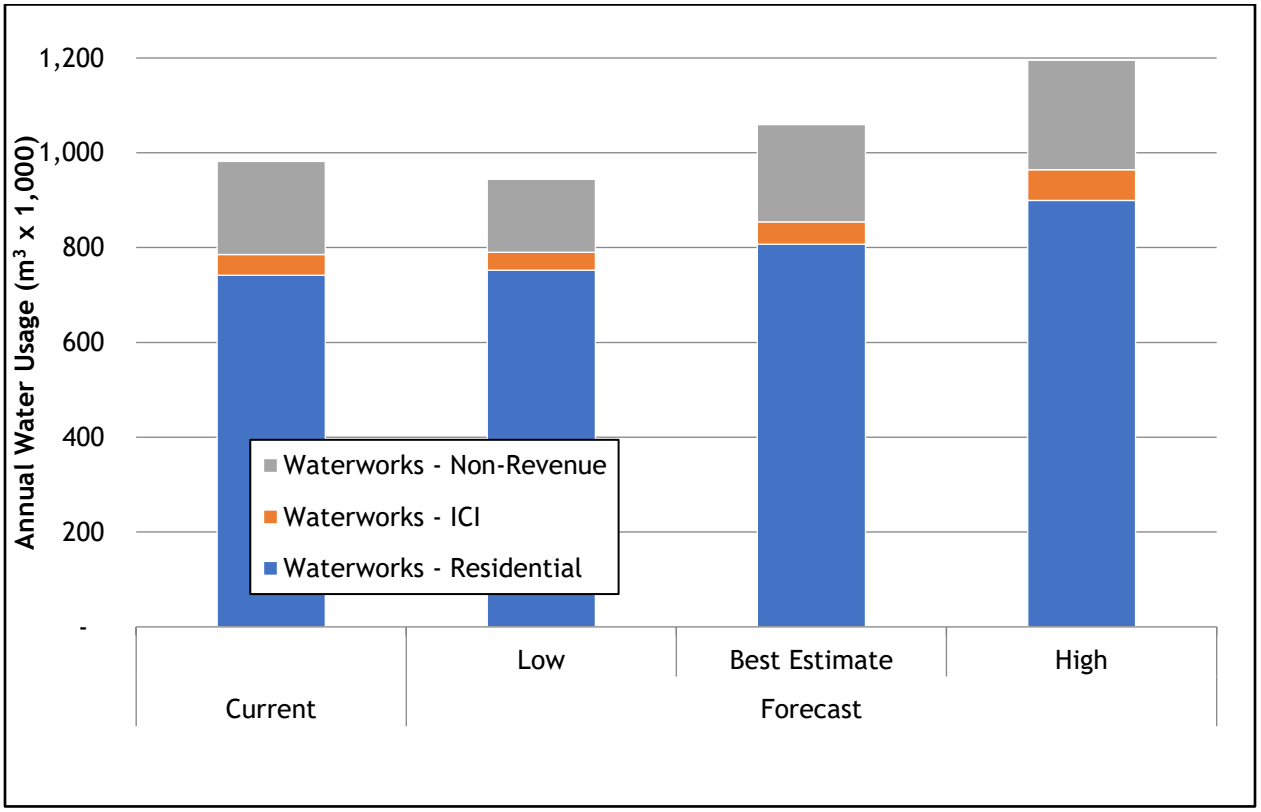


Figure 10: Scenario 2 Current 2020 and Base Case 2030 Forecast Total Water Demand for Nine RDN WSAs

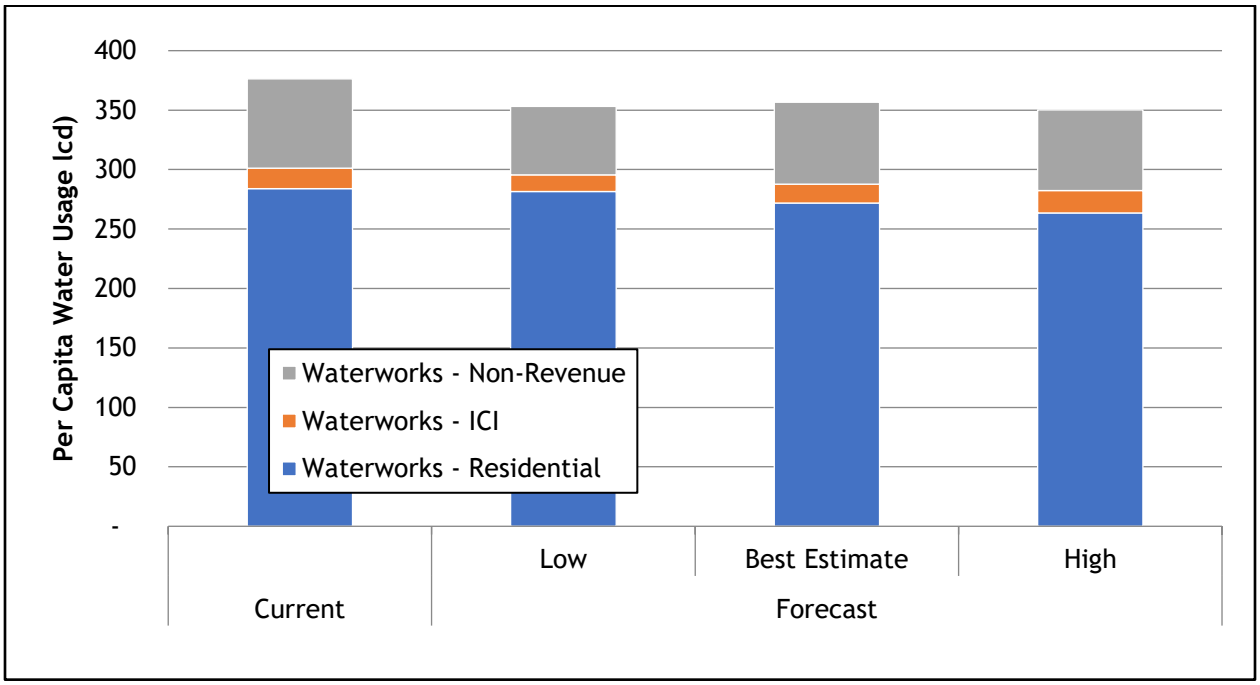


Figure 11: Scenario 2 Current 2020 and Base Case 2030 Forecast Per Capita Water Demand for Nine RDN WSAs

Scenario 2 Conservation Cases

For the purpose of illustrating uncertainty, the forecast system loss management conservation case total water demand for the nine water services under Scenario 2 is illustrated in Figure 12. Compared to the 2030 forecast base case and using the best estimate forecasts, 2030 total water demands are expected to be reduced by 3.8% using a system loss management program. Comparatively, under Scenario 1, total demands were expected to be reduced by 1.7% using a system loss management program.

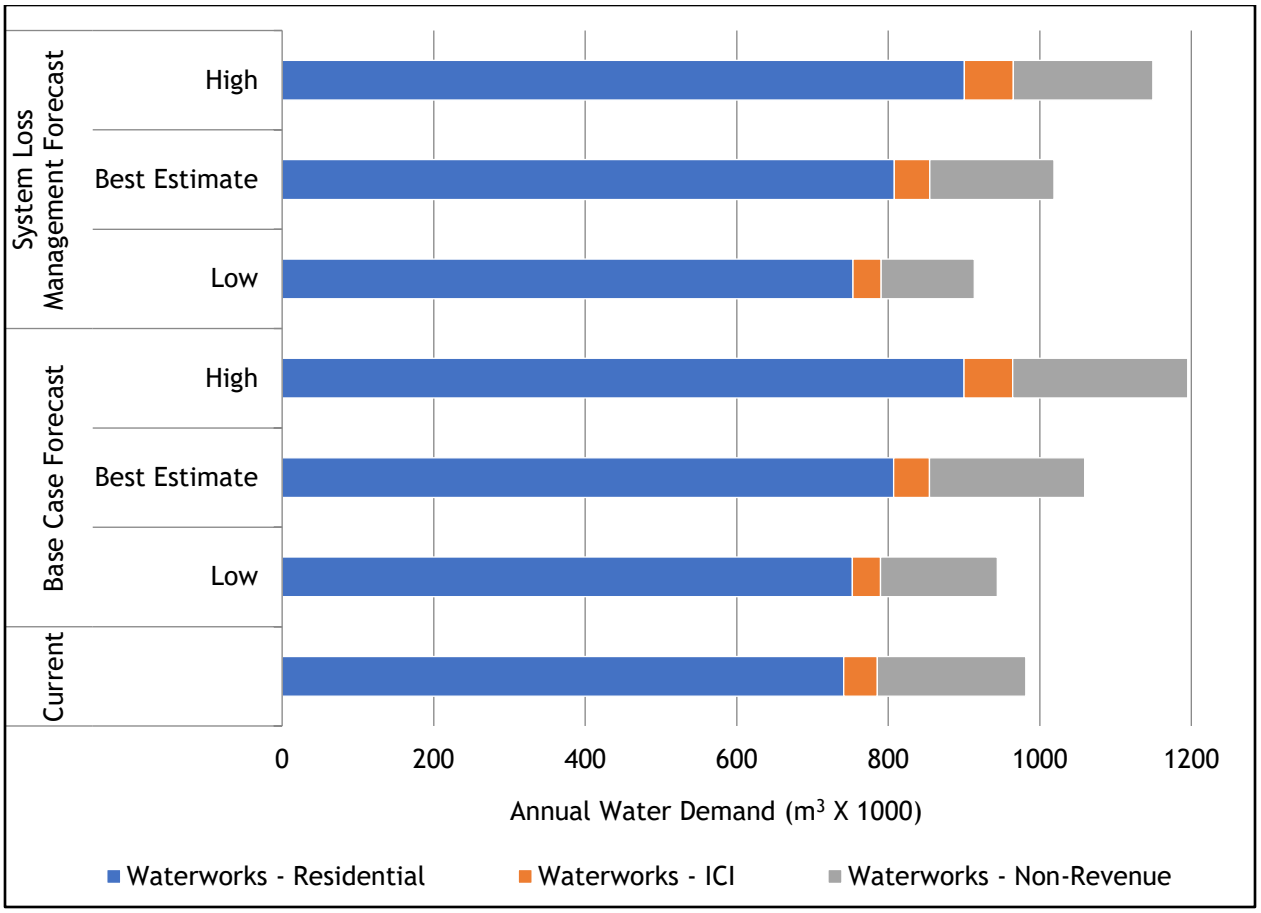


Figure 12: Scenario 2 Current 2020, 2030 Base Case, and 2030 Conservation Cases Total Water Demand Forecast for Nine RDN WSAs

The Scenario 2 forecast conservation cases' per capita water demand for the nine water services is illustrated in Figure 13 and the following is a breakdown of per capita demands for 2020 and for the 2030 forecast base case and conservation cases.

Scenario 2 Residential Demand

- 2020: 284 LCD
- 2030 Forecast Base case: 272 LCD
- 2030 Forecast System Loss Management Program: 272 LCD

Scenario 2 Total System Demand

- 2020: 376 LCD
- 2030 Forecast Base Case: 357 LCD
- 2030 Forecast System Loss Management Program: 343 LCD

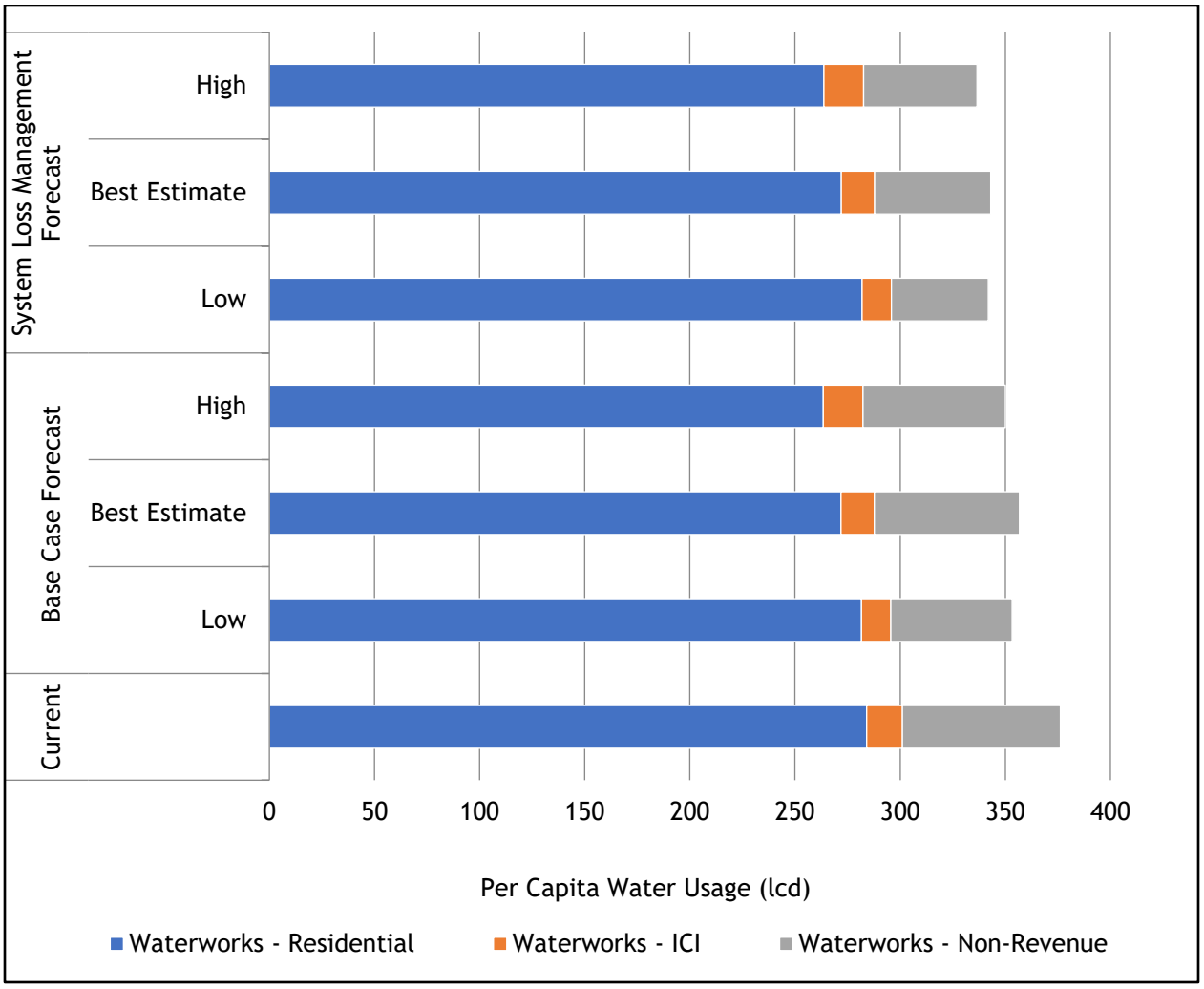


Figure 13: Scenario 2 Current 2020, 2030 Base Case, and 2030 Conservation Cases Per Capita Water Demand Forecast for Nine RDN WSAs

4.2.3 Summary

Table 2 provides a summary of all current and forecast water demands calculated for Scenario 1 and Scenario 2.

Table 2. Demand Forecast Summary for Scenario 1 and Scenario 2

Balance	Scenario 1													Scenario 2						
	Current	Base Case Forecast			Residential Irrigation Program Forecast			Pricing Adjustment Forecast			System Loss Management Forecast			Current	Base Case Forecast			System Loss Management Forecast		
		Low	Best Estimate	High	Low	Best Estimate	High	Low	Best Estimate	High	Low	Best Estimate	High		Low	Best Estimate	High	Low	Best Estimate	High
Total Demand Per Year, m^3 X 1000																				
Residential	842	839	896	993	821	876	972	755	806	894	839	896	993	741	753	807	900	753	808	901
ICI	45	38	48	65	38	47	65	34	43	59	38	48	65	44	37	47	65	37	47	65
NRW	88	69	92	104	69	92	104	69	92	104	55	74	83	196	154	205	231	123	164	184
Total	**975**	**946**	**1036**	**1162**	**928**	**1016**	**1141**	**859**	**941**	**1056**	**932**	**1018**	**1141**	**982**	**944**	**1059**	**1195**	**914**	**1019**	**1149**
% Of Base Case		100%	100%	100%	98.0%	98.1%	98.2%	90.7%	90.9%	90.9%	98.5%	98.3%	98.2%		100%	100%	100%	96.8%	96.2%	96.1%
Per Capita Demand, LCD*																				
Residential	323	314	302	291	307	295	285	283	272	262	314	302	291	284	282	272	264	282	272	264
ICI	17	14	16	19	14	16	19	13	14	17	14	16	19	17	14	16	19	14	16	19
NRW	34	26	31	30	26	31	30	26	31	30	21	25	24	75	58	69	68	46	55	54
Total	**374**	**354**	**349**	**340**	**347**	**342**	**334**	**321**	**317**	**309**	**349**	**343**	**334**	**376**	**353**	**357**	**350**	**342**	**343**	**336**
% Of Base Case		100%	100%	100%	98.0%	98.0%	98.2%	90.7%	90.8%	90.9%	98.6%	98.3%	98.2%		100%	100%	100%	96.9%	96.1%	96.0%

* Note that, because the high and low forecasts are primarily driven by population growth, with higher population growth, we actually see slightly lower per capita demands (but higher overall demands with more people) because there is a greater usage of efficient water fixtures in a greater number of new housing developments and because population growth drives higher density.

5.0 Conclusion

The findings in this report generally support the preliminary direction set out in the *Existing Program Review* (Technical Memo #1) and subsequent discussions with RDN staff. Five key conclusions emerge.

First, analysis of water production data indicates that summer use remains high in most WSAs, compared to winter base averages, consistent with findings from previous work (AquaVic, 2013; McSorley 2018). From on our experience corroborated by anecdotal reports from RDN staff, this is without doubt by high levels of outdoor irrigation of lawns and gardens.

This lends support to continuing the current Team WaterSmart irrigation audits and rebates as suggested in the *Existing Program Review*. Ideally, these will continue to be targeted systematically at accounts with high consumption and to WSAs where summer use is relatively high (e.g., Englishman River, San Pareil, Surfside) compared to other WSAs.

Second, reports provided to us by RDN from previous analysis indicates that non-revenue water levels are high (RDN 2020a), although there remains some uncertainty about this conclusion based on the water balances we developed to inform demand forecasting. Preliminary steps for validating and then addressing this are discussed in Appendix 3, below, and will be elaborated on further in the final Water Conservation Plan update.

Third, the analysis supports some level of attention to non-single family residential (i.e., "commercial") demand. From preliminary discussions about the findings in this memo, this constitutes a larger portion of total demand than RDN staff initially expected, and much of this is concentrated in a very small number of accounts. Suggested steps include:

- tighten water use accounting and billing data management practices (discussed further in Appendix 3);
- separate what is actually strata and multi-family residential use out of the commercial category, then target these customers with traditional residential demand management efforts; in some cases this will need to be done collaboratively with property managers and strata councils; we also suggest sub-metering some of these customers where this is feasible and appropriate;
- target true commercial and institutional users, especially higher volume consumers, with measures suitable for these sectors; we suggest that this be done through a pilot project that will facilitate learning for the Drinking Water and Watershed Protection Program at the regional scale.

Fourth, in general, a targeted project to improve and document water use accounting methods will assist future analysis of this kind. This will also aid with more precisely quantifying non-revenue water and will help target effort aimed at high volume use residential customers and WSAs. Again, see Appendix 3 for additional detail.

Finally, the demand forecasting in Section 4 generally continues to support measures identified earlier in the project, specifically, irrigation audits and rebates, a water service pricing review, and non-revenue water management.

These conclusions will inform further discussions with RDN staff and development of the final Water Conservation Plan update in the next phase of the project.

6.0 References

American Water Works Association (2016). Water Audits and Loss Control Programs, Manual of Water Supply Practices M36, 4th ed., Denver.

Aquavic Water Solutions (2013). Water Conservation Plan. Prepared for RDN, October 2013.

ESRI (2007). Evaluation population projections. https://www.esri.com/library/whitepapers/pdfs/evaluating-population.pdf

Koers and Associates (2012). Development Cost Charges Study for Nanoose Bay Peninsula Water System. Prepared for Regional District of Nanaimo.

McSorley, H. (2018a). Team WaterSmart Free Irrigation Check-Up Service: Conservation Program Impact Evaluation. Report prepared for Team WaterSmart, Drinking Water & Watershed Protection Program, Regional District of Nanaimo, March 2018.

McSorley, H. (2018b). Water Conservation Evaluation: Targets, Trends and Trajectories. Report prepared for Regional District of Nanaimo, June 2018.

Morales, M.A., Heaney, J.P., and R. Friedman (2011). Estimating Commercial, Industrial, and Institutional Water Use Based on Heated Building Area. Journal of the American Water Works Association. 103(6).

Pacific Institute (2016). A Community Guide for Evaluating Future Urban Water Demand. http://pacinst.org/app/uploads/2016/08/A-Community-Guide-for-Evaluating-Future-Urban-Water-Demand-1.pdf

Province of BC, POLIS Project on Ecological Governance, and Okanagan Basin Water Board (2013). Water Conservation Guide for British Columbia, Victoria, December 2013.

RDN (2020a). mw-RDN Nonrevenue water summary. Microsoft Excel Spreadsheet.

RDN (2020b). walk sequence files Sept 2019. Microsoft Excel Spreadsheet.

RDN (2020c). New Calculator Monthly Production for Econics. Microsoft Excel Spreadsheet.

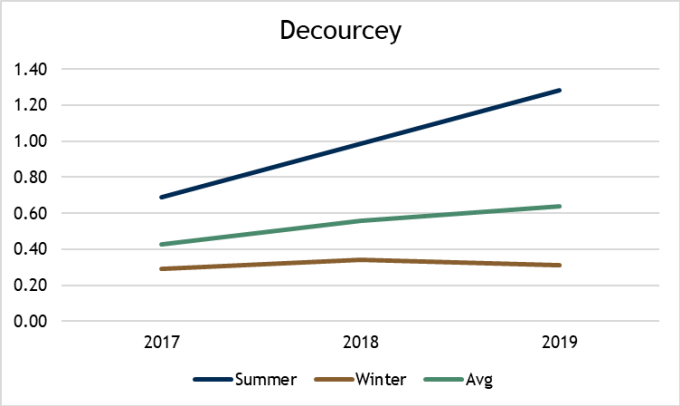
RDN (2020d). Calculated 2019 Commercial Consumption Data. Microsoft Excel Spreadsheet.

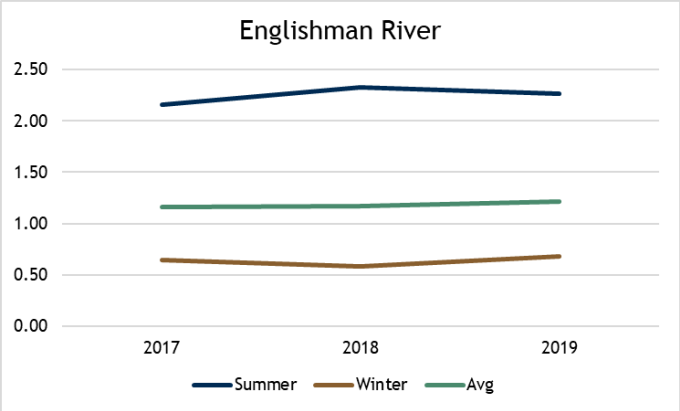
RDN (2020e). 2019 Consumption Totals Residential. Microsoft Word Document.

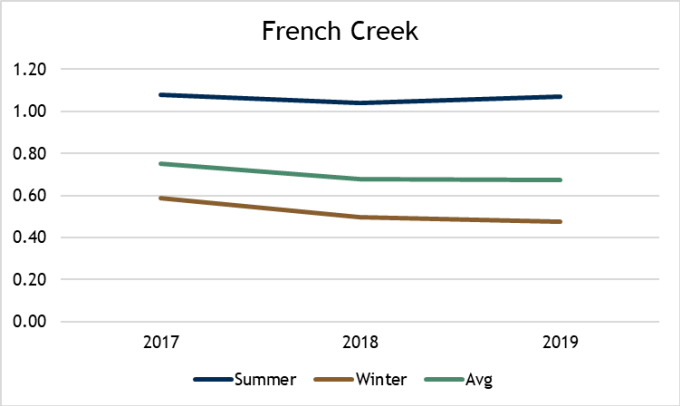
Statistics Canada (2017). Nanoose Bay, UNP [Designated place], British Columbia and British Columbia [Province] (table). Census Profile. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. Ottawa. Released 29 November 2017. Accessed at https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E. Accessed on 9 March 2020.

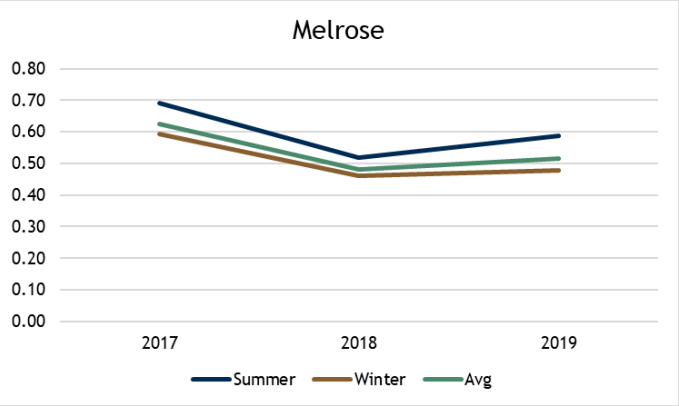
Appendix 1: Per Connection Water Production for WSAs (2017 to 2019)

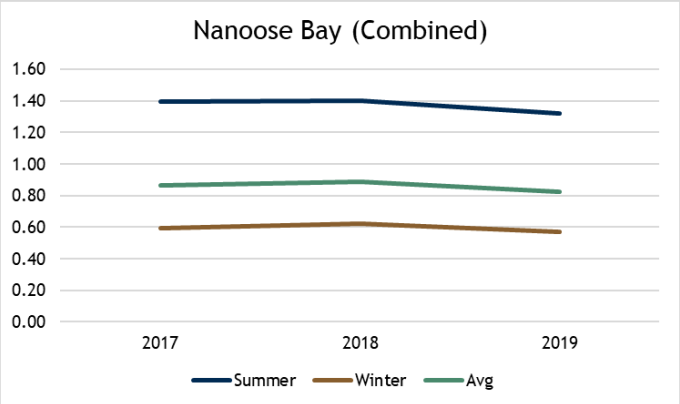
See Section 2 for an explanation of the methodology used to develop the figures below. All figures depict consumption on the vertical axis as cubic meters per connection per day. Note that data includes commercial consumption and accounts.

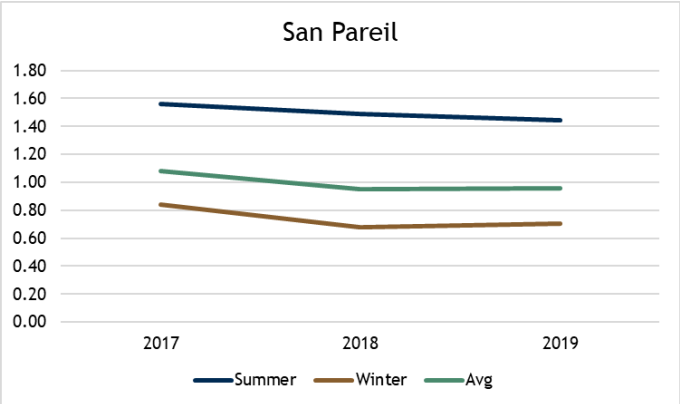


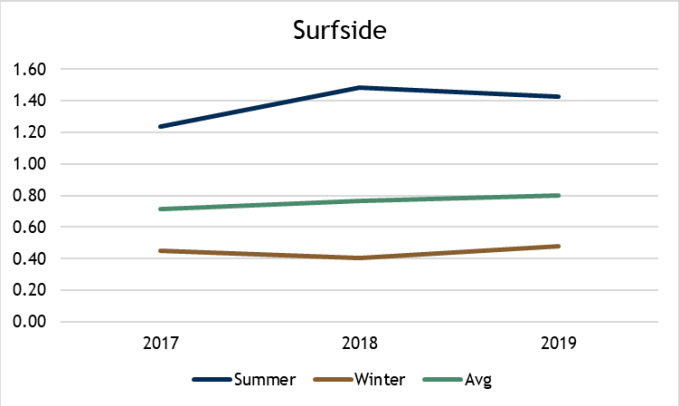


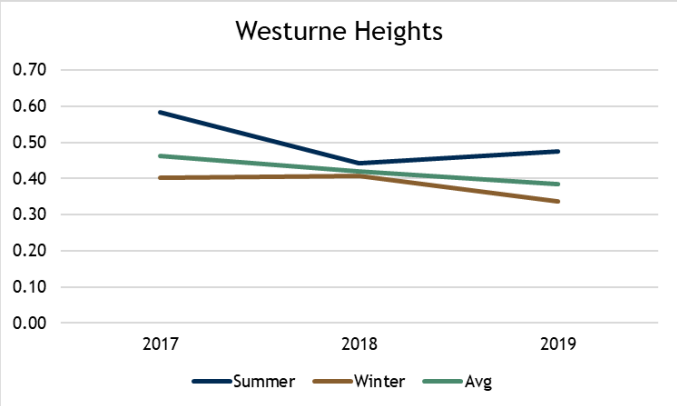


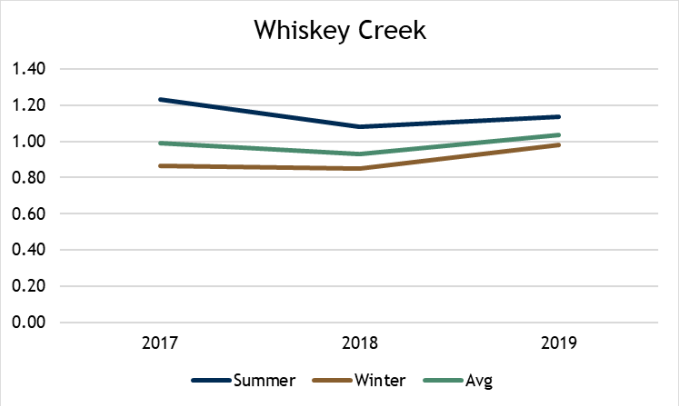


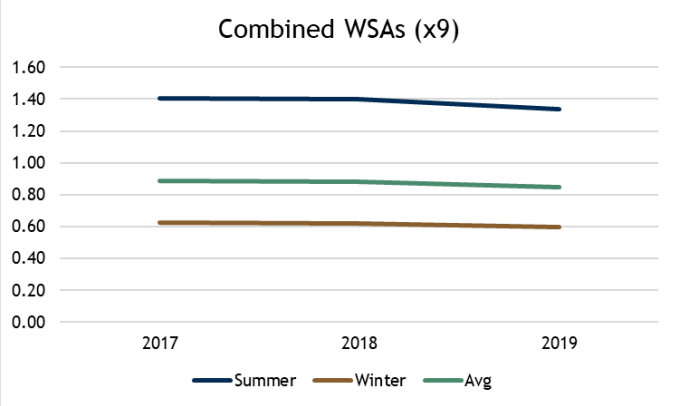





Surfside
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
2017
2018
2019
Summer
Winter
Avg


Westurne Heights
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
2017
2018
2019
Summer
Winter
Avg


Whiskey Creek
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
2017
2018
2019
Summer
Winter
Avg


Combined WSAs (x9)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
2017
2018
2019
Summer
Winter
Avg

Appendix 2: Demand Forecasting Assumptions

This appendix provides additional details on assumptions used in demand forecasting in Section 4.

Table A1: Proposed Conservation Measures and Forecast Impact

Measure	Maintain	Enhance	Add	Forecast Impact
Youth Resources	X			Status quo
TWS Publications, Website and Events	X			Status quo
Residential Irrigation System Check-Ups/High User Program		X		1% annual reduction in per capita demand (10% total over 10 years)♦
Irrigation Upgrades and Soil Improvements Rebate	X			No change (savings included in check-ups)
Rainwater Harvesting Rebates	X			Status quo
Water Restrictions	X			Status quo
ICI Pilot Project			X	Status quo
Water Services Pricing Adjustments		X		2% annual reduction in per capita demand* (20% total over 10 years)
System Loss Management			X	40% total reduction in NRW (4%/year)❖

♦ assumption informed by McSorley (2018a)

* based on price elasticity of demand of -.40 and 30% increase in real price.

❖ assumes on average reduction of non-revenue water to 20% of total production across all WSAs.

Table A2: RDN-Specific Modelling Assumptions

Parameter		Modelling Assumption		Source
Modelling period		2020 to 2030		Staff direction (see Assumption 4)
Residential liters per connection per day		710		Based on RDN (2020e) (see Assumption 5)
Residential occupancy rate		2.2		Statistic Canada (2017) (see Assumption 11)
Residential liters per capita per day		323		Derived
Total system production per year (2019)		976,476 m^3		RDN (2020c) (see Assumption 7)
Total system production per day (2019)		2,675 m^3		Derived
Scenario 1 water balance (% of production)	Non-revenue water	9%	88,757 m^3	Derived (see Assumption 8)
	Single family residential	82%	802,508 m^3	Based on RDN (2020e)
	Strata/multi-family residential	4%	39,952 m^3	Estimate based on RDN (2020d)
	True commercial/ institutional	5%	45,259 m^3	Estimate based on RDN (2020d)
Scenario 2 water balance (% of production)	Non-revenue water	20%	195,295 m^3	Based on RDN (2020a)
	Single family residential	71%	695,970 m^3	Derived (see Assumption 8)
	Strata/multi-family residential	4%	39,952 m^3	Estimate based on RDN (2020d)
	True commercial/ institutional	5%	45,259 m^3	Estimate based on RDN (2020d)
SF residential connections (all WSAs)		3,096		RDN (2020b)
SF residential population (all WSAs)		6,811		Derived
Peaking factor		1.9		Derived based on RDN (2020c) (see Assumption 12)
Growth		1.3%		Based on Koers and Associates (2012) (see Assumption 9)

Table A3: General Modelling Assumptions

Input	RDN WSAs	Notes/Reference
Permanent Population	7,150	6,811 SFR and 339 MFR, derived
Transient Population	0	Assume insignificant in absence of data
Total Land Area (ha)	48,148	Official community plans
Developed Land Area (ha)	1,010	Official community plans
Agricultural Land Area (ha)	0	Official community plans
Metered	Yes	Baseline usage analysis
Residential Land Area Growth Rate (%)	0.25%	Esri, 2007
Industrial Land Area Growth Rate (%)	0.50%	Esri, 2007
Commercial Land Area Growth Rate (%)	0.50%	Esri, 2007
Institutional Land Area Growth Rate (%)	0.50%	Esri, 2007
Base Fixture Replacement Rate (%)	3%	Pacific Institute, 2016
Pre-1990 Indoor Base Residential Demand (L/c/d)	195	DeOreo et al. 2016
Post-1990 Indoor Base Residential Demand (L/c/d)	140	DeOreo et al. 2016
Population with Pre-1990 Fixtures or Leakage (%)	40%	Calibrated to residential base demand to achieve 323 LCD for Scenario 1 and 284 LCD for Scenario 2 including residential irrigation and leakage
Population with Post-1990 Fixtures or no Leakage (%)	60%	Calibrated to residential base demand to achieve 323 LCD for Scenario 1 and 284 LCD for Scenario 2 including residential irrigation and leakage
Scenario 1 Residential Leakage	80 LCD	Calibrated to residential base demand
Scenario 2 Residential Leakage	25 LCD	Calibrated to residential base demand
Indoor Base Residential Demand (L/c/d)	170	DeOreo et al. 2016
Industrial (m3/m2/year)	0.74	Morales et al, 2016
Commercial (m3/m2/year)	1.94	Morales et al, 2016
Institutional (m3/m2/year)	1.16	Morales et al, 2016
Industrial (m3/m2/year)	0.28	Morales et al, 2016
Commercial (m3/m2/year)	1.15	Morales et al, 2016
Institutional (m^3/m^2/year)	0.76	Morales et al, 2016
Residential Landscape Coverage Ratio (%)	40%	BC Rural Residential Water Design Guidelines
Residential % Irrigated	40%	Calibrated to baseline usage analysis
ICI Landscape Coverage Ratio (%)	20%	Default is half of the residential lot coverage ratio
Agricultural % Irrigated (%)	0%	Assume no agricultural demand
Landscape Water Usage (m^3/ha/d)	15	Calculated from evapotranspiration rates, irrigation type and land cover
Agricultural Water Usage (m^3/ha/d)	13	Calculated from evapotranspiration rates, irrigation type and land cover
Scenario 1 Infrastructure Condition Factor	0.6	Calibrated to baseline usage analysis to reflect 9% distribution system losses as a component of the water balance
Scenario 2 Infrastructure Condition Factor	1.33	Calibrated to baseline usage analysis to reflect 20% distribution system losses as a component of the total water balance

Appendix 3: Preliminary Recommendations on Water Use Accounting and Non-Revenue Water Management Procedures

During the course of this analysis, we encountered a number of data issues that helped us identify potential opportunities to improve water use accounting and non-revenue water management going forward.

First, Section 2 highlights large variations in water production among the WSAs, in some cases beyond what we would expect from normal differences in community water demand from neighborhood to neighborhood. In that section, we provided some explanations for why this is the case, including possible problems with water use data.

Second, during the analysis of non-single family residential (i.e., "commercial") billing data, we noted a number of challenges with the way that this data is currently coded and managed, as discussed in detail in Section 3.

Third, we made a preliminary attempt to reconcile total water production, total water consumption (from billing data) and non-revenue water estimates, all provided to us by RDN (2020a, 2020c, 2020e). Unfortunately, we were unable to do so within the scope of this project and so were unable to produce a single reliable water balance for the WSAs (i.e., a reconciled accounting of the relative proportions of total production attributable to residential and non-residential consumption and non-water revenue). This led to the decision to include two scenarios in the water forecasting in Section 4, above, each using different water balances.

Finally and related, with respect to the non-revenue water estimates provided by RDN (2020a), we again note significant variation from WSA to WSA, with notably high averages in San Pareil, Whiskey Creek, Nanoose Bay and Melrose Terrace. In some cases this is possibly attributable to known sources of loss, such as filter backflushing. However, this does not appear to be well documented and staff indicate that they would like to tighten up accounting of non-revenue water going forward.

All of the above lead us leads to the observation that there are a number of opportunities to improve current water use data and accounting practices, many of which require simple and easily implemented business process changes.

Preliminary recommended enhancements include the following:

1. **Improve Management of "Commercial" Data in the Water Billing System**
    - expand the number of bill codes used for non-single family residential accounts in the billing system from one to at least five, as follows:
        1. commercial - ideally with an additional data field identifying the appropriate North American Industry Classification System (NAICS) code;[2]
        2. institutional;
        3. utility;
        4. residential strata;
        5. undeveloped land;
        6. non-water (i.e., sewer).
    - ensure that accounts are linked to BC Assessment property classes and that this can be produced in billing data exports;[3]
    - where feasible, submeter individual dwellings within strata accounts and bill them individually (e.g., single family house in strata developments);
    - check billing coding errors and remedy as appropriate for the handful of accounts in the commercial category that appear to be simply single family residential dwellings or not actually water accounts (e.g., a sewer account found to not actually be in a WSA);
    - for all multi-family residential accounts, add a field identifying dwelling type (single family houses, multi-family town or row houses, multi-family apartment, mobile homes, other);
    - for all multi-family residential accounts, add a field identifying the number of dwellings within the account (i.e., number of townhouses, apartments, etc.).

2. **Non-Revenue Water Accounting and Management**
    - use widely accepted International Water Association and American Water Works Association methods to complete water audits in all WSAs (See, for example, AWWA, 2016);
    - address already known major sources of non-revenue water (e.g., for filter backflushing in Whiskey Creek);
        - where feasible, eliminate the source of loss;
        - where elimination is not feasible, install meters to accurately track volumes lost;
        - where metering is not feasible, develop methods and business practices to consistently estimate and track;
    - where appropriate, conduct night flow studies and other analysis to accurately quantify volumes truly lost to system loss (i.e., leakage);
    - use IWA and AWWA methodologies to develop infrastructure leakage indices (ILIs) for WSAs, modified as appropriate for the circumstances of small systems;[4] use these to establish measurable water loss reduction targets;
    - implement standard industry best practices for managing system loss as appropriate; as a starting point, these efforts may be best targeted as WSAs with high reported non-revenue water figures (i.e., San Pareil, Whiskey Creek, Nanoose Bay and Melrose Terrace);

[2] See https://www.statcan.gc.ca/eng/concepts/industry
[3] See https://info.bcassessment.ca/Services-products/property-classes-and-exemptions/understanding-property-classes-and-exemptions
[4] See AWWA (2016), Chapter 7 (Considerations for Small Systems)

- looking to the future, consider piloting pressure management and other more advanced system loss management techniques, both to reduce real losses in RDN WSAs and to develop learning and experience for the benefit of other water service providers in the region.

3. Standardize Water Use Accounting and Reporting Procedures

- develop a standard, documented water use accounting methodology for the WSAs aligned with best practice for future analysis of this kind;
    - document inputs and procedures used to track daily and monthly water production in WSAs; within this, clarify how volumes from surface and groundwater sources are accounted for in Nanoose;
    - document procedures used to create billing system exports to quantify metered water consumption; within this, clarify how non-single family residential consumption will be consistently handled and accounted for in reports;
- reconcile production, consumption (billing) and non-revenue water accounting to develop robust, valid water balances for all WSAs;
- going forward, calculate and report on per unit water consumption using the more conventional metric of 'residential liters per capita per day' rather than 'residential liters per connection per day'; ensure that commercial, institutional and other consumption are not included in these calculations. For consistency, ensure calculations and reporting specify whether multi-family residential consumption is included or excluded.

These preliminary recommendations will be discussed further with RDN staff and re-iterated in the final Water Conservation Plan update as appropriate.