Water Conservation Evaluation: Targets, Trends and Trajectories

Water Conservation in the Water Service Areas Operated by the Regional District of Nanaimo

Includes addendum "Water Use and Precipitation Patterns" starting on p. 47 of this PDF. Added July 2018.
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Executive Summary

The Regional District of Nanaimo (RDN) operates nine small water service areas, all of which are metered. Data collected for water production and water use in each water service area were analyzed, and were interpreted in this report against previously defined targets for water conservation.

The motivation for water conservation is to manage water demand in order to ensure resiliency of supply and infrastructure into the future, as growth and climate change affect water resources.

Two ambitious targets were developed (in 2008 and 2013) for RDN water service areas:

1. Reduce average annual residential water use by 33% between 2004 and 2018
2. Maintain maximum month water production at or below 2004 production levels until 2018

This evaluation found that, across all nine RDN water service areas, average annual daily water use per connection decreased 31% from 2004 to 2017; from an average of 819 litres used per day at each single-family residence, to 569 litres per day per connection. With sustained and continual conservation efforts in 2018, it is likely that Target 1 will be successfully achieved. This evaluation also found that maximum month water production remained below the 2004 reference level from 2011 to 2017.

With the RDN wate service areas substantially on track to meet the current targets, the next steps for the RDN to consider are:

- use findings on individual systems to target efforts for increased water conservation
- revisit and assign new targets for the next operational period
- engage developers and other departments in water conservation efforts
- continue to be a water conservation leader and advance innovative technologies through education and incentives

This report examines trends in water use and water production in each of the RDN water service areas. It provides trajectories for the next four years, and summarizes conservation milestones and future considerations. By evaluating historical and current trends, this report provides a bridge to future target-setting and implementation of continued and new water conservation measures.

Introduction

This report evaluates water production and single-family residential water use across the nine water service areas (WSAs) operated by the Regional District of Nanaimo (RDN). Water production and water-use data from the past sixteen years (2001 to 2017) were analyzed and interpreted.

"Water production" refers to the total inputs of water that enters a WSA distribution system, including groundwater and surface water. Water production may be distributed among any end users, including single-family residences and all other water consumers, including multi-family residential, institutional, commercial, or service uses (e.g. utility maintenance and water main flushing). In most RDN WSAs, production is equal to the total volume sourced from the local groundwater wells. [1] However, production in the Nanoose Bay Peninsula WSA includes both groundwater and surface water inputs. Nanoose Bay Peninsula production includes groundwater from local sources and surface water supplied from the Englishman River (per the Englishman River Water Service agreement with the City of Parksville). The Whiskey Creek WSA does not currently source groundwater from any aquifers, and instead relies on surface water from nearby Crocker Creek.

"Water use" refers to any act that removes treated fresh-water from a WSA distribution system and either converts it into greywater or wastewater, or applies it to the environment (e.g. washing, flushing, and irrigation). This report covers single-family residential water use only, and does not include multi-family residential, institutional, commercial, or service uses.[2] Because this report evaluated total production rates (representative of all municipal water inputs to each service area) and only single-family residential water-use data, no categorical conclusions should be drawn about supply and demand from this report.

Table 1 (below) summarizes growth in each WSA by the number of single-family residential connections from 2013 to 2017.[3] Since 2013, the number of single-family residential connection has not changed in Decourcey or Melrose Terrace WSAs. Englishman River WSA had the greatest increase in single-family residential connections, with most growth occurring between 2014 and 2016 (3.7% average inter-annual increase from 2014 to 2016). In the Nanoose Bay Peninsula WSA, the number of single-family residential connections increased by 1.5% from 2016 to 2017.

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[1] A summary of each WSA and the associated aquifer attributes is appended to this report (Table A1)

[2] Note that water use is monitored *per connection* in each WSA, which allows for direct comparison between WSAs, regardless of their relative populations. For RDN WSA-wide water usage, 'per-connection' usage prevented disproportionate skewing towards trends in larger WSAs by evaluating average household usage. For example, the RDN WSA-wide average household water use did not represent residential water use in Nanoose Bay Peninsula (the largest RDN WSA) more than Decourcey (the smallest RDN WSA) because usage rates were in units of volume used per day *per connection* (so, the number of connections did not skew the average).

[3] Appended is a more comprehensive connections table (Table A2) with data for single-family residential connections from 2001 – 2017, as well as proportions of production used by single-family residential water use (Table A3).

Table 1: RDN water service area single-family residential connections over the past five years

Water Service Area	Single-Family Residential Service Connections					Average annual Increase
	2013	**2014**	**2015**	**2016**	**2017**	
French Creek	236	236	238	238	239	0.3%
Surfside	37	37	37	37	38	0.3%
Decourcey	5	5	5	5	5	0.0%
San Pareil	281	280	281	282	282	0.1%
Nanoose Bay Peninsula	2056	2074	2098	2118	2151	1.1%
Englishman River	137	138	143	149	151	2.5%
Melrose Terrace	28	28	28	28	28	0.0%
Whiskey Creek	123	123	123	-	124	0.3%
Westurne Heights	-	-	-	-	17	-

Previous Conservation Reports

The 2013 *Water Conservation Plan* presented "the first strategic water conservation plan for the Regional District of Nanaimo Water Service Areas" (AquaVic 2013). The Water Conservation Plan ("2013 Plan") described trends in water production and water use in each RDN WSA and outlined conservation goals and targets. The 2013 Plan followed a comprehensive 2008 document by HB Lanarc Consultants, "Innovative Options and Opportunities for Sustainable Water Use". This 2018 *Water Conservation Evaluation* report*,* follows-up on the targets presented in the 2013 Plan and the 2008 Innovative Options report.

Water Conservation Targets

This report evaluates the progress across the RDN water service areas (WSAs) towards meeting two predefined targets that were set to achieve water conservation goals across RDN WSAs. The water conservation targets focused on sustainable water production and water use. Target 1 was proposed in the Innovative Options report, and was based on participant responses in a workshop on Sustainable Water Use (HB Lanarc 2008).[4]

Target 1*:* "Reduce average annual residential water use by 33% between 2004 and 2018".

The goal associated with Target 1 was to achieve a steady rate of residential water use despite increasing populations across the RDN WSAs (HB Lanarc 2008). Sustainable water use is achievable if per capita use declines while population increases. The year 2004 was likely selected as a reference because RDN Team WaterSmart conservation program initiatives began in 2004.[5]

[4] Participants represented all the municipalities in the RDN and included real estate agents, civil engineers, water utility managers, developers, planners, wastewater management consultants, politicians and representatives from local stewardship groups (HB Lanarc 2008).

[5] Team WaterSmart was incorporated into the RDN's Drinking Water and Watershed Protection Program in 2009.

Target 2 was recommended in the 2013 Water Conservation Plan, and was intended to reduce negative impacts on local water resources during the summer, when water-stress is highest (Aquavic 2013).

> **Target 2***:* "Maintain maximum month water production at or below 2004 production levels until 2018".

In Target 2, "maximum month water production" indicates an individual month in which water production reached a maximum rate for that year. The goal associated with Target 2 was to "minimize strain on local water resources" by monitoring peak production rates (Aquavic 2013).[6]

Note that the number of single-family residential connection in the French Creek WSA dropped in 2005, when 465 service connections (Chartwell) were transferred to the Town of Qualicum Beach. The Chartwell transfer reduced total RDN WSA single-family connections by 15.8% (2004 – 2005). Therefore, Target 2 referenced production rates associated with high population. The number of connections over time is detailed in the appendix of this report.

In addition to evaluating Target 2, this report includes supplemental targets (Target 2.1 and 2.2), described below.

Supplementing Target 2

Tracking and reducing peak water production is a valuable goal; however, this report identified three challenges in the formulation of Target 2:

1. Bulk water production (from the Englishman River) was recorded annually from 2001 to 2005, and monthly maximum production values for that period were *estimated* based on data from later years (in which maximum month Bulk production was approximately 30% of annual Bulk production).
2. Production dropped in 2005 when French Creek transferred 465 single-family residential service connections (Chartwell subdivision) to the Town of Qualicum Beach.
3. Target 2 did not appear to account for planned increases in production of surface water supply to the Nanoose Bay Peninsula (from the Englishman River Water Service).

Perhaps the reference year for Target 2 would have been better set to 2006 (rather than 2004). Evaluating maximum month production relative to 2006 would have referenced accurate monthly Bulk water production data (rather than estimated monthly Bulk production), and would have focused on the period following the transfer of Chartwell service out of French Creek WSA.

[6] Note that Target 2 had already been exceeded twice (in 2006 and 2010) when it was created in 2013.

Target 2.1

The Nanoose Bay Peninsula has a unique reliance on a combination of groundwater from aquifer sources and surface water from the Englishman River. The Englishman River Water Service was established as a long-term plan for both the City of Parksville and the Nanoose Bay Peninsula WSA to acquire additional supply of surface water from the Englishman River. The planned increase in water supply will accommodate expected growth in this WSA, and associated higher user demand. Utilizing more surface water ("Bulk water") will relieve some pressure on the aquifers that provide groundwater to the Nanoose Bay Peninsula WSA - the largest RDN WSA. Considering the Englishman River Water Service plan, this Water Conservation Evaluation report presents and evaluates an augmented version of Target 2 (Target 2.1), which distinguishes peak production from Bulk water production.

> **Target 2.1:** Maintain maximum month production – excluding Bulk surface water from Englishman River - at or below 2004 levels until 2018 and evaluate Bulk water production separately.

Target 2.1 intended to refocus Target 2 to account for the planned increase in Bulk water contributions to production in the Nanoose Bay Peninsula. The goal associated with Target 2.1 was the same as that for Target 2 (to reduce peak production and relieve stress on water sources), but the separate evaluation of Bulk production better reflects the Englishman River Water Service.

Target 2.2

Maximum month production indicates extreme values in production, which is valuable information for operations and ecological management. However, summer water production remains high over several months. Therefore, as an extension of Target 2, this report also evaluated overall summer production relative to 2006 levels (Target 2.2).[7]

> **Target 2.2:** Maintain *summer* water production at or below 2006 levels until 2018, where summer water production is defined as the cumulative water production for all RDN water service areas during the period of May to August.

The goal associated with Target 2.2 was to evaluate water production over the dry season, in consideration of strain on water sources during times of drought.

[7] Target 2.2 uses 2006 as a reference year because that was the first year that monthly Bulk water production values were available (as opposed to annual Bulk water production values and monthly estimates).

Furthermore, because both water production and water-use are highest over the summer, evaluating seasonal water production creates an opportunity to explore seasonal supply-and-demand relationships in future analyses.

The 2013 Water Conservation Plan categorized twenty-seven percent of water-use across the RDN WSAs as "unmetered", which constituted non-billable water used for main flushing and fire-control, and water lost to leaks and theft. Investigating supply-and-demand (i.e. production-and-use) trends for all metered users (not just single-family residential connections) within the RDN WSAs could inform more comprehensive water conservation measures by elucidating unmetered use.

When the 2013 Plan was created, there were eight WSAs operated by the RDN; in 2018, there are nine.[8] In each RDN WSA, volumes of water entering the distribution system and leaving the system are monitored as *production* and *use*, respectively. For this 2018 report, water production and water use data were analyzed to evaluate progress towards meeting conservation targets presented in the 2008 Innovative Options report and 2013 Water Conservation Plan (Target 1 & Target 2). Supplementary targets (2.1 and 2.2) were also evaluated. Water production and water use data from each WSA were analyzed for trends over time. Trends across the RDN WSAs were used to generate linear forecasts for water use and production. Water conservation measures that have been implemented across RDN WSAs were reviewed. And, suggestions for continued or expanded conservation efforts were provided for consideration.

[8] Brief overviews of each RDN water service area are appended

Conservation Target Evaluation

Target 1 and Target 2 focused on fostering sustainable water use and production amidst growing population across the RDN WSAs. The progress toward meeting the predefined Targets (1 and 2) and supplemental Targets (2.1 and 2.2) are summarized below.

Target 1: Residential Water Use

Target 1 was to achieve a thirty-three percent (33%) reduction in average residential water use across the nine RDN WSAs from 2004 to 2018. Figure 1 shows the average annual daily water use for single-family homes across the RDN WSAs.[9] The average volume used per day per connection decreased thirty-one percent (31%) from 2004 to 2017, from an average of 819 litres used per day at each single-family residence to 569 Litres per day per connection.

The 2017 water-use data is right on track to meet Target 1. With continued conservation efforts through 2018, it is likely that Target 1 will be successfully achieved by the end of the year. In order to achieve Target 1 by the end of 2018, average household water-use needs to decline by twenty litres per day, from the 2017 average of 569 L/day to 549 L/day per connection. The required conservation for 2018 amounts to approximately 8L per person per day.

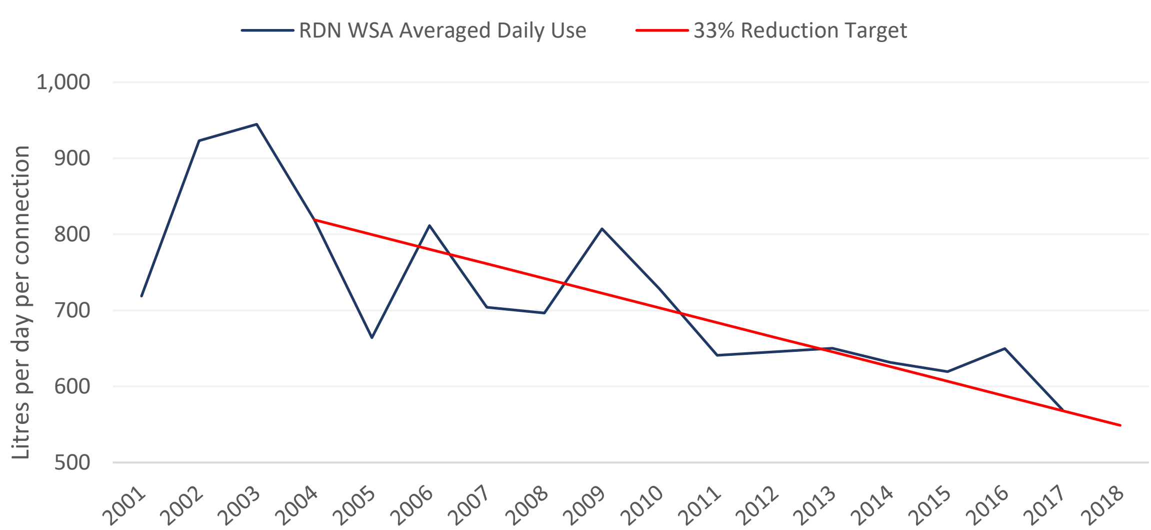

Figure 1: Annualized daily water use (average volume per single-family residential connection per day), across all RDN water service areas, relative to the thirty-three percent reduction target set in *Innovative Options and Opportunities for Sustainable Water Use* (HB Lanarc 2008).

[9] Average annual use was based on a full billing year of data (May – May) at each single-family residential connection; calculations of water use in a calendar year (Jan – Dec) were very similar are not included in this report.

Target 2: Maximum Month Production

Based on cumulative water production across the RDN WSAs, the month of maximum water production was identified for each year of production record. Table 1 (next page) summarizes maximum month water production values across the RDN WSAs from 2001 to 2017, both including and excluding Bulk water contributions to total production.

Figure 2 shows maximum month water production over time, with reference to the 2004 maximum month production threshold. Note that if 2006 had been assigned as the reference year for Target 2 (as mentioned in the "Supplementing Target 2" section, above), the graph would have been very similar to the plot shown in Figure 2, as 2004 and 2006 maximum month production values differed by approximately 30 m^3/day.

When Target 2 was set in the 2013 Water Conservation Plan, it was noted that maximum month production in 2006 and 2010 had already exceeded the 2004 maximum month production threshold. With that caveat, maximum month production has remained below the 2004 reference level from 2011 to 2017.

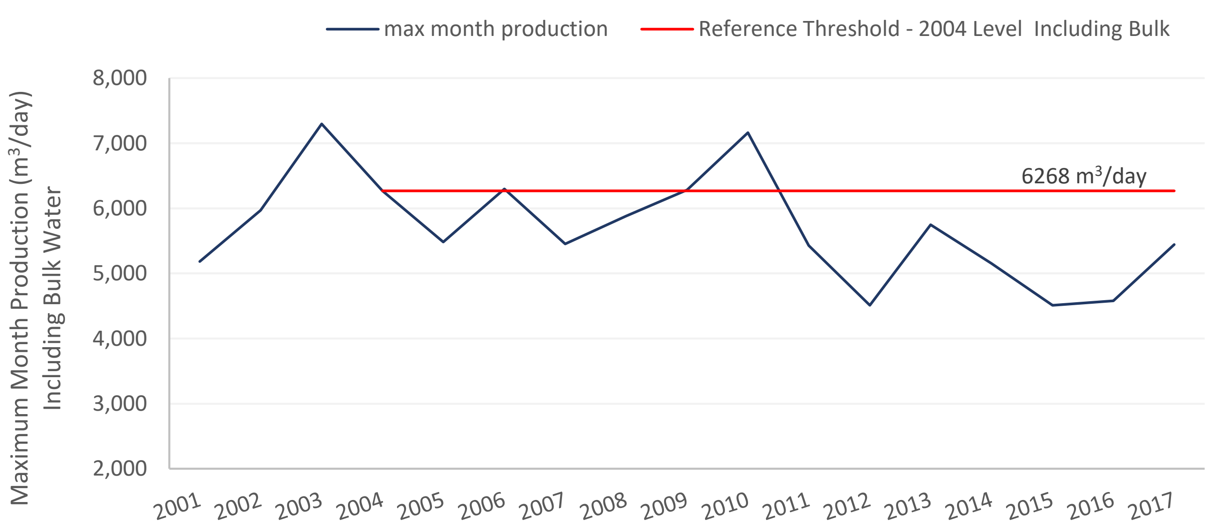

Figure 2: Maximum month production each year based on cumulative RDN water service area production (including Bulk water supply). The horizontal red line indicates the Target 2 reference (*Water Conservation Plan*, Aquavic 2013) to maintain maximum month production at or below the 2004 levels (6268 m^3/day).

Table 2: Maximum month water production rates across the RDN water service areas (with and without Bulk water from Englishman River)

Year	Month of Maximum Production	Maximum Month Water Production (m³ / month)			Maximum Month Water Production (m³ / day)	
		RDN WSA-Wide Excluding bulk water	Bulk surface water**	RDN WSA-Wide Including Bulk	Excluding Bulk	Including Bulk
2001	July	149,456	11,193	160,649	4,821	5,182
2002	July	162,592	22,437	185,029	5,245	5,969
2003	June	196,989	21,906	218,895	6,566	7,297
2004	July	170,552	23,751	194,303	5,502	6,268
2005	August	141,245	28,779	170,024	4,556	5,485
2006	July	161,722	33,440	195,162	5,217	6,296
2007	August	131,036	38,030	169,066	4,227	5,454
2008	July	146,248	36,100	182,348	4,718	5,882
2009	June	144,987	43,500	188,487	4,833	6,283
2010	July	180,128	41,850	221,978	5,811	7,161
2011	August	137,471	30,800	168,271	4,435	5,428
2012	August	109,530	30,290	139,820	3,533	4,510
2013	July	118,468	59,720	178,188	3,822	5,748
2014	July	103,524	56,252	159,776	3,339	5,154
2015	June	94,843	40,480	135,323	3,161	4,511
2016	August	93,687	48,260	141,947	3,022	4,579
2017	July	104,779	63,930	168,709	3,380	5,442

* Single-family residential connections in French Creek WSA dropped by 67% in 2005, 465 homes transferred to Qualicum Beach service

** From Englishman River, Englishman River Water Service

Grey values include estimated values: maximum month Bulk contributions from 2001 - 2005 were estimated from annual production values, assuming that max. month production was approximately 30% of annual production (based on relationships in production data from 2006 onward)

Supplemental Target 2.1: Maximum Month Production – Excluding Bulk Water

The long-term plan for Nanoose Bay Peninsula WSA is increased Bulk water contributions to production (Englishman River Water Service). Target 2.1 *excludes* Bulk water inputs in the evaluation of RDN WSA-wide production.[10] Figure 3 shows maximum month production levels across the RDN WSAs, excluding surface water from the Englishman River (Bulk water), and a reference to 2004 maximum month production (excluding Bulk water).

When Bulk water was excluded from the peak production analysis, maximum month production exceeded the 2004 reference level only once, in 2010, and has otherwise remained below the 2004 reference level. Overall, maximum month production excluding Bulk water has decreased over time and has remained relatively steady over the past five years, at around 3300 cubic meters per day.

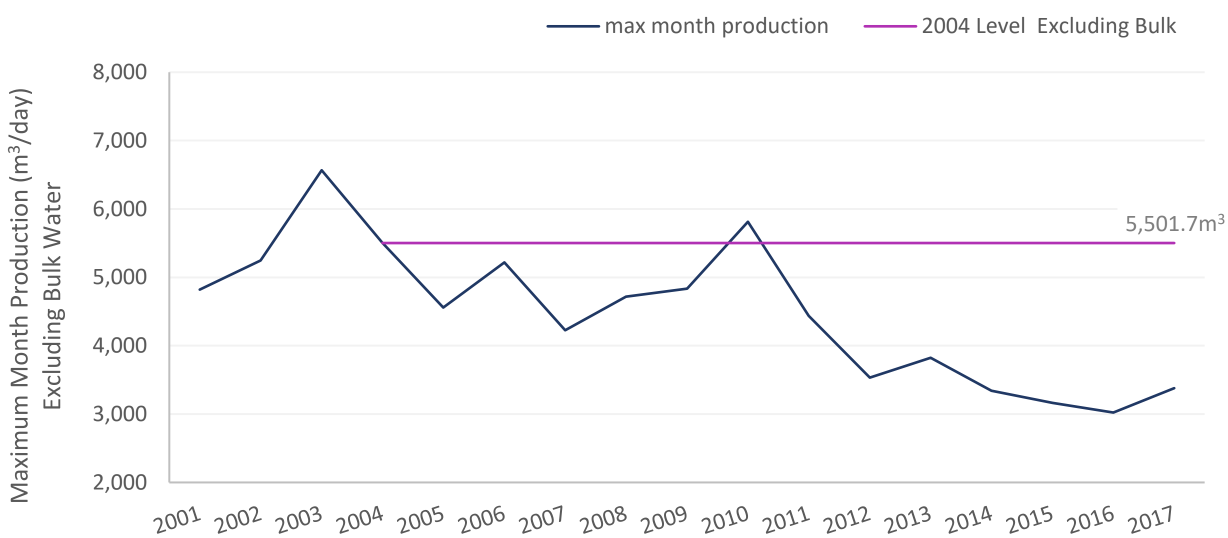

Figure 3: Maximum month water production based on cumulative RDN water service area production rates - not including bulk water from the Englishman River. The horizontal line indicates the Target level of 2004 maximum month production excluding bulk water (5502 m^3/day).

As the Englishman River Water Service plan focuses on supplying greater volumes of Bulk water to the Nanoose Bay Peninsula as growth continues, it would be wise to continue to evaluate water production within the RDN WSAs separately from Bulk water production. Because the Englishman River Water Service is anticipated to be fully implemented an operational in 2019, future production targets could be referenced to production rates achieved during 2018 or 2019.

[10] Trends in Bulk water production are included with the Nanoose Bay Peninsula WSA evaluation.

Supplemental Target 2.2: Reduce Summer Water Production

Water production peaks in the middle of summer (Table 2), but remains high over the entire summer period (Table 3). Summer water production (production during the period from May 1 to August 31), both including and excluding bulk water, was evaluated across the RDN WSAs and compared to 2006 summer production levels (Figure 4).

Summer water production has remained below 2006 summer production level each year to date (Target 2.2, Figure 4). Summer production rates *including* Bulk water have increased slightly over the past few years and vary around 4,000 cubic meters per day. In contrast, summer water production *excluding* Bulk water supply has dropped below half of the 2006 level, and has remained fairly steady since 2012 (around 2,800 cubic meters per day). Seasonal production in each water service area is explored further in following sections.

Table 3: RDN WSA-wide Summer Production

Year	Excluding Bulk water (m^3/day)	Including Bulk water* (m^3/day)
2001	4090	4318
2002	4630	5087
2003	5242	5688
2004	4938	5421
2005	3757	4342
2006	4266	5090
2007	3739	4575
2008	3580	4273
2009	4191	5174
2010	3864	4547
2011	3574	4208
2012	2910	3591
2013	2690	3898
2014	2813	4134
2015	2592	3656
2016	2850	4189
2017	2861	4356

* Grey values include estimated Bulk values (2001-2005)

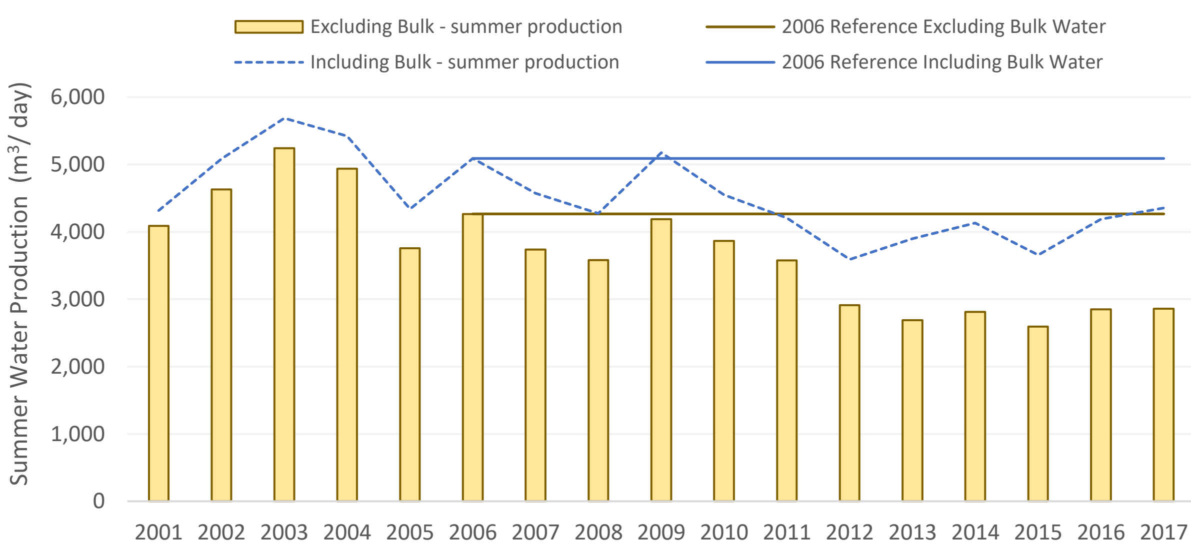

Figure 4: Summer water production (May 1 – Aug 31) across the RDN water service areas, relative to summer water production in 2006, both including and excluding bulk water supply from the Englishman River.

Trends in Residential Water Use

In each RDN WSA, single-family residential water use is billed seasonally. The summer billing period is comprised of approximately 123 days (May – Aug) and the winter period covers approximately 242 days (Sept – Apr). Water-use across the RDN WSAs was evaluated on an annual and seasonal basis.[11]

Water Use Across all RDN Water Service Areas

Single-family residential water-use data from across all RDN WSA were averaged to create an overview of the RDN WSA-wide trends in water use.[12] Annual and seasonal water use trends are explored here as average use per connection.

Annual Use

Figure 5 shows the annualized average water use across the RDN WSAs. Average single-family residential water use reached a maximum of 945 litres per day (~0.95 m^3/day) per household in 2003 and has decreased since then to a minimum of 569 litres per day (~0.57 m^3/day) per household in 2017. Over the past six years (2011 to 2017), there has been a decreasing trend in water use across the RDN WSAs, with an average annual water use rate of 628 L/day (0.63 m^3/day) per single-family residential connection.

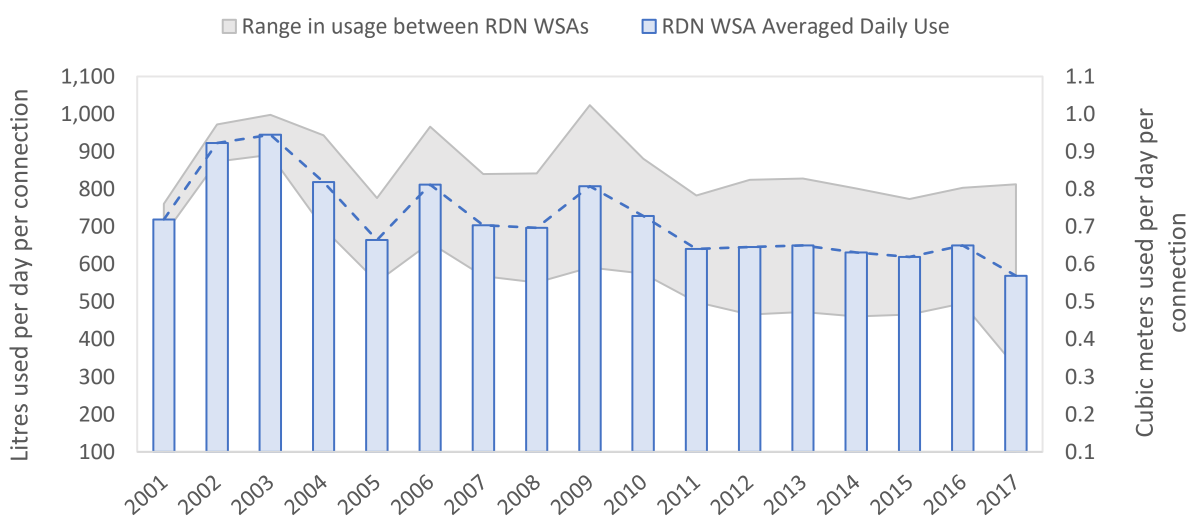

Figure 5: Annualized average daily water use at single-family residential connections across all RDN water service areas. The shaded area shows the range in use across the individual water service areas.

[11] Annualized average water use was calculated from each full billing year of usage data (May – May).
[12] Recall that Target 1 focused on reducing average daily use across all RDN WSAs.

Seasonal Use

Seasonal use was examined as average volumes used during the summer (May – Aug) and winter (Sept – Apr) periods. Seasonal water use across the RDN WSAs is summarized for summer and winter periods in Figure 6. Summer water use is approximately 2.5 times greater than winter water use across the RDN WSAs, and both have decreased over time.

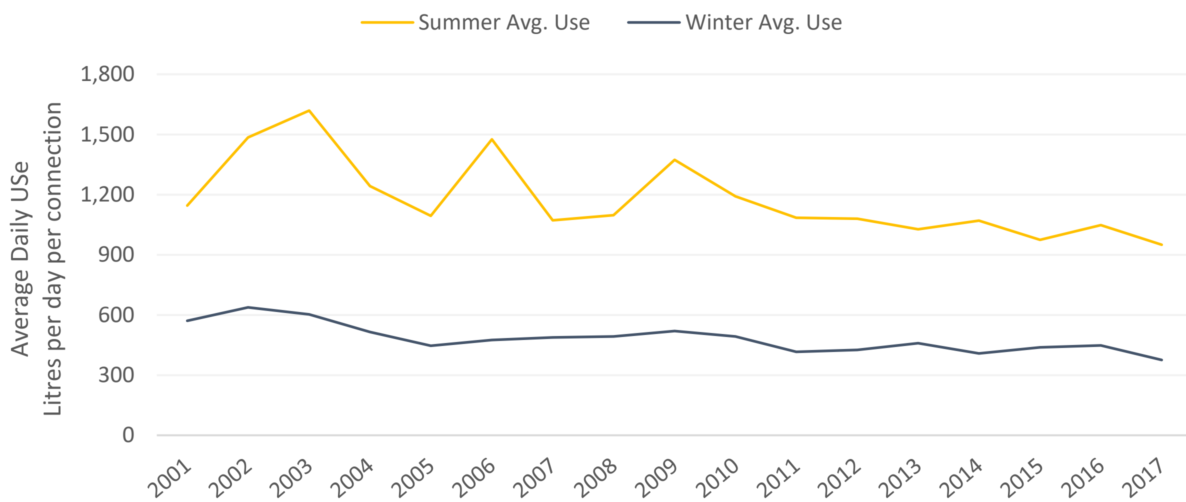

Figure 6: Average household seasonal water use across all RDN water service areas for the summer and winter periods (May 1 – Aug 31, and Sept 1 – Apr 30).

Across the RDN WSAs, summer water use has been lower over the past six years than during the preceding decade. Water usage has become more consistent across RDN WSA single-family residences. From 2001 to 2010, summer water use averaged approximately 1300 litres used per day (1.3 m^3/day), per connection, with a relative standard deviation of approximately fifteen percent. Over the past six years (from 2011 to 2017), summer water use averaged 1030 litres per day (1.03 m^3/day) per connection, with only five percent relative standard deviation.

Winter water use has been less variable than summer water use over the past sixteen years, and has also decreased with time. From 2001 to 2010, average winter water-use across the RDN WSAs averaged 524 litres per day (0.52 m^3/day) per connection (plus or minus twelve percent). Since 2011, winter water use averaged 424 litres per day (0.42 m^3/day) per connection (plus or minus seven percent). The stability in water use rates over the past several years indicates that across the RDN WSAs, single-family residents are becoming more consistent with water use habits.

Water Use in each Water Service Area

In 2018, there are nine WSAs operated by the RDN. The WSAs Whiskey Creek and Westurne Heights were acquired in 2011 and 2016, respectively. Water-use in each of the RDN WSAs was evaluated on an annual and seasonal basis. Annual and seasonal water-use trends for single-family residences in each RDN WSA are summarized here. More detailed graphs of annual and seasonal usage are included in the appendix of this report.

French Creek

Since 2001, annual water use in the French Creek WSA has decreased by approximately 27%. In 2017, average annual water use was 558 litres per day per household.

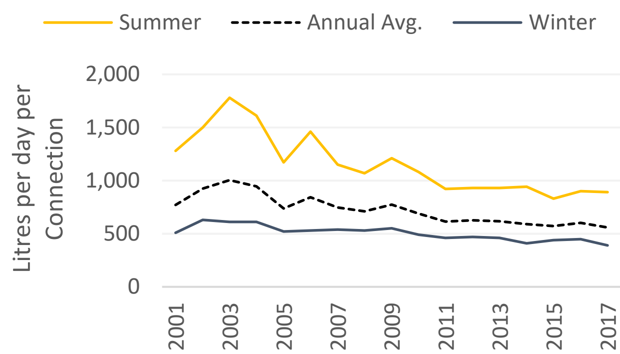

Figure 7: Annual and seasonal water use trends for single-family residential connections in the French Creek water service area

On average, summer water use in French Creek has been 2.3 times higher than winter water use. Summer water use has been stable (5% coefficient of variance) since 2013 with an average rate of 898 litres per day (0.9 m^3/day) per connection. Winter water-use in 2017 was lower than average across French Creek single-family residences, at 390 litres per day. Since 2004, winter water use in this area has averaged 489 litres per day per connection.

Surfside

There has been very little change in average annual water use in Surfside over time. From 2001 to 2017, annual water use in this WSA has decreased approximately 0.3%. Annual water use in 2017 averaged 670 litres per day (0.67 m^3/day) per single-family residential connection.

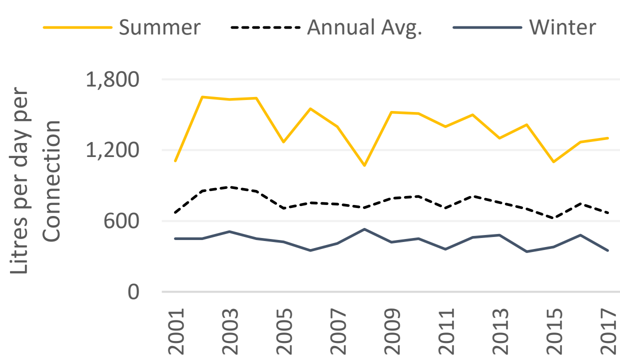

Figure 8: Annual and seasonal water use trends for single-family residential connections in Surfside WSA

Summer water use has had a great deal of fluctuation over time. While summer water use in the Surfside WSA has decreased slightly over time, rates remain above 1000L per day per household. Summer water use in this area is 3.2 times greater than winter water use. Winter water use in Surfside decreased approximately 20% from 2001 to 2017, reaching 350 litres per day (0.35 m^3/day) per household in 2017. Since 2001, Surfside winter water-use has averaged 429 litres per day (0.43 m^3/day) per household.

Decourcey

Since 2001, the Decourcey WSA has reduced average annual water use by 46%. From 2012 to 2016, annual water use averaged 620 litres per day (0.62 m^3/day) per household. In 2017, annual use dropped significantly below that average, to 378 L/day per connection. The large decrease in annual use was due to a major decrease in summer water use during 2017.

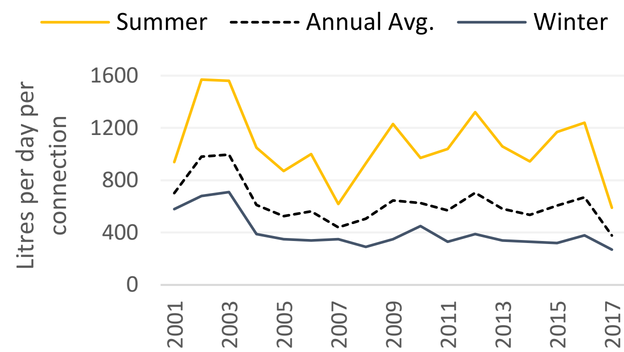

Figure 9: Annual and seasonal water use trends for single-family residential connections in Decourcey

In 2017, the rate of single-family residential water-use was 590 litres per day per household – which is half the rate of water-use from previous summer periods. Summer water-use in Decourcey has been an average of 2.6 times greater than winter water use. In 2017, summer water use was only twice as great as winter water use. Winter water-use in Decourcey decreased from approximately 350 L/day in previous years, to 270 L/day per connection in 2017.

San Pareil

Similar to Decourcey, San Pareil WSA showed considerable water use reduction in 2017. San Pareil has reduced annual average water use by approximately 50% since 2002 (first full year of data). From 2012 to 2016, annual water use in this WSA averaged a stable 630 litres per day (0.63 m^3/day) per household. In 2017, annual water use dropped to 472 litres per day (0.47 m^3/day) per household, due to decreased summer and winter water use.

On average, each single-family residence used twice as much water during the summer period compared to the winter. Water use in both seasons has declined over time. Summer water use in 2017 was 750 litres per day (0.75 m^3/day) per household, down from the 2012-2016 household average of 964 L/day. Winter water use dropped from approximately 460 litres per day (0.46 m^3/day) per household to 330 L/day in 2017.

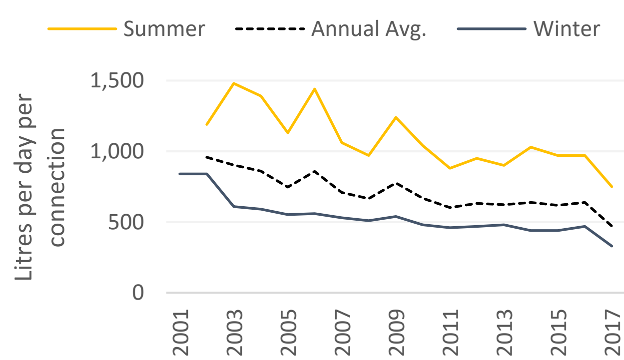

Figure 10: Annual and seasonal water use trends for single-family residential connections in San Pareil

Englishman River

The Englishman River WSA has increased average annual water use by 94% from the first full year of data (2005) to 2017. In 2004, empty lots were developed into new subdivisions and new homes were established on one-acre parcels. New properties and new landscapes demanded far more water than the previously unoccupied lots, explaining the massive increase in water use over time.

Over the past several years, annual water use in Englishman River WSA has leveled out and reached a steady rate. Despite leveling out, Englishman River WSA has the highest water usage of all RDN WSAs. From 2010 to 2017, average annual water use has been 967 litres per day (0.97 m^3/day) per household. In 2017, annual use was above that average, at 1005 litres per day (1.01 m^3/day) per household.

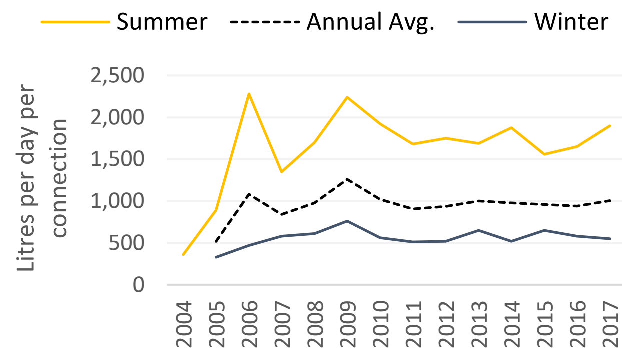

Figure 11: Annual and seasonal water use trends for single-family residential connections in the Englishman River water service area

Relative to the winter period, water use triples during the summer in this WSA. In Englishman River WSA, winter water-use rates have been steady since 2010, at 584 litres per day (0.58 m^3/day) per household. Summer water use in the Englishman River WSA increased from approximately 1700 litres per day (2012-2016 average), to 1900 litres per day (1.9 m^3/day) per household in 2017.

Nanoose Bay Peninsula

Since 2001, there has been 7% reduction in average annual water use across the Nanoose Bay Peninsula WSA. Annual water use since 2012 has held steady at an average 664 litres per day (0.66 m^3/day) per single-family residential connection.

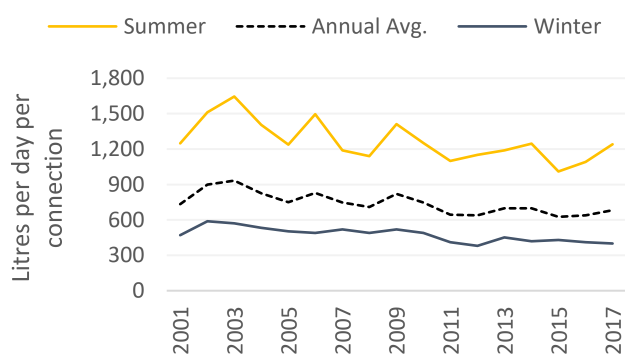

Figure 12: Annual and seasonal water use trends for single-family residential connections in the Nanoose Bay Peninsula water service area

Summer water use has been 2.7 times greater than winter water use in this WSA. Summer water use in 2017 was slightly higher than average, at 1240 litres per day per home, compared to the 2012-2016 average of 1137 litres per day (1.14 m^3/day) per single-family residential connection. Winter water use in 2017 was slightly below average at 400 L / day per connection (previous 4 years, 418 L/day).

Melrose Terrace

Melrose Terrace WSA reduced annual water use by 29% from 2006 (first full year of data) to 2017. This WSA has had the lowest average annual water use rates across the nine RDN WSAs. Average annual water use increased from 406 litres per day per household (2012 – 2016 average), to 533 litres per day (0.53 m^3/day) per connection in 2017. The recent increase in average annual water use was due to increases in both summer and winter water use.

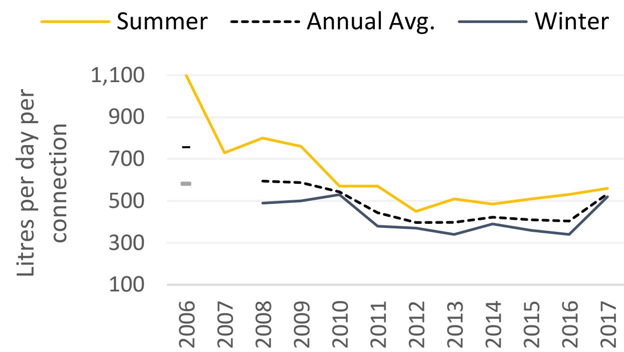

Figure 13: Annual and seasonal water use trends for single-family residential connections in the Melrose Terrace water service area

Summer water use in Melrose has been 1.4 times greater than winter water use (the lowest seasonal difference across RDN WSAs). Winter water use increased from 360 litres per day (2012-2016 average), to 520 litres per day per connection in 2017. Similarly, summer water use increased from approximately 500 litres per day to 560 litres per day per connection.

Whiskey Creek

Average annual water use in Whiskey Creek has increased 65% since its acquisition in 2012. In 2017, annual water use averaged 698 litres per day per single-family residence (the second highest water usage, below Englishman River WSA). Summer water use in 2017 increased to 1.7 times greater than winter water use (previously, the seasonal difference was 1.5 times).

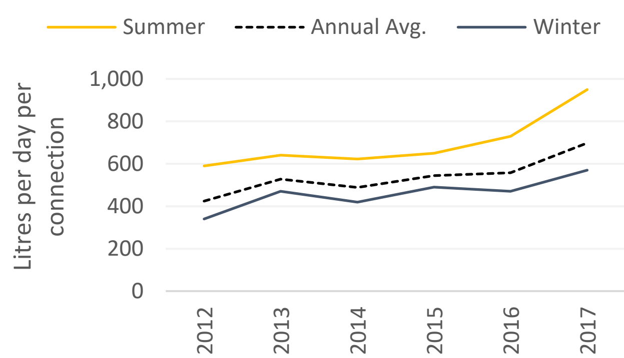

Figure 14: Annual and seasonal water use trends for single-family residential connections in the Whiskey Creek water service area

Summer water use reached 950 litres per day (0.95 m^3/day) per single-family residence in 2017 (much greater than previous summer rates of approximate 640 L/day per home). The highest winter water-use of 2017 occurred in Whiskey Creek, at 570 litres per day (0.57 m^3/day) per single-family residence.

Westurne Heights

Westurne Heights WSA was acquired in 2016 and only one season of water use data was available. Therefore, no water use trends exist yet. The average single-family residential water-use in the summer of 2017 was the lowest of the RDN WSAs at 370 litres per day per connection (0.37 m^3 per day per home). From 2012 to 2016, Melrose Terrace had the lowest water usage across the RDN WSAs.

Summary: Trends in Water Use

Table 4 (below) summarizes water usage in each RDN WSA by showing average use from 2012 to 2016, water use in 2017, and the overall change in annual water use from the earliest year of available data to 2017.

Englishman River WSA had the highest water usage of the nine RDN WSAs, with the exception that Whiskey Creek WSA used the most water in winter of 2017. San Pareil WSA had the largest reduction in water use over time (almost 51% reduction from 2001 to 2017). Whiskey Creek WSA has increased water use more than any other WSA, and had the highest winter water use in 2017 (second highest annual water usage in 2017). Decourcey WSA has had the lowest annual water use in 2017 and has had the lowest winter water use of the nine WSAs since 2012.

Table 4: Summary of single-family residential water use over the past 5 years in each water service area

Water Service Area	Average Water Use (Litres per day per connection)						Change over period of record**
	Annual Water Use		Summer Water Use		Winter Water Use		
	2012-2016 average	2017 average	2012-2016 average	2017 average	2012-2016 average	2017 average	
French Creek	601	558	906	890	446	390	-27.4%
Surfside	728	670	1317	1300	428	350	-0.3%
Decourcey	620	378 L	1147	590	352 L	270 L	-46.1%
San Pareil	630	472	964	750	460	330	-50.8% L
Englishman River	962 H	1005 H	1705 H	1900 H	584 H	550	-6.9%
Nanoose Bay Pen.	660	683	1137	1240	418	400	-6.8%
Melrose	406 L	533	497 L	560	360	520	-29.4%
Whiskey Creek	508	698	647	950	438	570 H	64.5% H
Westurne Heights	N/A	N/A	N/A	370 L	N/A	N/A	N/A
RDN WSA-wide	639	569	1040	950	436	376	-20.8%

* recall that summer is approximately 123 days & winter is approximately 242 days
* superscript H indicates the highest (maximum) value, L indicates the lowest (minimum) value
** period of record = first full year of data to 2017
** based on annual usage: percent change = (decrease / original)x100 = ((2017 - earliest) / earliest)x100
** negative change indicates a decrease, positive change indicates an increase

Trends in Water Production

All of the water entering a system for any end user is considered water production, including all ground water sources and surface water sources. Production volumes (all water inputs to a WSA), could be used by any connection or service within a WSA, and cannot be compared directly to the residential water use discussed in this report (above). Water production was evaluated on an annualized (May to May) and seasonal (summer and winter) basis for RDN WSAs, individually and as a group. To evaluate seasonal trends, monthly water production values were separated into summer and winter periods. To mimic billing seasons, summer production was calculated for the 123-day period of May 1 to August 31, and winter covered the 242-day period from September 1 to April 30.

Water Production Across all RDN Water Service Areas

Water production is summarized here as cumulative annual production (m^3) and average daily production (m^3 / day) across the nine RDN WSAs for annual and seasonal trends.

Annual Production

Despite growing population, total water production across the RDN WSAs has decreased since 2001 (Figure 15). Note that service and production demand declined in 2005 when the Chartwell subdivision was transferred from French Creek to the Town of Qualicum Beach.

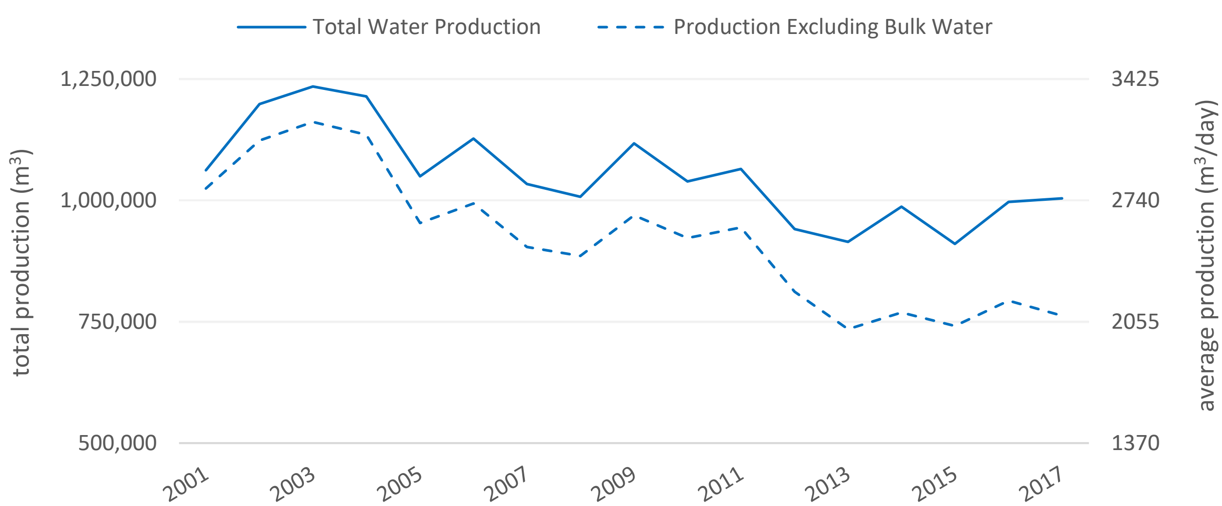

Figure 15: Annual production across the RDN water service areas, both including and excluding Bulk surface water from the Englishman River. The two axes show the total cumulative volume produced per year (left axis) and annual production volume averaged as daily rates (right axis).

Production including Bulk has decreased by 5.5% (2001 – 2017). Since 2012, annual production rates including Bulk water leveled out to approximately 2600 m^3 per day (~949,800 m^3 per year). In 2017, annual production was up from that average to 2750 m^3 per day (~1,003,790 m^3 per year).

Excluding Bulk water supply, RDN WSA-wide production has dropped 25.6% since 2001. Annual production excluding Bulk water averaged 2109 m^3 per day (~769,900 m^3 per year) from 2012 to 2017. Excluding Bulk water, production for 2017 was just below that average, at 2089 m^3 per day (~762,300 m^3 per year).

Seasonal Production

Production volumes show greater variation during the summer than winter season (similar to fluctuations in seasonal water-use). In general, summer production has decreased from 2001 to 2017. Winter production has steadily declined across the RDN WSAs. Over the past ten years, there has been an increase in bulk water supplied to the Nanoose Bay Peninsula WSA during the winter months as well as in the summer (bulk production detailed with Nanoose Bay production). Figure 16 shows the summer and winter seasonal production rates for RDN WSAs as a whole.

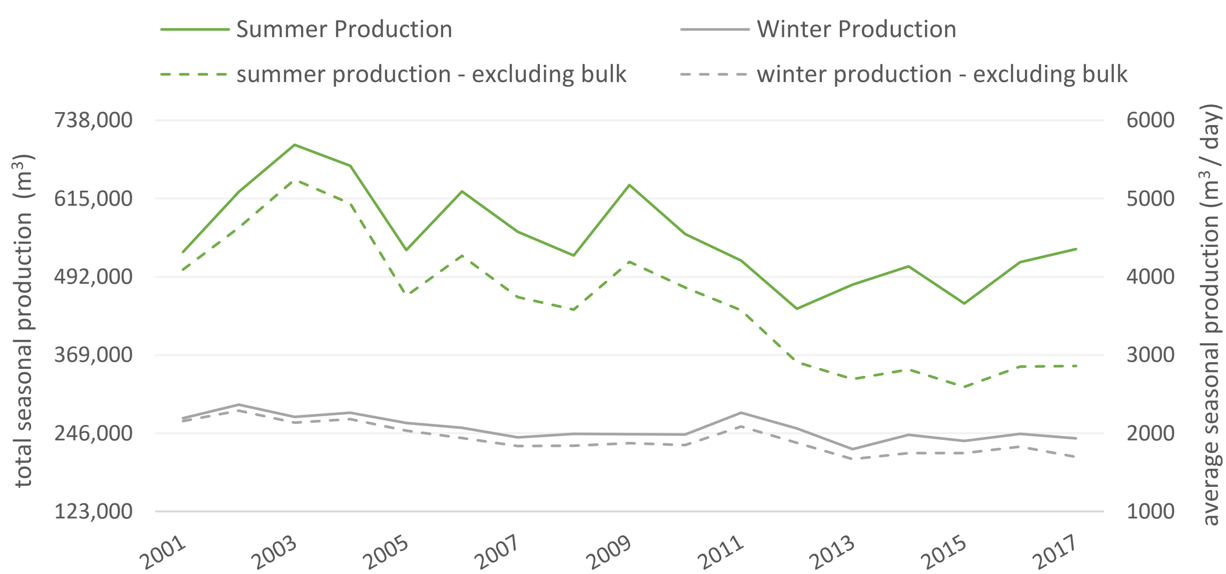

Figure 16: RDN WSA-wide water production during summer (May 1 – Aug 31) and winter (Sept 1 – April 30) seasons. Each seasonal period includes all active water service areas, and is broken out to show total production with and without Bulk water from the Englishman River.

Seasonal Water Production Summary Points:

Summer Production - excluding Bulk water supply:

For the 123 days of summer, water production excluding Bulk water supply averaged 2770 m^3 per day from 2012 to 2016. In 2017, production excluding bulk was up above that average to 2860 m^3 per day.

Summer Production - including Bulk water supply:

Including Bulk water supply, summer water production averaged 3890 m^3 per day from 2012 to 2016. In 2017, summer production including bulk increased to almost 4360 m^3 per day.

Winter Production - excluding Bulk water supply:

For the 242 days of winter, water production excluding Bulk averaged 1946 m^3 per day from 2012 to 2016. Winter water production was slightly lower in 2017, at 1934 m^3 per day.

Winter Production - including Bulk water supply:

Excluding Bulk water supply, RDN WSA-wide winter water production averaged 1770 m^3 day from 2012 to 2016. Winter production was below average in 2017, just below 1700 m^3 day.

Water Production in each Water Service Area

Trends in water production in each RDN WSA are summarized in the following sections. Table 5 (below) summarizes total annual production rates as the gross cumulative water production through each year, in units of cubic meters (total).

The sections that follow describe trends in water production in each RDN WSA, in units of cubic meters per day. Daily production rates allow for easier comparison between seasonal and annual water production. Seasonal trends were evaluated for the 123-day summer period (May – Aug), and 242-day winter period (Sept – Apr).

Table 5: Summaries of Total Annual Production in each RDN Water Service Area – all volumes in cubic meters (m^3)

Year	French Creek*	Surfside	Decourcey	San Pareil	Nanoose Bay Penninsula	Bulk Water	N.B.P + Bulk	Englishman River	Melrose Terrace	Whiskey Creek	Westurne Heights	RDN WSA-wide Total Including Bulk
2001	221,092	8,763	1,083	137,654	655,774	37,310	693,084					1,061,676
2002	237,366	10,594	1,434	122,646	751,192	74,790	825,982					1,198,022
2003	261,459	10,784	1,371	129,846	757,967	73,020	830,987					1,234,447
2004	249,903	11,418	903	132,396	727,720	79,170	806,890	12,492				1,214,002
2005	105,537	9,902	805	106,992	702,104	95,930	798,034	21,261	6,865			1,049,397
2006	72,816	13,724	877	95,659	757,227	133,580	890,807	44,379	8,697			1,126,959
2007	62,838	12,930	622	131,439	654,181	129,650	783,831	34,823	7,238			1,033,720
2008	65,383	11,030	783	101,986	651,062	121,430	772,492	46,932	8,470			1,007,076
2009	67,613	10,965	1,022	118,839	705,609	148,110	853,719	56,863	7,964			1,116,986
2010	62,134	10,798	1,031	113,141	674,531	117,040	791,571	53,156	7,258			1,039,088
2011	56,869	10,430	1,283	86,307	690,733	120,690	811,423	53,329	6,369	38,825		1,064,835
2012	59,227	11,862	1,297	96,279	548,513	129,010	677,523	55,754	6,232	32,404		940,578
2013	57,273	9,499	1,156	77,571	498,021	179,556	677,577	51,458	5,660	34,022		914,215
2014	56,900	10,034	1,127	123,381	476,235	218,073	694,308	60,584	5,483	35,154		986,970
2015	52,937	9,040	1,155	106,861	476,503	168,944	645,447	52,165	5,346	37,320		910,270
2016	58,128	9,762	1,347	110,085	507,409	203,861	711,270	58,738	6,311	41,171	182	996,994
2017	65,694	9,887	777	111,400	456,764	241,486	698,250	63,747	6,393	44,767	2,876	1,003,790

* Chartwell was part of French Creek until 2005, when Qualicum Beach took over the service for that subdivision.

* Single-family residential connections in French Creek were declined by 67% in 2005, thereby reducing production demand

** All production volumes are in cubic meters (m^3)

Table 5 (above) summarizes total annual production (gross volumes), while the following sections discuss trends in annual and seasonal production as production *per day*. Comparison between summer, winter, and annual production rates is more direct when evaluating production on a per-day basis (e.g. summer production volume is greater than winter production volume, and the seasonal period is approximately half as long. Therefore, daily production rates are more comparable than gross production volumes).

French Creek

From 2001 until 2005, the French Creek WSA included Sandpiper and Chartwell subdivisions. In 2005, Chartwell was taken over by the Town of Qualicum Beach. From 2005 to 2017, French Creek annual production decreased by 38%.

Since 2011, annual production has been at a steady rate of approximately 150 m^3 per day, with an increasing trend over the past couple of years.

Summer water production in the French Creek WSA is approximately twice as great as winter production. Summer production in 2017 was 258 m^3 per day, which was greater than the approximate average of 230 m^3 per day from previous years (~28,000 L/day difference).

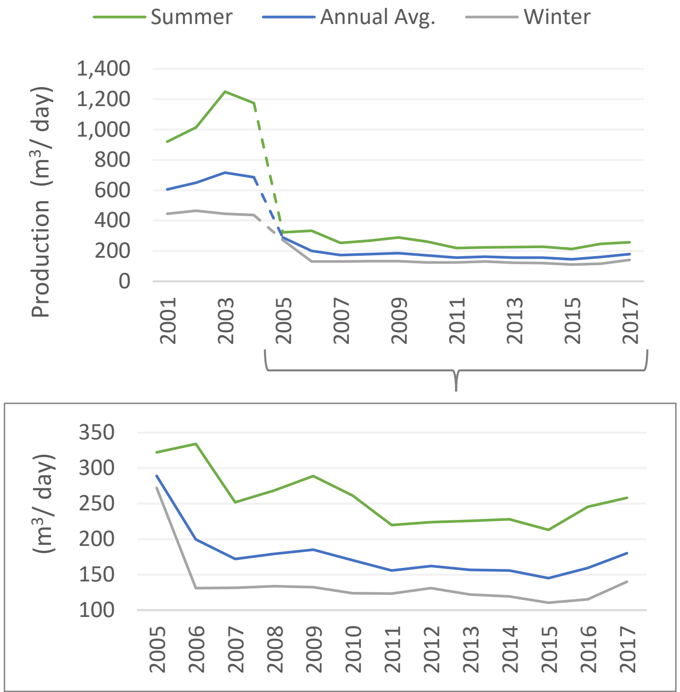

Figure 17: Annual and seasonal water production trends in the French Creek water service area. The lower plot shows production from 2005 on, following the removal of Chartwell subdivision from this service area.

Winter water production increased above average in 2017 also (by approximately 20,000 L/day). From 2012 to 2016, average winter production was 120 m^3 per day, and 2017 winter production increased to 140 m^3 per day.

Surfside

Water production in the Surfside WSA has been quite steady over time, but does show a slight decreasing trend. In 2017, annual water production was 27 m^3 per day.

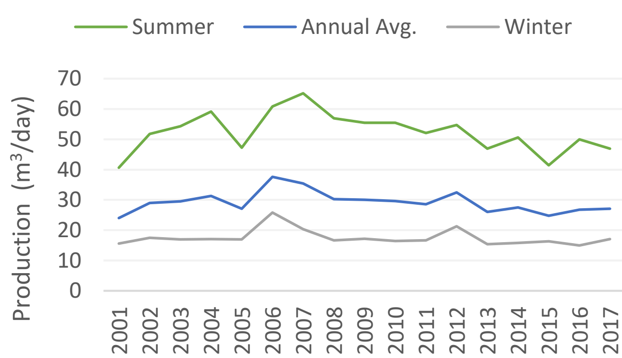

Figure 18: Annual and seasonal water production trends in the Surfside water service area

Summer water production in this WSA has been approximately three times greater than winter production. In 2017, summer production was 47 m^3 per day, slightly below the 49 m^3 per day average of previous years. In 2017, winter water production remained at the average of 17 m^3 per day.

Decourcey

Decourcey is the smallest RDN WSA (only five single-family residential connections) and it has the lowest rate of water production. Annual production in Decourcey decreased by 28% from 2001 to 2017. Annual water production was 2.1 m^3 per day in 2017, down from the 3.3 m^3 daily average from 2012 to 2016. Winter water production is an average of three times less than summer production in Decourcey WSA. Summer production in 2017 was 3.4 m^3 per day, and winter water production was 1.5 m^3 per day.

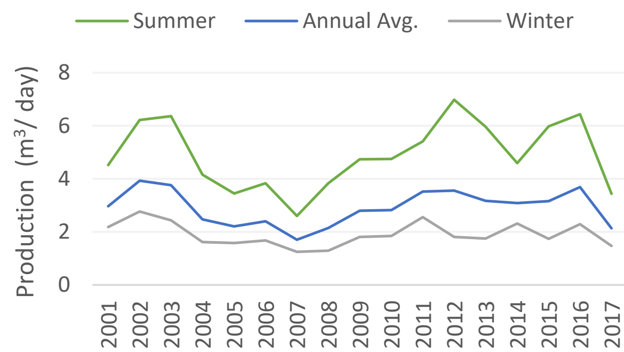

Figure 19: Annual and seasonal water production trends in the Decourcey water service area

San Pareil

Since 2001, San Pareil has reduced annual water production by 19%. In 2017, annual water production was 305 m^3 per day. Summer water production in this WSA has been approximately double that of winter production. Summer production in 2017 was 440 m^3 per day, and winter production was 237 m^3 per day.

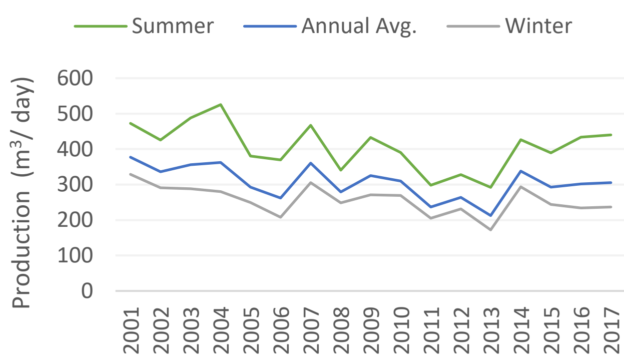

Figure 20: Annual and seasonal water production trends in the San Pareil water service area

Englishman River

Englishman River WSA has increased production 410% from 2004 (when vacant lots began to develop with new homes and landscaping) to 2017. Annual production from 2012 to 2016 averaged 153 m^3 per day, and in 2017 production was 175 m^3 per day. Summer production rates have been about three times greater than winter production. In 2017, summer production was 326 m^3 per day and winter production was 98 m^3 per day.

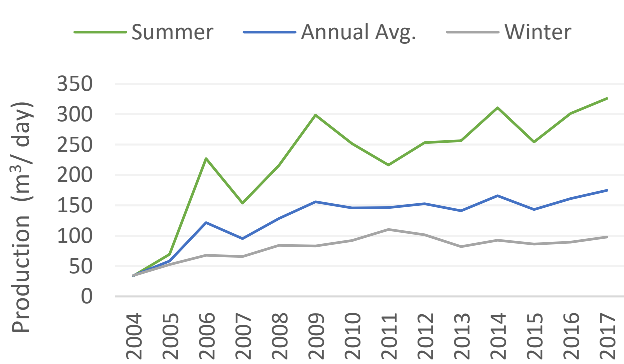

Figure 21: Annual and seasonal water production trends in the Englishman River water service area

Nanoose Bay Peninsula & Bulk Water

Water production in the Nanoose Bay Peninsula WSA includes both groundwater as well as surface water supplied from the Englishman River. Therefore, water production in this WSA was assessed for both scenarios, including and excluding Bulk water contributions.

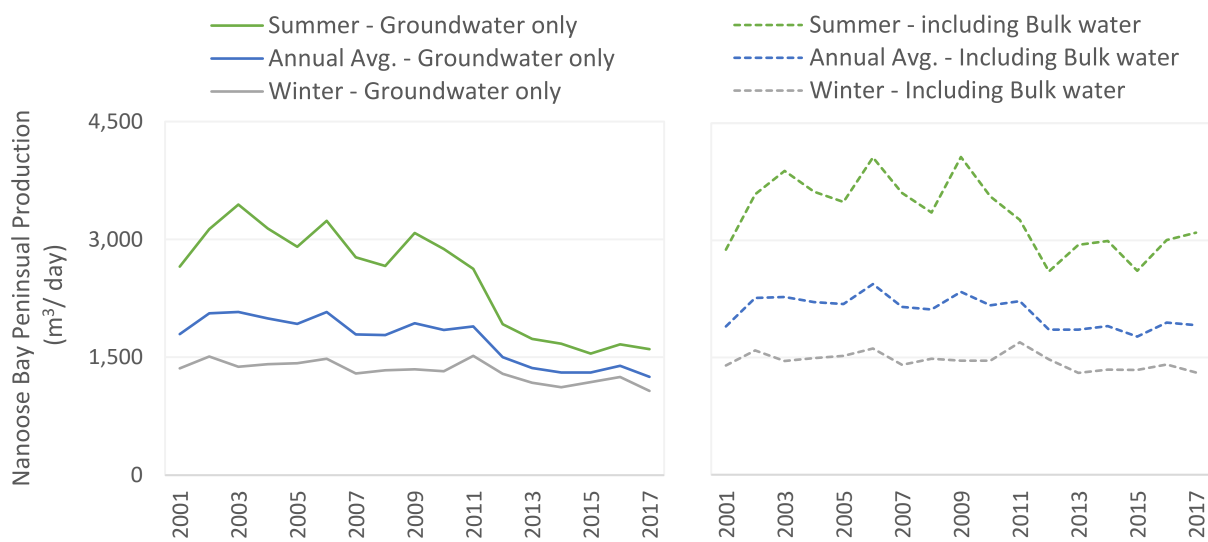

Figure 22: Annual and seasonal water production trends in the Nanoose Bay Peninsula water service area. The plot on the left shows trends in daily water production in Nanoose Bay Peninsula *excluding* bulk water and the plot on the right shows *including* Bulk water from the Englishman River.

Nanoose Bay Peninsula Production – Groundwater only

Excluding Bulk surface water, production in the Nanoose Bay Peninsula WSA has decreased by 30% since 2001. In 2017, annual production reached its lowest rate of 1251 m^3 per day.
Historically, summer water production in this WSA was twice as great as winter production. However, since 2012, summer water production has been less than 1.5 times greater than winter production. In 2017, summer groundwater production was 1604 m^3 per day, and winter groundwater production was 1072 m^3 per day.

Nanoose Bay Peninsula Production - Including Bulk Water

Including Bulk water, Nanoose Bay Peninsula production has remained quite steady since 2001, with an increase of 0.7% from 2001 to 2017. In 2017, production averaged 1913 m^3 per day.
Summer production including Bulk water has been approximately twice as great as winter production. In 2017, summer production (with Bulk) was 3099 m^3 per day, and winter production was 1310 m^3 per day.

Figure 23 shows the increase in Bulk water import over time, with the coinciding decrease in Nanoose Bay Peninsula groundwater production. The shift towards more surface-water supply relieves stress on the aquifers that underlie this water service area (information about aquifers and water regions included in the appendix).

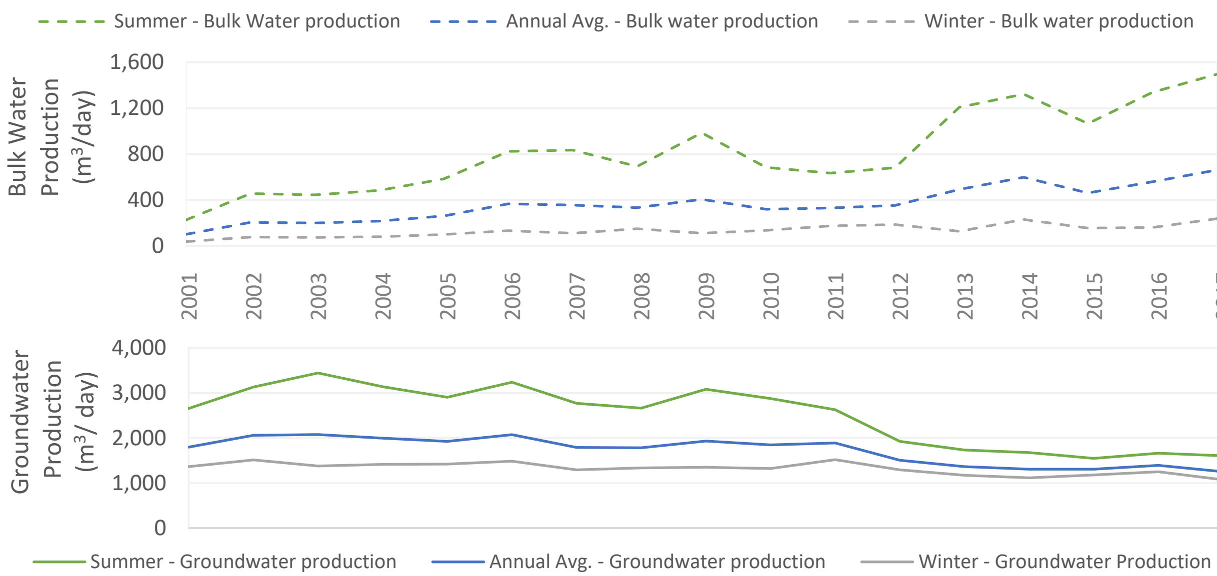

Figure 23: As Bulk surface water production increases (top panel), groundwater production in Nanoose Bay Peninsula decreases (bottom panel).

Bulk Water Production

Since 2001, production of surface water from the Englishman River has increased by nearly 550% (Figure 24). In 2017, annual average Bulk water production was 662 m^3 per day.

Bulk water supplements groundwater supply in the Nanoose Bay Peninsula WSA. The majority of Bulk water is supplied in the summer period.

Summer Bulk water production has been approximately six times greater than winter Bulk production since 2012. In 2017, Bulk production in the summer averaged 1495 m^3 per day, and winter Bulk water production averaged 238 m^3 per day.

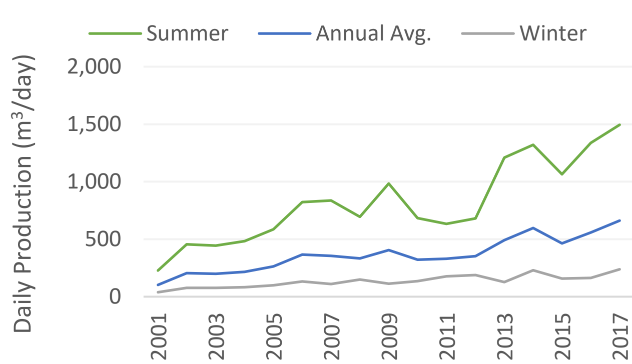

Figure 24: Annual and seasonal trends in Bulk surface water supplied from the Englishman River

Melrose Terrace

Since 2005 (first full year of data), Melrose Terrace WSA has reduced annual water production by almost 7%. In 2017, water production was higher than the previous five years. Annual production averaged 18 m^3 per day, summer production was 19 m^3 per day, and winter production was 17 m^3 per day.

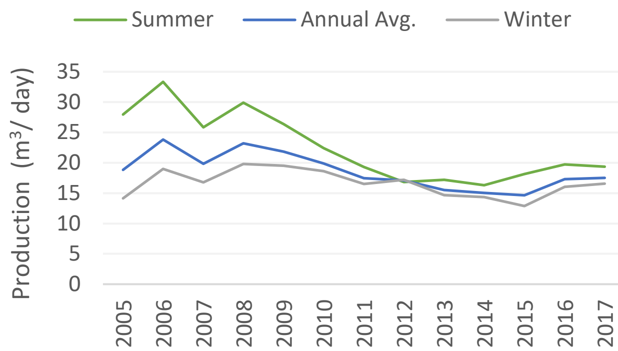

Figure 25: Annual and seasonal trends in water production in the Melrose Terrace water service area

Summer production was once twice as great as winter production. More recently, the seasonal difference has decreased to summer production being 1.2 times greater than winter production.

Whiskey Creek

Whiskey Creek WSA has increased annual water production approximately 15% since 2011 (first full year of data). In 2017, average annual water production in this WSA was 123 m^3 per day.

Summer production in Whiskey Creek WSA is an average of 1.3 times greater compared to winter production. In 2017, summer production was 153 m^3 per day, and winter production 107 m^3 per day.

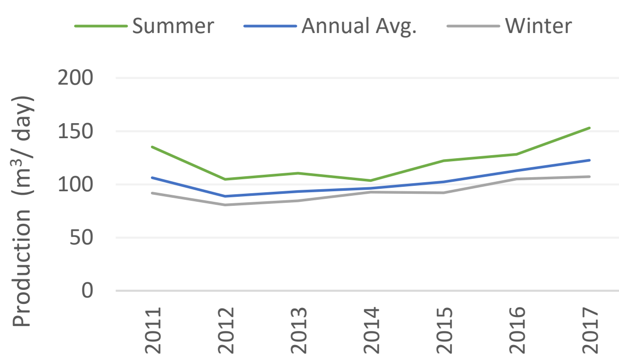

Figure 26: Annual and seasonal trends in water production in the Whiskey Creek water service area

Westurne Heights

Average annual water production in the Westurne Heights WSA in 2017 was eight cubic meters per day. Summer water production was ten cubic meters per day, and winter production was seven cubic meters per day.

Summary: Trends in Water Production

Table 6 (below) summarizes water production in each RDN WSA by showing the average production rate over the 2012 to 2016 period, production in 2017, and the overall change in annual water production from the earliest year of available data to 2017.

The highest water production has been for the largest RDN WSA, Nanoose Bay Peninsula (including and excluding Bulk water production). Aside from the newly acquired Westurne Heights WSA, the lowest production has been in Decourcey (the smallest WSA). The greatest reduction was in French Creek WSA water production, due to the transfer of Chartwell to Qualicum Beach service area; the second largest decrease was in Nanoose Bay Peninsula groundwater production. Englishman River WSA increased water production the most out of the RDN WSAs, and bulk water production has increased the most overall.

Table 6: Summary of average water production for each water service area

	average water production (cubic meters per day)						Change over period of record**
	Annual Production		Summer Production		Winter Production		
Water Service Area	2012-2016 average	2017 average	2012-2016 average	2017 average	2012-2016 average	2017 average	
French Creek	156	180	227	258	120	140	-37.8%
Surfside	28	27	49	47	17	17	12.8%
Decourcey	3	2	6	3	2	1	-28.2%
San Pareil	282	305	374	440	235	237	-19.1%
Englishman River	153	175	275	326	90	98	410%
NBP Groundwater only*	1374	1251	1709	1604	1203	1072	-30.3%
NBP including Bulk water*	1866	1913	2831	3099	1376	1310	0.75%
Bulk water*	493	662	1123	1495	173	238	547%
Melrose	16	18	18	19	15	17	-6.9%
Whiskey Creek	99	123	114	153	91	107	15.3%
Westurne Heights	N/A	8	0	10	0	7	N/A
RDN WSA-wide (excluding Bulk water)	2109	2089	2771	2861	1773	1696	-25.6%
RDN WSA-wide (including Bulk water)	2602	2750	3894	4356	1946	1934	-5.5%

* Refer to Table 1 for number of residential service connection in each WSA in 2017

* NBP = Nanoose Bay Peninsula

* Bulk water = surface water from the Englishman River

** period of record = first full year of data to 2017

** percent change = (decrease / original)*100 = ((2017 - earliest) / earliest) *100

** negative change indicates a decrease, positive change indicates an increase

Trajectories: Forecasts and Patterns

Forecasts for water use and production over the next four years were predicted based on historical water use and water production data across all RDN WSAs, and are presented below.

Water Production Forecast

From trends in water production across the RDN WSAs over the past sixteen years, forecasts were generated for the next four years (Figure 27). Based on production rates since 2001, it is anticipated that until 2022, average annual production across the RDN WSAs will decrease overall (both including and excluding bulk water production). Winter water production is expected to remain fairly steady over the next four years and summer water production rates are expected to decline (both including and excluding bulk water).

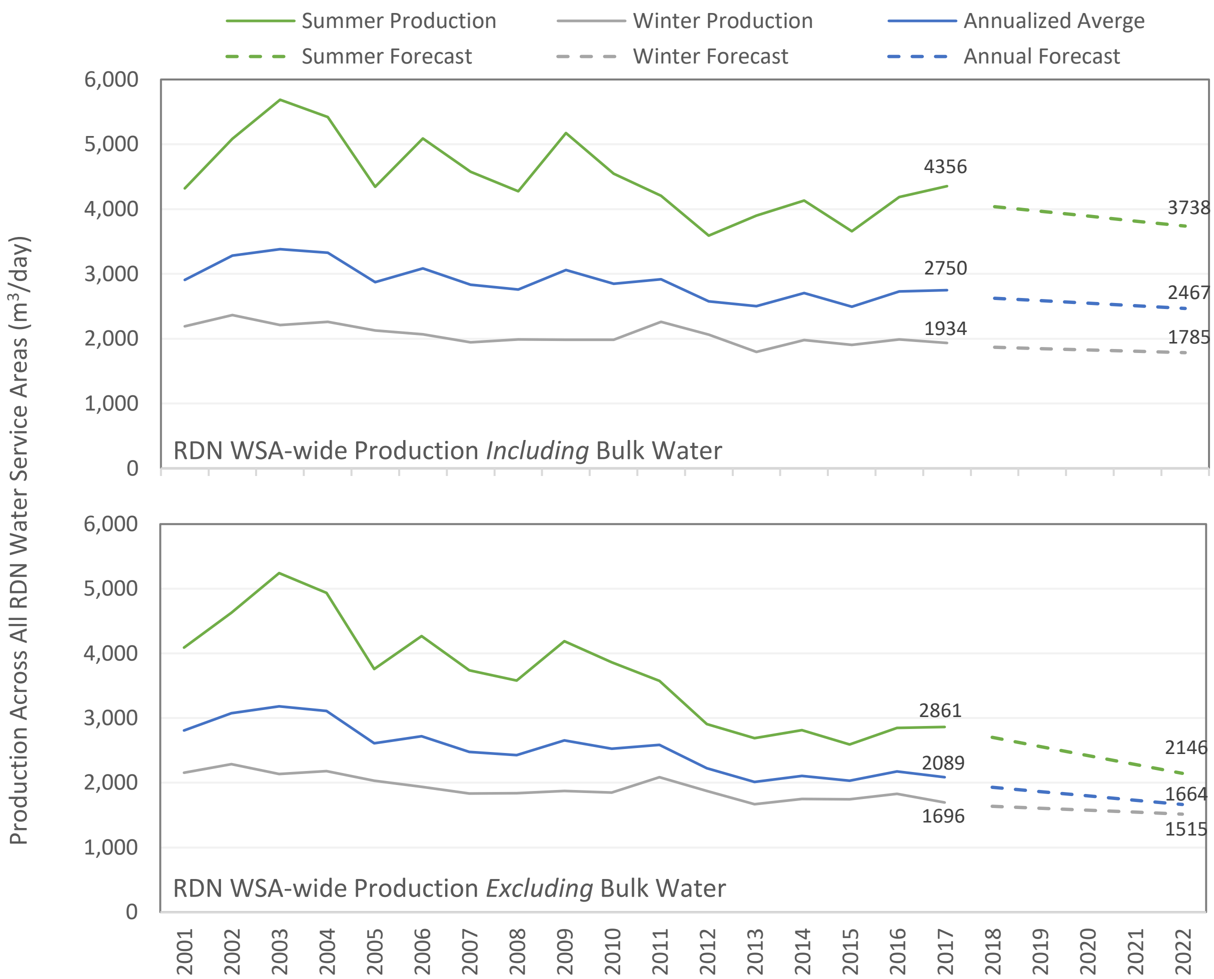

Figure 27: Water production across all RDN water service areas (2001 to 2017) and forecasts for annual and seasonal production from 2018 to 2022.

Water Use Forecast

From single-family residential water use across the RDN WSAs, forecasts were generated for the next four years (Figure 28). Based on water-use data analyzed for this report, it is anticipated that until 2022, average annual water use, summer water use and winter water use at single-family residential connections across the RDN WSAs will decrease overall.

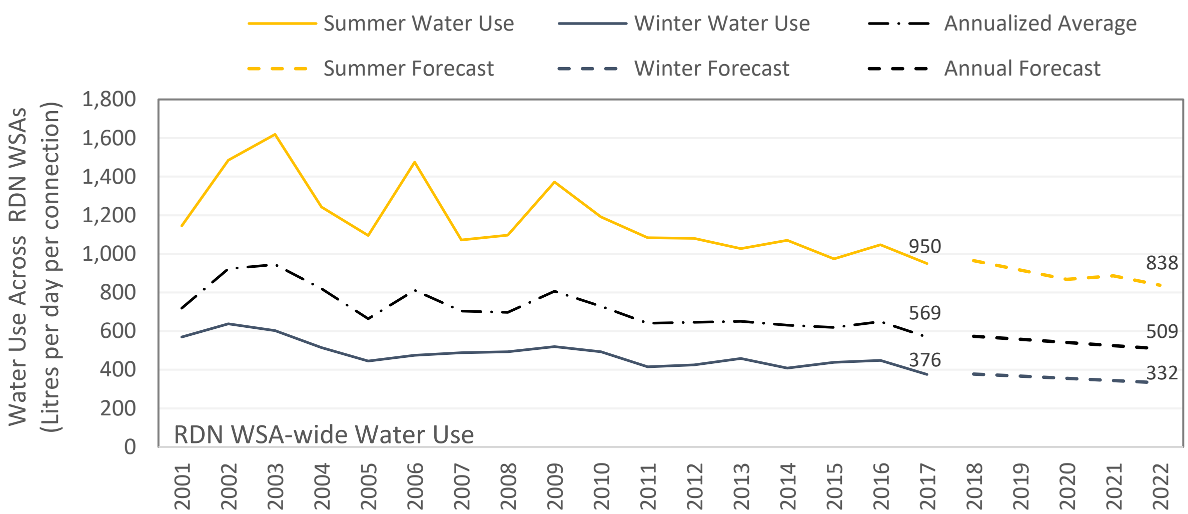

Figure 28: Single-family residential water use across all RDN water service areas and forecasts for annual and seasonal production over the next four years.

Water Use Patterns

An interesting oscillating pattern was evident when the inter-annual change in water-use for each WSA was plotted over time. Inter-annual change expresses the difference (as a percent) in single-family residential water-use, from one year to the next. Oscillation was observed for seasonal and annual water use changes from year-to-year (Figure 29). Essentially, the majority of RDN WSAs increase and decrease their water use at the same time. While it is beyond the scope of this report's evaluation, it is possible that the pattern in inter-annual water-use changes follows climatic shifts (e.g. El Niño Southern Oscillation (ENSO), or Pacific Decadal Oscillation (PDO) cycles). Figure 29 shows the inter-annual changes in water use for all RDN WSA (except Westurne Heights).

It is anticipated that inter-annual changes in water use will continue to show a similar oscillating patter into the future, with progressively decreasing amplitude. Over time, water use has become more level across the RDN WSAs, indicating that single-family residential users in the RDN WSAs are becoming more consistent in their water use habits. These trends indicate that single-family residential water use is approaching a steady-state. However, water conservation efforts should evolve with time and will continue to enhance water efficiency.

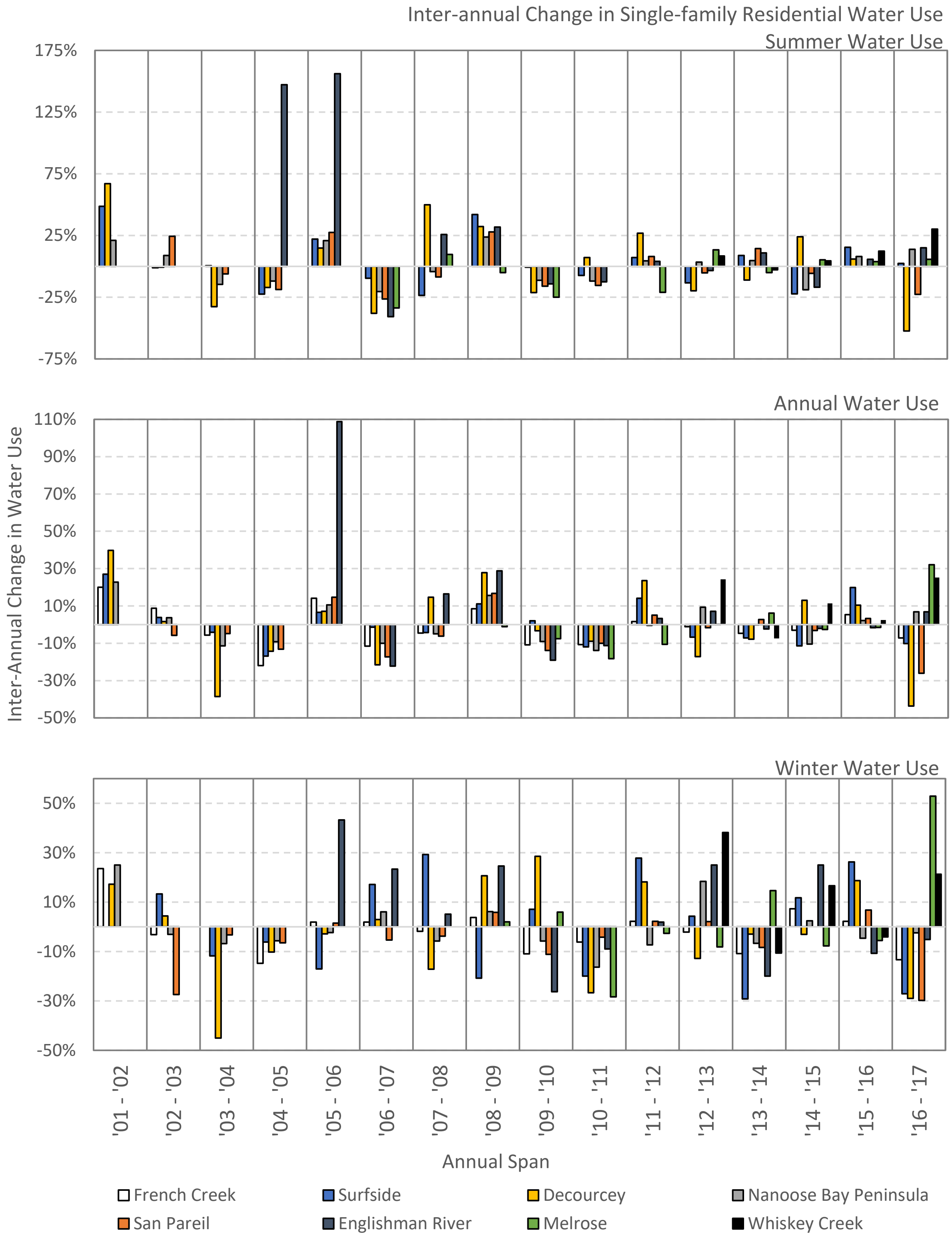

Figure 29: Inter-annual change in seasonal and annual water use across the RDN water service areas over time (excluding Westurne Heights due to insufficient data). It appears that RDN WSA residents increase and decrease their water-use habits with similar timing, possibly in response to weather patterns.

Water Conservation Measures

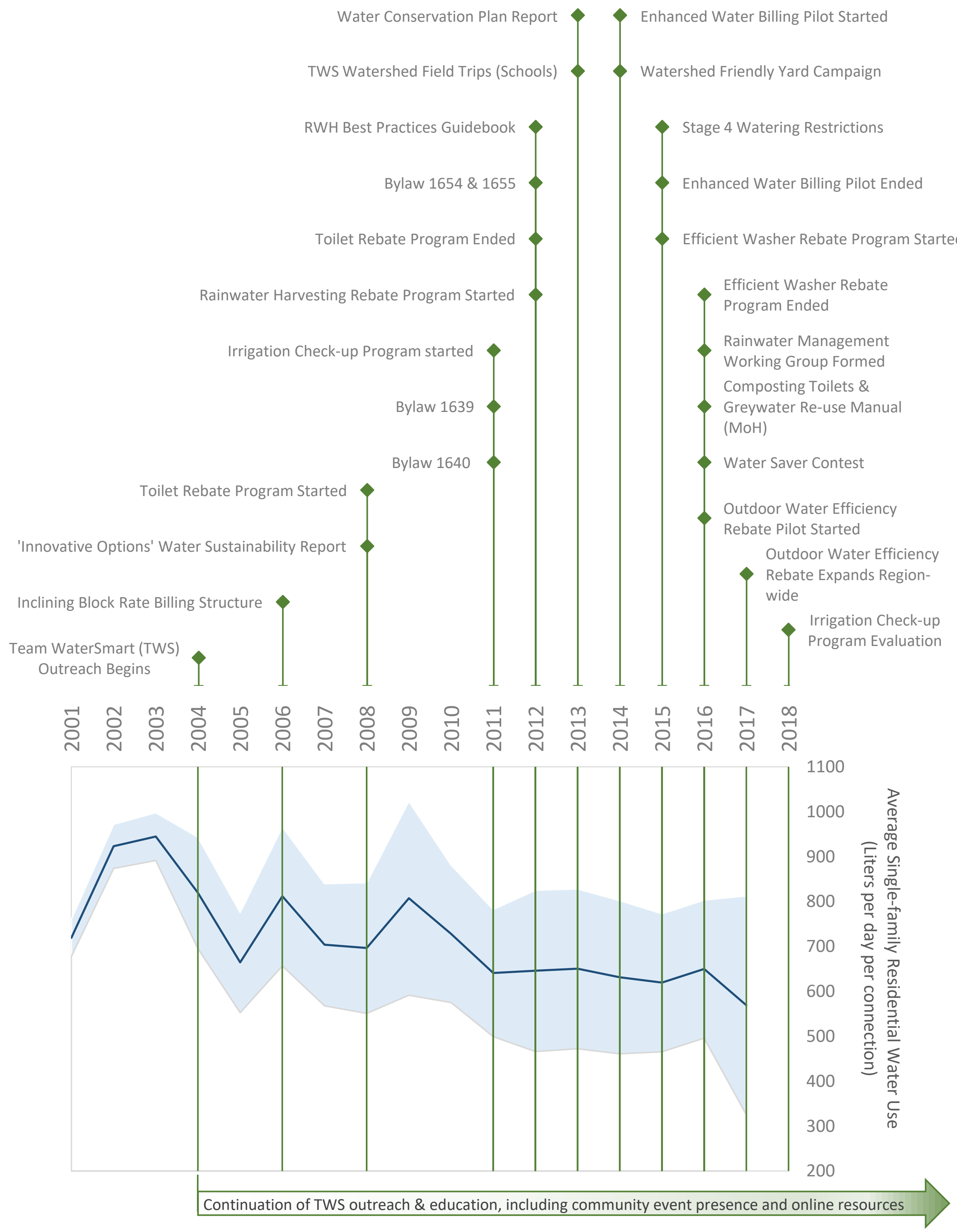

Figure 30: Timeline of key water conservation initiatives implemented across RDN water service areas and the corresponding average annual water-use for single-family residential connections.

Figure 30 illustrates the timing of some key water conservation initiatives that have been implemented since 2001, along with the corresponding single-family residential water use levels. The conservation timeline (Figure 30) is not a comprehensive list of conservation efforts across RDN-WSAs, but instead highlights key water conservation milestones. Water conservation strategies across RDN WSAs range from education, to financial incentives (rebates and inclining block rate billing), to bylaw and policy decisions. Continuing to dedicate resources and attention to water conservation will undoubtedly continue to yield positive results across the RDN WSAs.

Suggestions and Future Considerations

The RDN's DWWP program and Team WaterSmart have made tremendous strides in public education and water conservation promotion. Many ongoing initiatives will continue to improve water conservation and public awareness of water resources. Below are suggestions for future consideration. Most of these suggestions are intentionally broad, to allow for adaptation or inspiration of new or tangential ideas, while some are more specific.

RDN Inter-departmental knowledge mobilization & collaboration

- (Ongoing) DWWP to support Planning project on landscape & irrigation design standards
  - Existing zoning bylaw specs to be updated with current and consistent language focused on water conservation planning and water-smart irrigation technologies
- (Ongoing) DWWP to collaborate with WWS / Sustainability departments on a Best Practices Guidebook for Greywater Re-Use (Ministry of Health information on greywater systems was recently 2016).
- Consider collaborating with WWS to evaluate how water conservation relieves pressure on the waste water systems (both through reduced waste and storm-water harvesting)

Explore the role of Developers in water conservation

- Conduct outreach with developers - similar to the outreach provided with the Water Purveyors Working Group, irrigation professionals training, relators (VIREB conferences)
- Work more closely with developers to facilitate a focus on water conservation in new developments across the RDN WSAs
- Explore the possibilities of an incentive program(s) for water conservation in developments (that does not involve direct monetary incentives). Possibilities to explore:
  - Bond program with permitting department - deposit with application that includes water conservation, which would be returned when conservation work is complete
  - Reward and highlight innovation with a "Gold star" program to acknowledge initiatives taken by developers who focus on water conservation
    - <u>Example</u>: City of Guelph "Blue Built Home" Program http://guelph.ca/water-conservation/blue-built-home/

Showcase landscape and irrigation standards

Highlight water conservation with informational signs / installations

- Bring awareness to existing water-smart installations with informational signage and/or social media features. Some possible RDN areas to start include:
  - The RDN Administrative building's native plants, rain garden and irrigation choices
  - Xeriscape garden at the Jack Begley Field in Nanoose Bay

Example: RDN - Church Road Solid Waste Transfer Station

- Rainwater harvesting system used for on-site equipment / surface washing
  - Information provided for those who care to look and learn

Example: Metro Vancouver - Hillcrest Geyser

An art installation and water-park exists at the Hillcrest Recreation Centre that draws attention to the ubiquitous use of treated water for all activities and the use of a greywater system

- The Hillcrest Recreation Centre has greywater system that combines harvested rainwater and non-potable groundwater. The greywater is used for sanitary purposes. During the summer, when there is not enough rainwater to sustain the system, treated municipal water (Metro Vancouver) water is brought in to supplement the greywater system.
- Before the treated municipal water enters the mixed greywater system (where it will no longer be available for consumption), it is piped to the Hillcrest Geyser which erupts as a fun water park. The water is collected at the base of the Geyser and piped to the greywater sanitary system.
- There is a plaque adjacent to the installation which provides information about the installation. The beauty of the Hillcrest Geyser is that it highlights the existing greywater system at the recreation center, it shines a light on the fact that we use drinking water for almost everything (from toilet flushing to water parks), and it identifies that rainwater harvesting alone cannot generally sustain a system through the summer.

Possible Project: New take on the yard-sign campaign -- water-smart walking-tours

- Similar to a heritage-home walking tour, all customers within the RDN WSAs (or across the region) can register to have their xeriscape front yard / rainwater harvesting / rain garden included on a walking-friendly route
- Residents can gain inspiration for outdoor water conservation by others
- Perhaps Parks would be interested in collaborating?
- The informational signs (RDN admin building / Jack Begley Field rock garden) idea could be combined with this project to highlight both residential and service/industry efforts.

Possible Project: Facilitate a voluntary audit program for industry / commercial / services to evaluate their water conservation initiatives. The prize is public recognition and accolades.

Evaluate metered water use for all users across RDN WSAs

Water use data from single-family residential connections were evaluated in this report, and it is suggested that water use data for all metered users in each WSA are analyzed in future analyses. By evaluating all users in a WSA, better understanding can be gained regarding volumes consumed by un-metered use, as well as supply and demand relationships.

Advance greywater harvesting

In 2016, the Ministry of Health released a manual on composting toilets and greywater re-use which can be used in the development of an RDN Best Practices Guidebook on Greywater Re-Use (joint project with RDN DWWP, WWS, and Sustainability), similar in scope to the Rainwater Harvesting Guidebook of 2012.

Below are a couple of examples of greywater pilot programs implemented in other regions:

1. City of Guelph Greywater Field Test Program

   The City of Guelph launched a greywater reuse rebate program (similar to RDN's Rainwater Harvesting Rebate) that offered $1000 toward the installation of approved greywater reuse systems within new and existing homes. Here is an excerpt from their website:

   > "In May of 2009 the City of Guelph initiated the Greywater Field Test. This innovative study aimed to assess the feasibility of large-scale adoption of centralized home based greywater reuse technologies in continuation of the City's water conservation objectives. As part of the study a home installation target of 30 greywater reuse systems was established with installations taking place within new and existing single family homes in the Guelph community."

   https://guelph.ca/living/environment/water/water-conservation/greywater-reuse-system/

2. Example: Greywater Action, collaboration with Pasadena Water and Power

   > "Greywater Action is a collaborative of educators who teach residents and tradespeople about affordable and simple household water systems that dramatically reduce water use and foster sustainable cultures of water." https://greywateraction.org/

   - They focus on workshops and presentations about greywater system design and construction
   - Work with policymakers and water districts to develop codes and incentives for greywater, rainwater harvesting, and composting toilets.
   - Motivated by the role of decentralized conservation measures in drought resilience, climate adaptation, and the return of healthy stream ecosystems

A major challenge in establishing greywater guidelines is that there are currently no BC plumbing codes available for greywater systems, and most available systems are retrofits to existing homes.

Explore localized greywater reclamation (sink-to-toilet)

There appear to be smaller-scale options for encouraging and pursuing greywater systems.

- Sink/toilet paired greywater system: some toilets flush with diluted greywater from the bathroom sink (toilet tank fills with 50% sink-used greywater and 50% drinking water)
- Explore outdoor grey-water irrigation systems

Revisit Target 1 at end of 2018 water billing year

This evaluation concluded that the RDN WSAs are on track to meet the 10-year goal of reducing water use by 33% by 2018. Target 1 should be re-visited when a full year of 2018 water use data is available.

Continue to grow education programs

Team WaterSmart outreach and education for school-age children and all individuals has a big impact on sharing crucial information about fresh water resources and water services in the RDN.

- Run an "8 L/day" campaign through 2018 to challenge each RDN WSA residents to reduce their water use by eight litres in order to achieve Target 1
  - Visual aid / infographic of what 8L looks like
  - Use social media for a fast release of intention (2018 summer watering has begun)
- Maintain and evolve education and outreach programs (school visits and public events)
- Consider the 2008 Innovative Options suggestion of hiring a Water Efficiency Coordinator
  - Rather than spreading this work among TWS and DWWP staff, consider assigning a position dedicated to conservation and education
- Prepare information about seasonal droughts to supplement education about watering restrictions, rainwater and greywater harvesting, and water as a shared resource
  - Visual aid / infographic of what seasonal drought is and how it affects residents
- Continue to collaborate with water utilities management and operations staff to further education and cross-disciplinary information sharing

Home in on new water conservation targets

The targets defined in the 2008 Innovative Options for Sustainable Water Use (HB Lanarc) and 2013 Water Conservation Plan (Aquavic) were set for completion in 2018. New targets should be created. This report suggested framing future production targets to reflect long-term water service plans (i.e. treating Bulk production separately from other WSA-based production).

Conclusions

Targets

Target 1 intended for a 33% reduction in average annual residential water use from 2004 to 2018. Up to and including 2017, the average annual residential water use across RDN WSAs has decreased by 31%. To successfully achieve Target 1 by the end of 2018, an additional conservation of twenty litres per day per household (approximately eight litres per person per day) is required. Conserving eight litres per person per day will reduce the 2017 household average of 569 litres per day (per connection) to the 2018 target of 549 L/day/connection (Target 1).

Target 2 was set in 2013 to "maintain maximum month water production at or below 2004 production levels until 2018". At the time that Target 2 was created, maximum month production had already exceeded the threshold of 2004 maximum month production levels (twice) in 2006 and 2010. From 2011 to 2017, however, maximum month production remained below the 2004 reference level.

Target 2 was reframed in this 2018 Water Conservation Evaluation, to reflect the long-term growth strategy for Nanoose Bay Peninsula WSA and the Englishman River Water Service (supplemental Target 2.1). Target 2.1 re-evaluated Target 2 as maximum month production excluding Bulk surface water supplied from the Englishman River. When Bulk water was excluded from the peak production analysis, maximum month production exceeded the 2004 reference level only once, in 2010, and otherwise remained below the 2004 reference level. Excluding Bulk water, RDN WSA-wide maximum month production has decreased and leveled out at approximately 3300 m^3/day.

Supplemental Target 2.2, an extension of Target 2, assessed production over the dry summer months (May – Aug). Each year, summer production across RDN WSAs has remained below the 2006 summer production level. Summer production rates *including* Bulk water have increased over the past few years and vary around 4,000 m^3/day. In contrast, summer water production *excluding* Bulk water supply has dropped to approximately half of 2004 levels, and has remained steady since 2012 (around 2,800 m^3/day).

The Englishman River Water Service is anticipated to be fully implemented an operational in 2019; therefore, future groundwater and Bulk water production targets could be referenced to 2018 or 2019 production rates (rates achieved during the first year of full operation). An "eight litre per day" campaign may help to engage single-family residents in meeting Target 1 conservation goals by the end of 2018.

Trends

Both water use and water production have decreased over time across the RDN WSAs. Summer water use and summer water production remain higher than winter rates. Water use has decreased in French Creek, Decourcey, San Pareil, Nanoose Bay Peninsula, and Melrose Terrace. Water use has remained relatively unchanged in the Surfside WSA. The small WSA of Decourcey had the lowest water-use rates (aside from the new WSA of Westurne Heights). In Englishman River and Whiskey Creek WSAs, water use has increased over time. Englishman River WSA had the highest water-use rates.

Water production has decreased in French Creek, Decourcey, San Pareil, Nanoose Bay Peninsula (excluding Bulk), and Melrose Terrace. Bulk water production (surface-water from the Englishman River) has increased a great deal since 2001 (as planned). Water production increased in Englishman River, Surfside, and Whiskey Creek water service areas. While the number of single-family residential connections in Surfside and Whiskey Creek have not increased significantly, the Englishman River WSA was the fastest growing (Table 1). Decourcey WSA had the lowest production rates, and Nanoose Bay Peninsula WSA had the highest (the smallest and largest RDN WSAs, respectively).

Extra conservation efforts could be targeted towards Englishman River WSA, as it has the highest single-family residential water usage and demonstrated increases in production over time. Investigating supply-and-demand (i.e. production-and-use) trends within the RDN WSAs for all metered users (single and multi-family residential, institutional, commercial, and services uses) could elucidate volumes consumed through unmetered use, and inform more comprehensive water conservation measures.

Trajectories

Based on the past sixteen years of data, linear forecasts were created for both single-family water use and RDN WSA-wide water production. It is anticipated that water use and water production across the RDN WSAs will continue to decline over the next four years.

It was observed that single-family residential water use has leveled out over the past several years in most RDN water service areas. Therefore, the decline in water usage may be less dramatic than previously observed. An oscillating pattern was observed for inter-annual changes in water use across the RDN WSAs, which could be tied to climatic cycles and changes. It would be interesting to explore relationships between precipitation and temperature trends with water use across the RDN WSAs.

References

AquaVic Water Solutions Inc. (2013). Water Conservation Plan. Prepared for the Regional District of Nanaimo. PDF download available via: http://www.rdn.bc.ca/dwwpreports (Region-Wide Reports).

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Acknowledgements

Innovative Options for Sustainable Water Use (2003) and the *Water Conservation Plan* (2013) set the groundwork for this Water Conservation Evaluation and provided valuable suggestions for ongoing water conservation efforts.

Thank you to the RDN operations and management, for providing Water Services and focusing on sustainability. Thank you to the Drinking Water and Watershed Protection program and Team WaterSmart for effectively disseminating conservation and watershed protection information. A big *thank you* to those who assisted in the development of this evaluation, especially Julie Pisani, Deb Churko, and Heather Dorken, who each provided data, information, context, feedback, edits and support.

Appendix

RDN Water Service Areas

French Creek

The French Creek Water Service Area, established in 1980, is an area west of Drew Road and south of the Island Highway between the City of Parksville and the Town of Qualicum Beach. Up until 2005, the French Creek WSA included Sandpiper and Chartwell; in 2005, Chartwell was taken over by the Town of Qualicum Beach. The water source for the French Creek Water Service Area comes from a series of local groundwater wells. The water is chlorinated and stored in one reservoir.

Surfside

The Surfside Water Service Area was established in 1986 and comprises an area north of Qualicum Beach on Surfside Drive and part of McFeely Drive. The water source is two groundwater wells. Water is chlorinated and pumped into the system on demand via a dual pressure tank arrangement.

Decourcey

The Decourcey Water Service Area was established in 1998 in a rural area south of Nanaimo, (Bissel Road and Pylades Drive). The water source for the Decourcey Water Service Area comes from one groundwater well located nearby. The water chlorinated and is stored in a reservoir.

San Pareil

The San Pareil Water Service Area was established in 1999, when residents requested via referendum that the RDN acquire the existing Bubbling Springs Water Utility. This system is located northeast of the bridge just prior to entering the City of Parksville. The water source for the San Pareil Water Service Area comes from two groundwater wells located nearby. The water is chlorinated and stored in two reservoirs.

Englishman River

The Englishman River Community Water Service Area was established in 2003. The area is located near the southern boundary of the City of Parksville between the Island Highway and the Englishman River. The water source for the Englishman River Community Water Service Area comes from a series of nearby groundwater wells. The water is chlorinated and stored in one reservoir.

Nanoose Bay Peninsula

The Nanoose Bay Peninsula Water System was established in 2005 by amalgamating seven water service areas (neighborhoods of Madrona, Wall Beach, Driftwood, Dolphin/Beachcomber, Fairwinds, Arbutus Park, and West Bay). The water supply originates from eleven groundwater wells located in the area, and is supplemented as required with water from the Englishman River. In 2012, a water treatment plant was installed to remove iron, manganese, ammonia and sulphur from the well water. Treated water is chlorinated and stored in several reservoirs throughout Nanoose Bay.

Melrose Terrace

The Melrose Terrace Water Service Area was established in April 2005, when the RDN acquired the existing Melrose Terrace Strata Plan VIS3747 water system. The water service area is located near the Alberni Highway southwest of Coombs. The water source for the Melrose Terrace Water Service Area comes from one groundwater well located nearby. The water supply is filtered, chlorinated and stored in a single reservoir.

Whiskey Creek

The Whiskey Creek Water Service Area was established in 2011 when the RDN acquired the existing Whiskey Creek Water District. The water service area supplies water to the Westerlea Estates subdivision located eight kilometers southwest of Qualicum Beach on the south side of Highway 4. The water source for the Whiskey Creek Water Service Area is surface water from nearby Crocker Creek. The water supply is filtered, chlorinated, and stored in one concrete reservoir.

Westurne Heights

The Westurne Heights Water Service Area was established in 2016 when the RDN acquired the pre-existing Westurne Heights Water Utility (established 1995). Water is supplied to properties along Westurne Heights Road, located 2.2 kilometers south of the intersection of Highway 4 and Chatsworth Road in Whiskey Creek. The water source for the Westurne Heights Water Service Area comes from one groundwater well located nearby. The water supply is chlorinated and stored in two underground reservoirs.

Water Regions and Aquifer Information

Eight of the nine RDN Water Service Areas rely on ground water resources, some of which are shared among multiple service areas and private well owners. Although the Whiskey Creek WSA resides over aquifers in the Little Qualicum Water Region, its water source is Crocker Creek. Table A1 (below) summarizes the water region that each WSA is located in and the mapped aquifers that provide groundwater.

Table A1: Summary of RDN Water Service Areas, Water Regions, and Aquifer Information

Water Region	RDN Water Service Area	Aquifer Type	Aquifer Number	Provincial Observation well
WR 5 - Nanoose	Nanoose Bay Penninsula	Bedrock	214	-
		Sand & Gravel	1098	392
	San Pareil	Sand & Gravel	221	-
	Englishman River	Sand & Gravel	1098	392
		Sand & Gravel	219	395
WR 3 - French Creek	French Creek	Sand & Gravel	217	303, 321
	Surfside	Sand & Gravel	664	389
WR 2 - Little Qualicum	Westurne Heights	Sand & Gravel	663	-
	Melrose	Sand & Gravel	663	-
WR 6 - Cedar-Yellow Point	Decourcey	Bedrock	162	390, 432

* Whiskey Creek water service area is supplied by surface water from Crocker Creek, aquifer resources are being researched

Single-Family Residential Connections

The number of single-family residential connections across all RDN water service areas dropped approximately 16% in 2005, when 465 connections were transferred from French Creek WSA to the Town of Qualicum Beach water services. RDN WSA single-family residential connections have increased since then, surpassing the 2004 level in 2011. The numbers of RDN water service connections to single-family residences over time are summarized in Table A2.

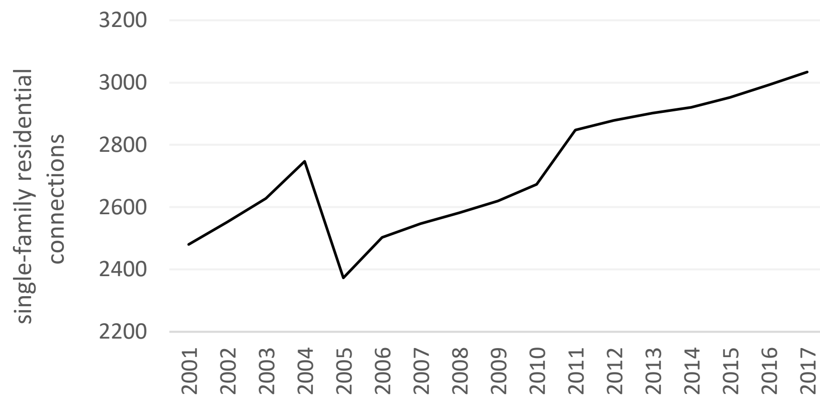

Figure A1: Single-family residential connections across all RDN water service areas from 2001 to 2017

Table A2: Single-Family Residential Connections per Year Across the RDN Water Service Areas

Water Service Area	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
French Creek	620	662	690	697	232	232	233	234	234	235	236	236	236	236	238	238	239
Surfside	32	33	34	36	37	38	38	38	37	37	37	37	37	37	38	37	38
Decourcey	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5
San Pareil	266	265	267	271	273	276	276	276	278	278	280	281	281	280	281	282	282
Nanoose Bay Peninsula	1559	1589	1634	1716	1772	1835	1869	1895	1924	1967	2008	2034	2056	2074	2098	2118	2151
Englishman River	-	-	-	24	55	91	100	107	117	125	133	136	137	138	143	149	151
Melrose Terrace	-	-	-	-	-	28	28	28	28	28	28	28	28	28	28	28	28
Whiskey Creek	-	-	-	-	-	-	-	-	-	-	123	122	123	123	123	136	124
Westurne Heights	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17
Total	**2481**	**2552**	**2629**	**2747**	**2373**	**2503**	**2548**	**2582**	**2620**	**2674**	**2848**	**2878**	**2902**	**2921**	**2952**	**2992**	**3034**

*Connections per year represents the average number of connections during summer and winter billing periods

** In 2005, the number of connections in French Creek WSA decreased when Chartwell was taken over by the Town of Qualicum Beach

Water Use and Precipitation Patterns:

Water Conservation in the Water Service Areas Operated by the Regional District of Nanaimo

Addendum to Water Conservation Evaluation: Targets, Trends and Trajectories (June 2018)

Prepared for the Regional District of Nanaimo, Water Services Department,

Regional and Community Utilities

By Hannah J. McSorley

July 2018

Table of Contents

Abbreviations

RDN .... Regional District of Nanaimo

WSA .... Water Service Area

Wx-Stn........................ Weather Station

Terminology

Inverse Relation: a contrary relationship between two variables such that they move in opposite directions (e.g. As *A* increases, *B* decreases; as *A* decreases, *B* increases).

Positive Relation: a direct relationship between two variables such that they move in the same direction (e.g. As *A* increases, *B* also increases).

Introduction

This document is an addendum to the June 2018 report *Water Conservation Evaluation: Targets, Trends and Trajectories*, which showed a pattern in single-family residential water-use that may have been linked to climatic variation. The majority of water service areas (WSAs) operated by the Regional District of Nanaimo (RDN) increased and decreased their water use at the same time, particularly during the summer period. It was suggested that the pattern in inter-annual water-use changes followed local weather patterns. To address the possible link between weather and water-use, this addendum examines seasonal patterns in precipitation relative to seasonal water-use in each of the nine WSAs operated by the RDN.

Summer water use is dominated by outdoor watering, particularly for irrigation of gardens and landscapes. Hypothetically, patterns in summer water use should respond inversely to local precipitation. When precipitation increases, we expect that summer water use should decrease in response; and when precipitation decreases, summer water use is expected to increase. Winter water-use patterns were not expected to show clear relationship to precipitation patters, as winter water use is dominated by indoor uses, and remains relatively independent of precipitation.

Precipitation Data

Precipitation data was obtained from eight weather stations in and around RDN water service areas. Table 1 summarizes the weather stations used for precipitation data in this document.

Table 1: Precipitation Gauges nearby RDN WSAs

Weather Station	Operated by	Climate ID	Latitude (N)	Longitude (W)	Elevation (m ASL)
Fairwinds	Fairwinds Golf	NA	49.2778	-124.1329	NA
Parksville - Public Works Yard	City of Parksville	NA	49.3036	-124.2694	35.0
Parksville - Community Park	City of Parksville	NA	49.3233	-124.3082	5.5
Qualicum Beach Airport	Environment Canada	1026562	49.3372	-124.3728	58.2
Little Qualicum Hatchery	Environment Canada	1024638	49.3528	-124.5122	30.0
Coombs	Environment Canada	1021850	49.3058	-124.4292	98.1
Nanaimo Airport	Environment Canada	1025370	49.0544	-123.8700	28.0
Gabriola	Environment Canada	1023042	49.1539	-123.7336	46.0

Data Handling

Monthly precipitation datasets were extracted from online sources for each weather station. To match seasonal water-metering periods, monthly precipitation data was aggregated into winter and summer seasons. The summer season is comprised of approximately 123 days, from May through August; and the winter season is approximately 242 days from September through April. Monthly data were removed when more than 15% of the days were missing precipitation measurements.

Seasonal Precipitation and Water Use

Water use data for each RDN WSA were compared to local precipitation from the nearest weather station. Time series of precipitation and single-family residential water-use data were plotted together, and relationships were discerned visually. Comparisons between water use and precipitation were completed for both the summer and winter seasons in each WSA. Table 2 shows which weather stations were associate with each of the RDN WSAs. The Appendix includes figures illustrating each WSA in proximity to the nearest weather station(s).

Table 2: Nearest Weather Stations to RDN WSAs

RDN Water Service Area	Weather Station
French Creek	Qulicum Beach Airport
Surfside	Little Qualicum Hatchery
Decourcey	Nanaimo Airport
	Gabriola
San Pareil	Parksville Public Works
	Parksville Community Park
Englishman River	Parksville Public Works
Nanoose Bay Peninsula	Fairwinds
Melrose Terrace	Coombs + Little Qualicum Hatchery
Whiskey Creek	Little Qualicum Hatchery
Westurne Heights*	Little Qualicum Hatchery

*Not included due to inadequate water use data

French Creek

French Creek WSA is closest to the Qualicum Beach Airport weather station operated by Environment Canada.

From 2007 to 2011, summer water use was inversely related to precipitation. Since 2011, water use has remained steady, while summer precipitation has declined over the same period.

There was not a clear or consistent relation between winter precipitation and winter water use in French Creek WSA. Winter water use has also declined over time.

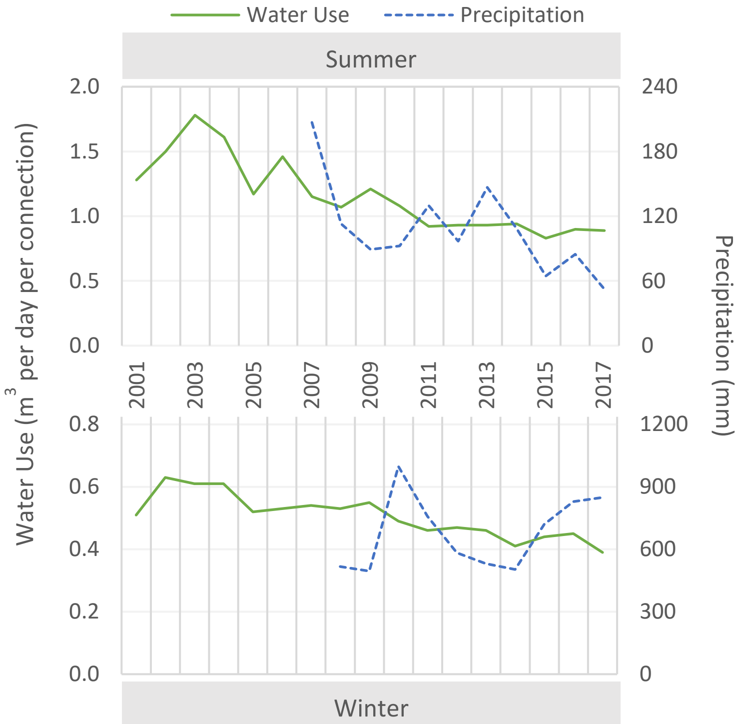

Figure 1: Weather and water use, French Creek WSA

Surfside

The Surfside WSA is closest to the Little Qualicum Hatchery weather station.

Summer water use in this WSA had an inverse relationship to precipitation until the summer of 2015 when stage 4 watering restrictions were implemented in response to drought conditions.

There appeared to be an inverse relation between precipitation and water use during some winters in the Surfside WSA, and a positive relation other years.

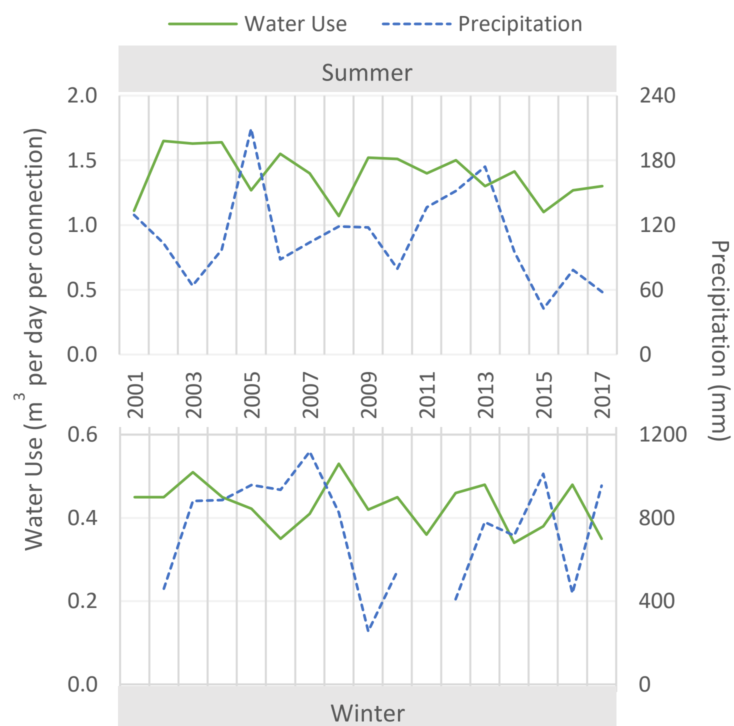

Figure 2: Weather and water use, Surfside WSA

Decourcey

Decourcey WSA is near the Nanaimo Airport weather station as well as the Gabriola weather station, both operated by Environment Canada.

From 2001 to 2012, summer water use in Decourcey had an inverse relationship to precipitation. The pattern broke down after 2012 was variable through to 2017.

Winter water-use in Decourcey responded inconsistently to precipitation, sometimes showing a positive relation and sometimes showing an inverse relation.

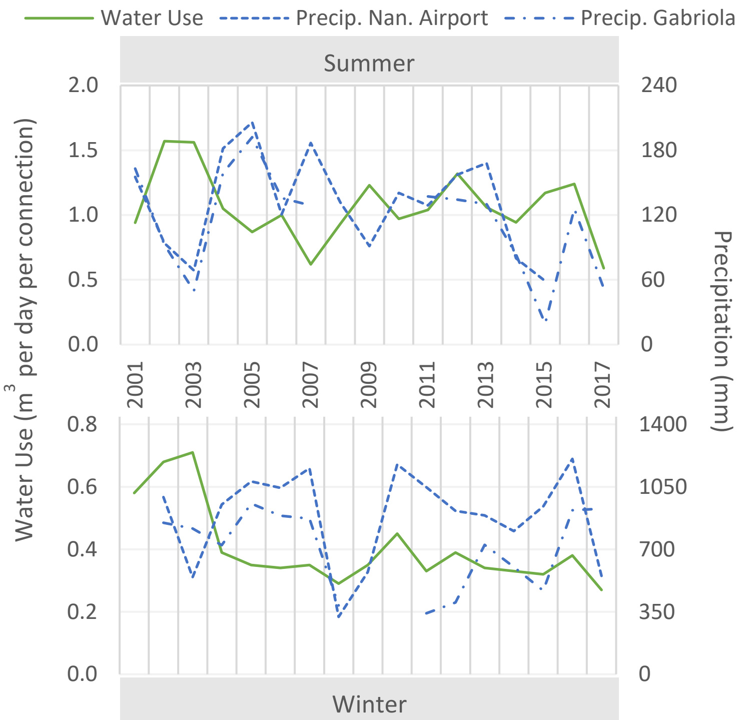

Figure 3: Weather and water use, Surfside WSA

San Pareil

San Pareil is closest to the two weather stations operated by the City of Parksville, located at the Public Works yard and Community Park.

Summer water use in San Pareil showed an inverse relationship to precipitation. However, during the drought of 2015, water use did not increase in response to low precipitation, because stage 4 watering restrictions were in place.

There appeared to be an inverse relation between precipitation and water use during some winters in the San Pareil WSA.

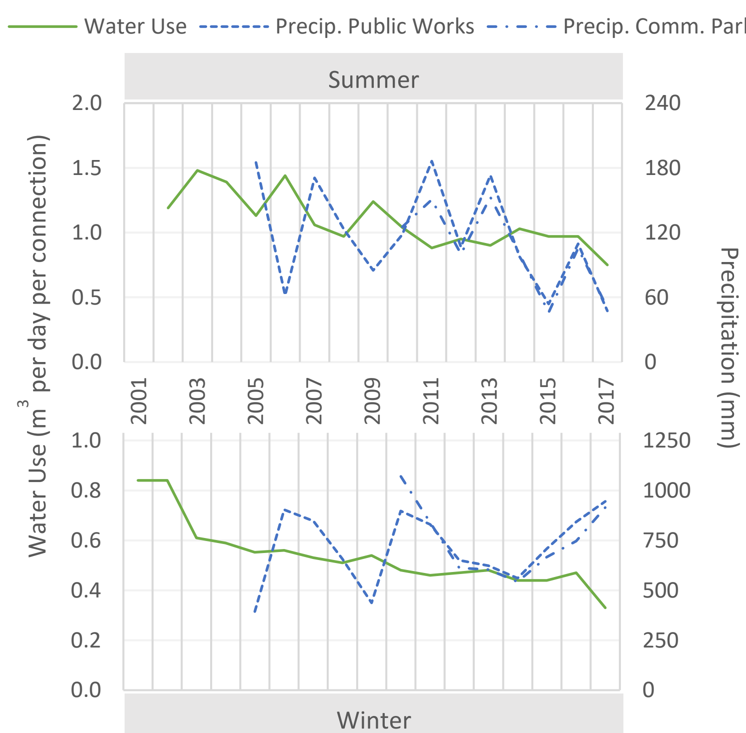

Figure 4: Weather and water use, San Pareil WSA

Englishman River

Englishman River WSA is closest to the Parksville Public Works yard.

There was a clear inverse relationship between summer water use and summer precipitation. An exception occurred in 2015, when water use declined despite low precipitation (stage 4 watering restrictions). Overall, summer water use has increased over time in this WSA, and has remained high.

Winter water use and precipitation had an inverse relationship during some winters.

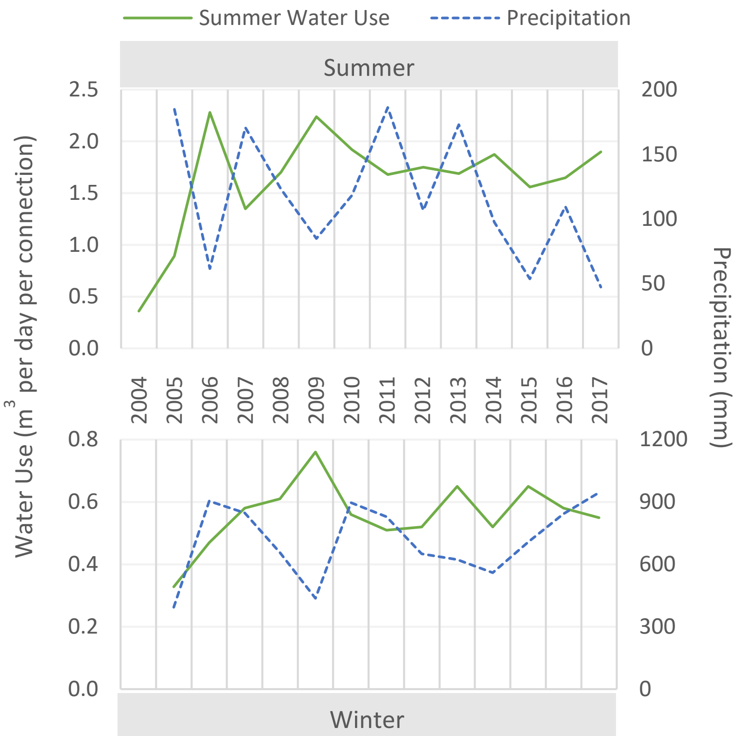

Figure 5: Weather and water use, Englishman River WSA

Nanoose Bay Peninsula

There is a rain gauge in Fairwinds, located near the centre of the Nanoose Bay Peninsula WSA. Fairwinds precipitation data exists only from 2008, while Nanoose Bay Peninsula water use data extends to 2001.

Summer water use in the Nanoose Bay Peninsula WSA displayed an inconsistent relationship to summer precipitation. 2009 to 2011 had inverse relation between water use and precipitation, but the pattern was less clear from 2012 to 2015.

Winter water use appeared to have a positive relation to winter precipitation in some years.

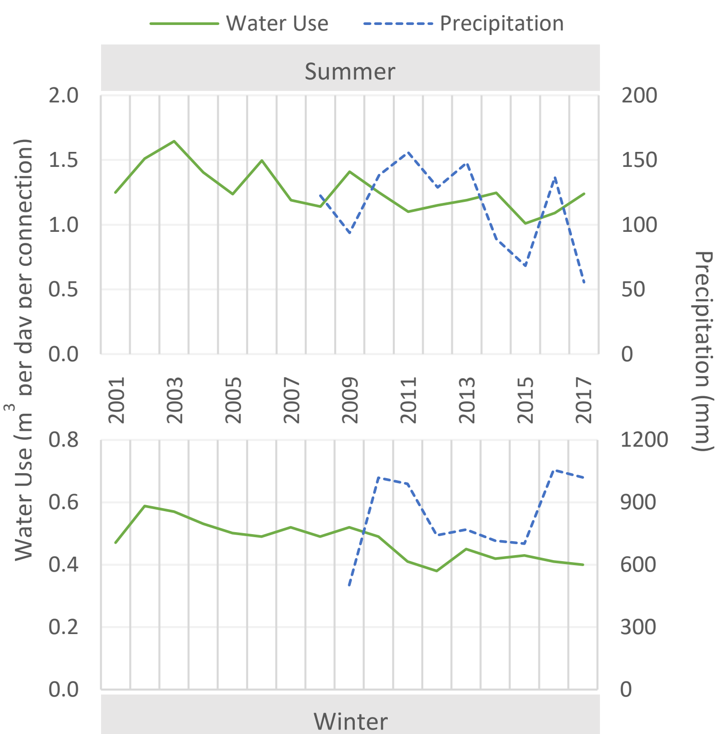

Figure 6: Weather and water use, Nanoose Bay Peninsula

Melrose Terrace

The WSAs of Melrose Terrace is close to the Coombs weather station and the Little Qualicum Hatchery weather station. Coombs station included summer precipitation data from 2006 to 2010 and Little Qualicum station had data continuous summer precipitation data from 2006 to 2018.

Melrose Terrace WSA did not have a consistent relationship between summer water use and summer precipitation. Summer 2010 water use declined despite lower precipitation. From 2014 to 2017 there was a gentle increase in summer water use, despite fluctuations in precipitation.

Winter water use in Melrose Terrace was inversely related to precipitation until 2015. Winters from 2015 to 2017 showed increasing water-use despite higher precipitation.

Note that this WSA has had the lowest average annual water use rates across the nine RDN WSAs.

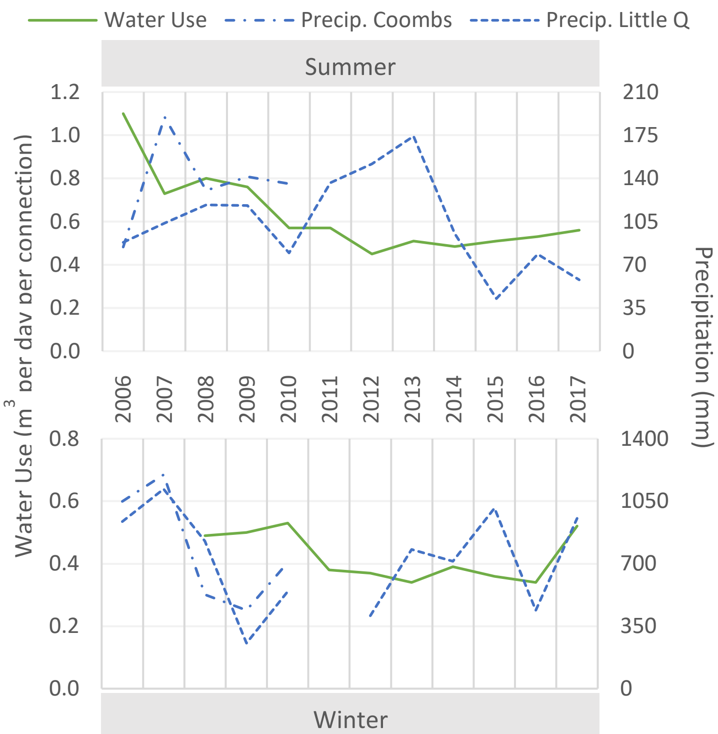

Figure 7: Weather and water use, Melrose Terrace WSA

Westurne Heights

Because Westurne Heights was recently acquired by the RDN, there was not enough water-use data to compare to precipitation. Westurne Heights is not included in a precipitation and water-use comparison.

Whiskey Creek

Whiskey Creek WSA is close to the Coombs weather station and the Little Qualicum Hatchery weather station, however only Little Qualicum station had continuous summer precipitation data from 2012 to 2018.

Since this WSA was acquired in 2012, summer water use has increased. There has not been a consistent relation between precipitation and summer water use.

Winter water use in Whiskey Creek WSA has increased over time and was positively related to precipitation patterns: winter water use increased with increasing precipitation.

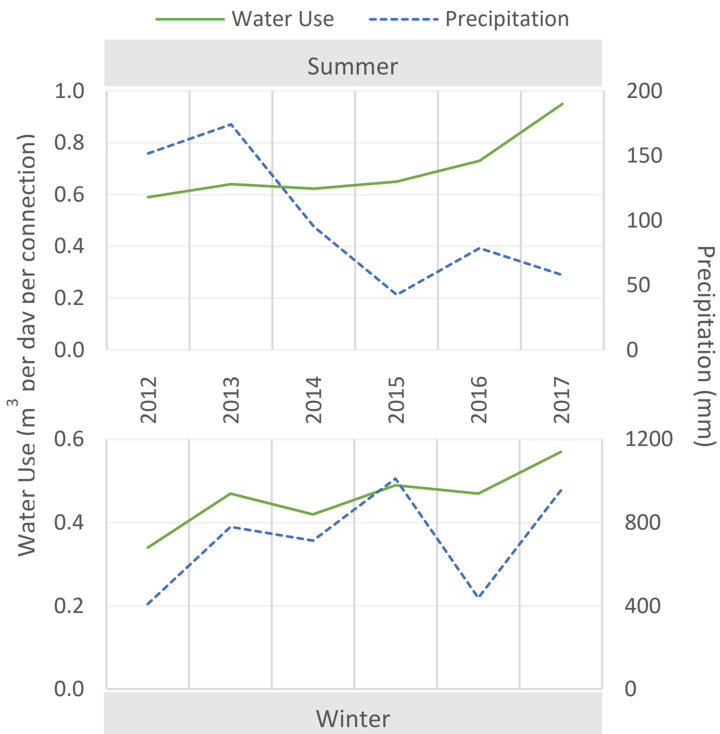

Figure 8: Weather and water use, Whiskey Creek WSA

Note that in 2017, this WSA had the second highest water use of the nine RDN WSAs and this WSA has shown an increase in single-family residential water use over time.

Conclusions

Summer water use in most of the RDN WSAs demonstrated an inverse relationship to summer precipitation. Most years, summer water use increased during times of low precipitation, and decreased with greater precipitation. These findings support the hypothesis that, in the RDN WSAs, summer water-use patterns responded inversely to precipitation patterns. This inverse relationship can be attributed to summer water use being dominated by outdoor use and irrigation.

Water use habits in Melrose Terrace and Whiskey Creek WSAs did not respond to precipitation patterns as anticipated. Melrose Terrace and Whiskey Creek did not show clear inverse relationships between summer precipitation and summer water use. These two WSAs were located furthest from the weather stations that they were related to; therefore, the precipitation measurements may or may not have accurately reflected local rainfall in these two WSAs.

Winter water-use had inconsistent relationships to winter precipitation patterns in French Creek, Surfside, and Melrose WSAs. During some winters, there appeared to be a positive relationship between water use and winter precipitation in Decourcey, Nanoose Bay Peninsula, and Whiskey Creek WSAs. San Pareil and Englishman River WSAs showed inverse relations between winter water use and winter precipitation. The inconsistent relationships between winter water use and winter precipitation across the RDN WSAs support the hypothesis that, because it is primarily indoor use, winter water use patterns are generally independent from precipitation patterns. This further supports that summer water use, dominated by outdoor irrigation and watering, respond inversely to summer precipitation.

At each of the eight weather stations around the RDN WSAs, decreasing summer precipitation has been measured over time. Longer and drier summers are anticipated to continue with climate change. Initiatives implemented through RDN Water Services, Drinking Water & Watershed Protection, and Team WaterSmart have yielded considerable reductions in single-family residential water use over the past fifteen years; continuing to engage residents in outdoor water conservation education, outreach, and incentives will help to prevent summer water use from increasing during future periods of drought.

Appendix

Figures 9 to 14 show the location of each RDN WSA in proximity to the weather station used for precipitation data comparison (as summarized in Table 2).

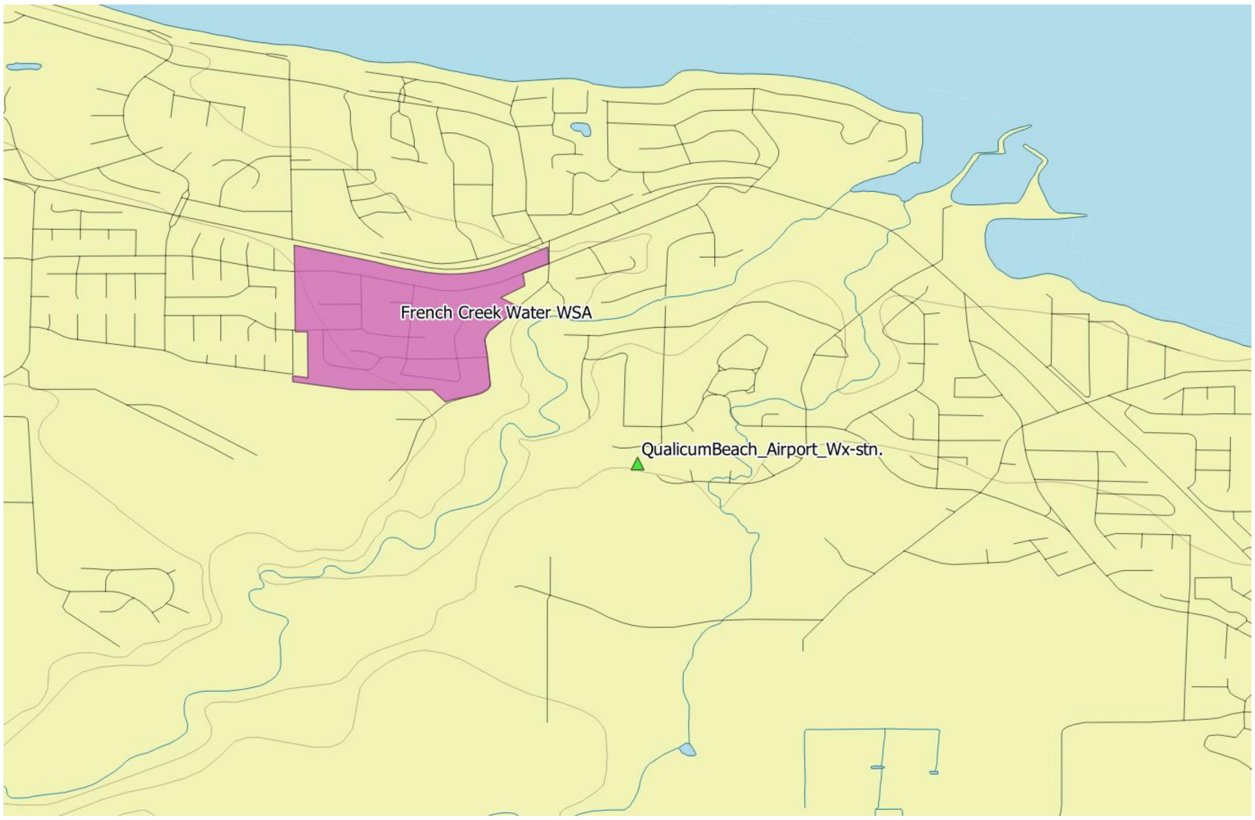

Figure 9: French Creek WSA in proximity to the Qualicum Beach Airport weather station.

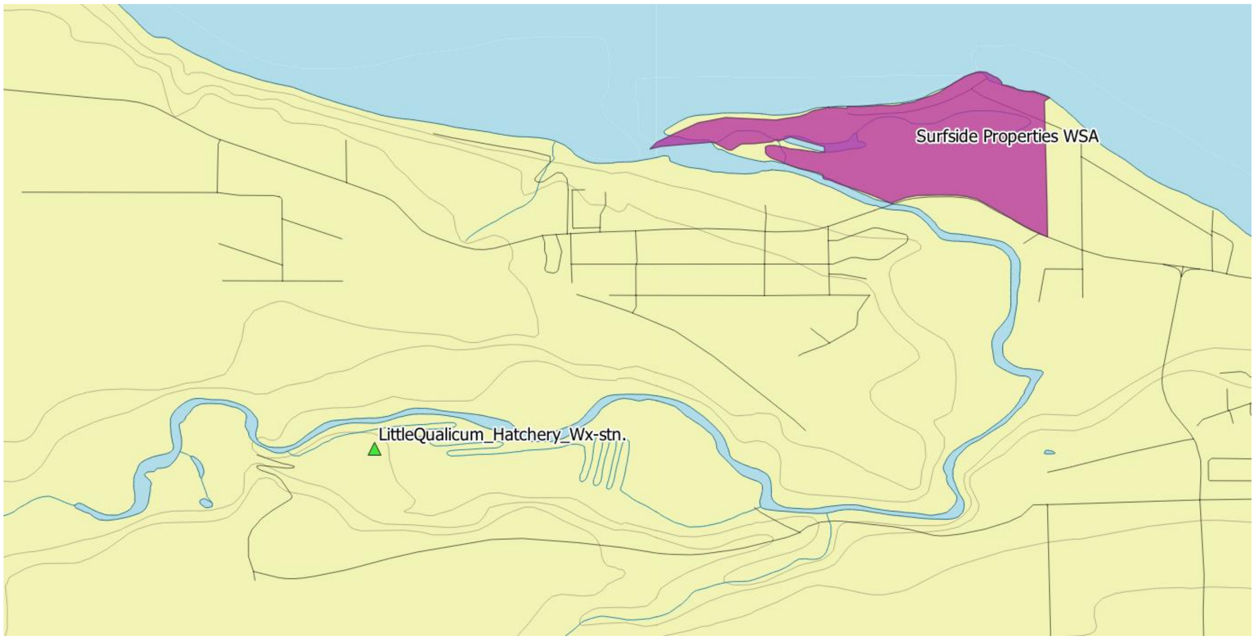

Figure 10: Surfside WSA in proximity to the Little Qualicum Hatchery weather station.

Figure 11: Decourcey WSA in proximity to the Nanaimo Airport and Gabriola weather stations.

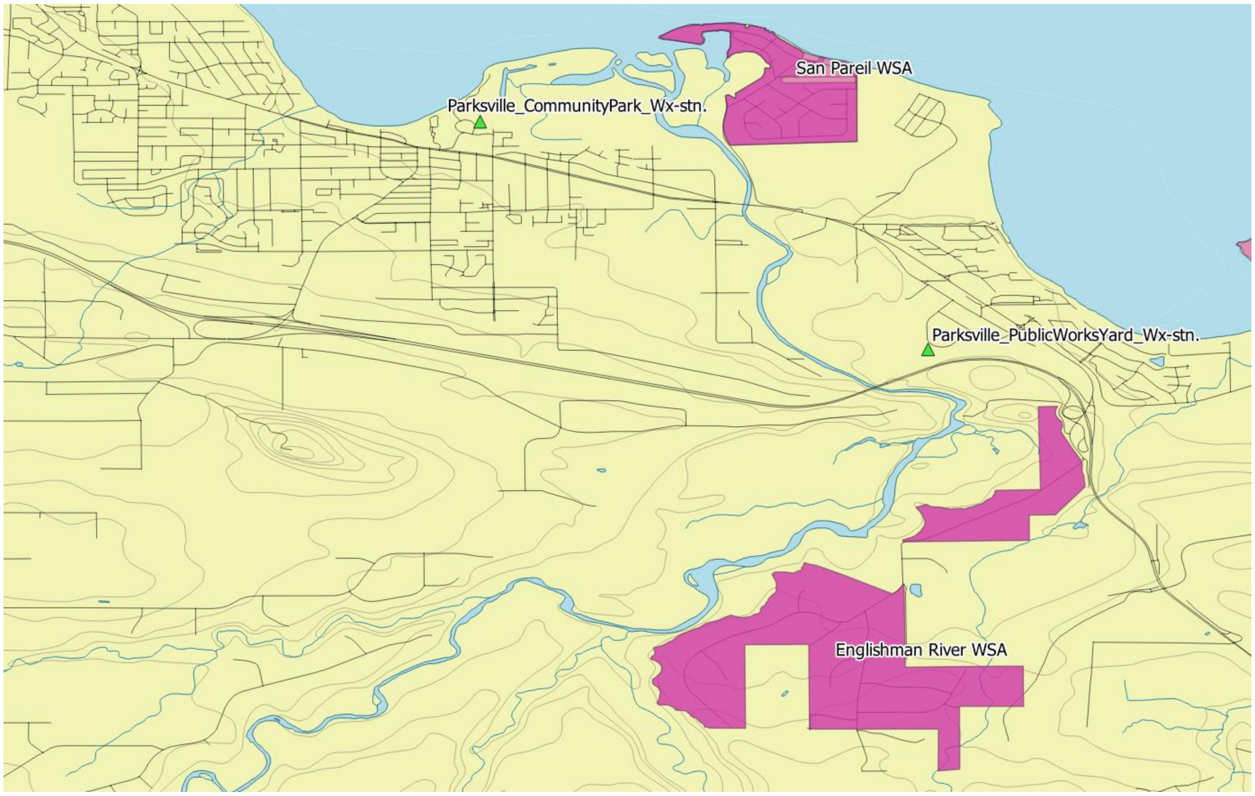

Figure 12: San Pareil and Englishman River WSAs in proximity to the Parksville Public Works Yard and Community Park weather stations. The City of Parksville "Public Works Yard" rainfall gauge is located at the engineering and operations works yard at 1116 Herring Gull Way in Parksville.

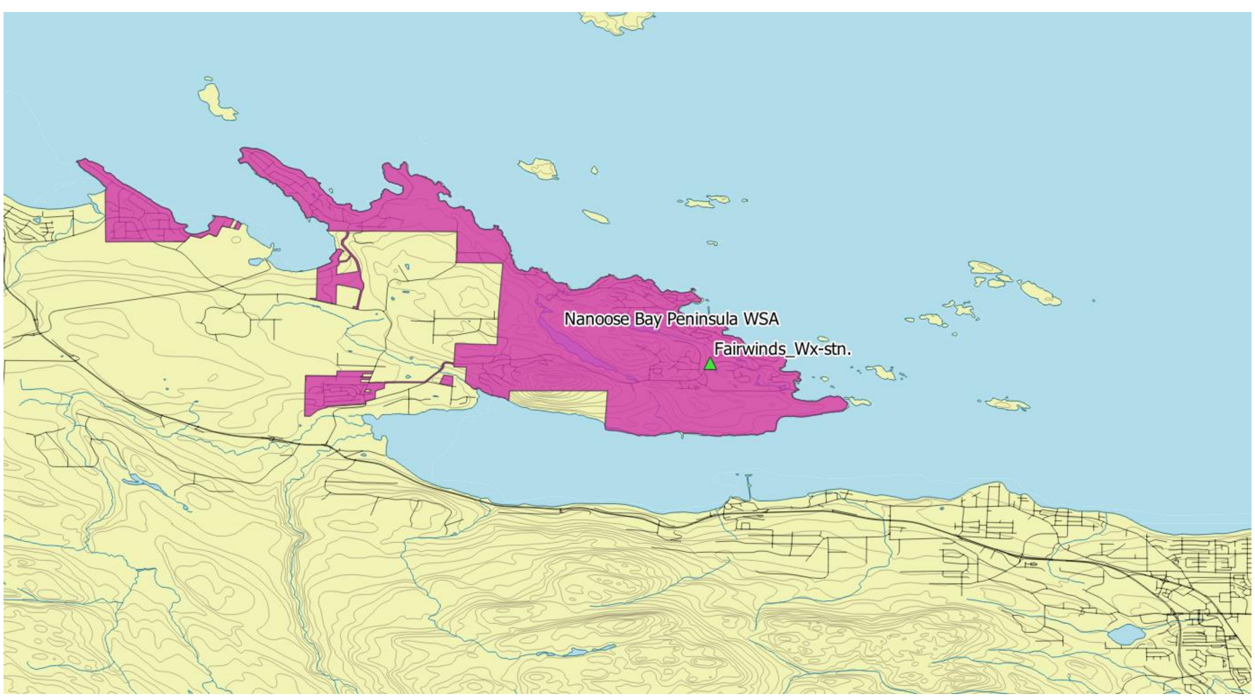

Figure 13: Nanoose Bay Peninsula WSA in proximity to the Fairwinds weather station.

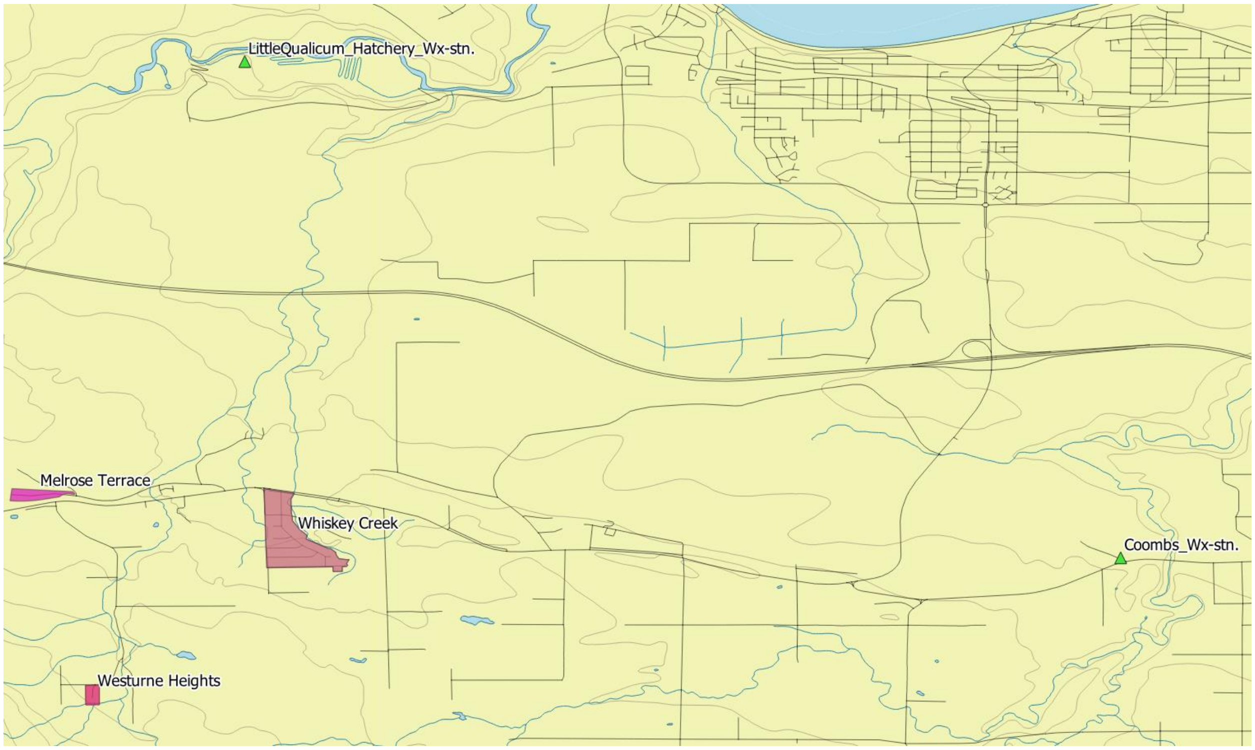

Figure 14: Melrose Terrace, Whiskey Creek, and Westuren Heights WSAs in proximity to the Coombs and Little Qualicum Hatchery weather stations.

Data Source References

City of Parksville, Operations Department. Rainfall Records. http://www.parksville.ca/cms.asp?wpID=192.

Government of Canada, Environment and Natural Resources. Historical Data. http://climate.weather.gc.ca/historical_data/search_historic_data_e.html