ANALYSIS OF WHATCOM COUNTY WATER USE[1]

Eric Hirst
Bellingham, WA
January 2017

This paper defines Whatcom County water use in greater detail than have past studies.[2] It provides month-by-month details on water use by sector. It also estimates consumptive use and return flows, again by month and sector. This disaggregation and its focus on summer is important because of our failure to meet the Washington Dept. of Ecology (Ecology) Nooksack River instream flow rule[3] during much of the summer and, more important, to protect fish and other wildlife that depend on an abundant supply of cold, oxygenated, clear water. Also the Washington State Water Resources Act calls for an allocation of water that meets the needs of fish, domestic, commercial, industrial, and agricultural uses.[4] Without good data on the details of water use, including trends over time (from month to month and year to year), it is not possible to make such allocations.

Although we have generally viewed water as an inexhaustible resource, in reality it is seasonally- and location-limited. And it is becoming more scarce as population grows and as the effects of climate change increase (smaller glaciers, earlier springtime snowmelt, and less rain and higher temperatures in summer). Much as we might like to, we can't give people something that doesn't exist. If we allow more human use of water, we are unavoidably robbing water from holders of senior water rights, including instream flows intended to protect fish and other wildlife as well as scenic and recreational values. Such a move would also undermine tribal treaty rights to enough water to support healthy salmon populations. As Ecology notes, "The water code, written 100 years ago, was not designed to accommodate the changing and dynamic needs of water users today. After a long history of seeing the public's water as an infinite resource, the realities of population growth, economic development, and importance of instream protection for fish demand that we manage water as the finite resource that it is."[5]

As explained in the Appendix, I used data from the U.S. Geological Survey on annual water use in Whatcom County for 2010 plus estimates of agricultural irrigation use for 2014. I also obtained data from the City of Bellingham, City of Lynden, Birch Bay Water & Sewer District,

[1] I thank Doug Allen, Henry Bierlink, Dan Eisses, Joanie Greenberg, Hank Kastner, and John (Buck) Smith for their helpful comments on a draft of this paper.
[2] The only official study I found on this subject, which does not cover the entire county, is C. Bandaragoda et al., Chapter 12 Existing Condition Water Budget Scenario, *Lower Nooksack Water Budget Project*, December 2012. See also E. Hirst, *Whatcom Irrigation Water Use*, May 2016 and Appendix A of E. Hirst, *Whatcom Water Problems and Possible Solutions*, May 2015.
[3] Dept. of Ecology, *Instream Resources Protection Program –Nooksack Water Resource Inventory Area (WRIA) 1*, Chapter 173-501 WAC, Dec. 1985 and June 1988.
[4] http://app.leg.wa.gov/rcw/default.aspx?cite=90.54
[5] Ecology, *water Resource Management: Where We Are Today*, Nov. 2016.

and Whatcom County Public Utility District #1 on daily water supplies and/or water use by customer class. [6]

RESULTS: BASE AND SEASONAL USES

Annual water use is 36 billion gallons per year. Agricultural irrigation is the dominant use, accounting for 44% of the total, followed by industrial (24%) and residential (20%). Combined, the remaining sectors account for 12% of the total.

Table 1. Total Whatcom County withdrawals/diversions, billion gallons/year

	Base	Seasonal	Total	% of Total
Residential	5.6	1.5	7.2	20%
Public supply	4.6	1.1	5.8	
Self-supplied	1.0	0.4	1.4	
Irrigation	0.4	15.3	15.7	44%
Livestock	1.4	0.0	1.4	4%
Aquaculture	1.1	0.0	1.1	3%
Industrial	7.8	0.6	8.5	24%
Mining	0.2	0.0	0.22	1%
Commercial	1.7	0.3	2.0	6%
Totals	18.1	17.8	35.9	100%
%	51%	49%	100%	

I disaggregated annual water use into Base and Seasonal shares, with Base water use defined as the average of monthly water use from January through May plus November and December. Seasonal water use is the increment above the Base for the five months of June through October. [7] Overall, water use is about evenly split between Base and Seasonal uses. Almost all (98%) irrigation water use is seasonal, as is 22% of residential and 14% of commercial.

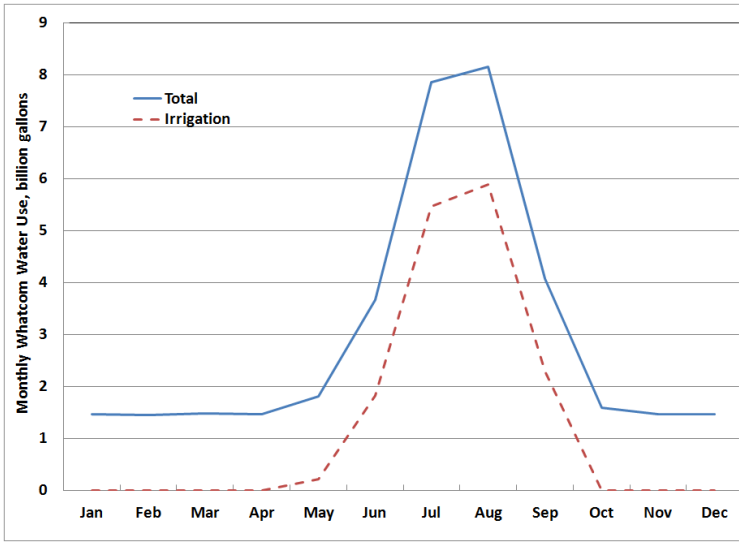

Fig 1. Month-by-month water use in Whatcom County, Total and Irrigation.

Water use varies dramatically from month to month (Fig. 1).

[6] Thanks to several people for providing data and interpretations thereof: Steve Banham (Lynden), Anitra Acceturo and Eric Johnston (Bellingham), Dan Eisses (Birch Bay), and Steve Jilk and Rebecca Schlotterback (PUD #1).

[7] Roughly speaking, Base water use is equivalent to indoor water use, while Seasonal water use is equivalent to outdoor use. But some seasonal water use is not for outdoor purposes because some Whatcom County residents are "snowbirds," who live elsewhere during the winter.

Usage peaks in July and August, primarily because of irrigation, at about 8 billion gallons/month. Summer water use (July through September) is 56% of the annual total. A closer look at the monthly details for June through September again shows the dominance of irrigation, followed by industrial and residential uses (Fig. 2)

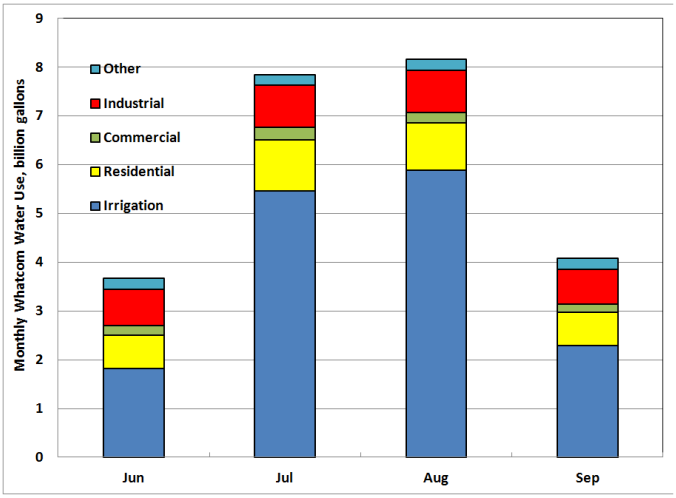

Fig. 2. Water use by sector for June through September.

RESULTS: CONSUMPTIVE USE AND RETURN FLOW

I separated water use for each sector into its consumptive use and return-flow components. Consumptive use is that portion of water withdrawal/diversion that is *not* returned to the local hydrological cycle. Return flow is the portion that *is* returned to the local system, although that return may be later in time, downstream of the extraction point, with higher temperature, and lower water quality.

The vast majority of indoor water use is returned, whereas the vast majority of outdoor water use is consumptive (because of losses to evaporation and transpiration). I assumed that 100% of Bellingham and 100% of PUD #1 water uses are consumptive because the water is returned to Bellingham Bay rather than a freshwater source.[8]

Table 2. Return flow and consumptive water use for Whatcom County

	Return flow	Consump-tive	Total	Consumptive as % of total
Residential	2.7	4.5	7.2	16%
Public supply	1.7	4.0	5.8	
Self-supplied	1.0	0.4	1.4	
Irrigation	2.4	13.3	15.7	47%
Livestock	1.2	0.1	1.4	0%
Aquaculture	0.1	1.0	1.1	4%
Industrial	1.0	7.5	8.5	27%
Mining	0.0	0.2	0.2	1%
Commercial	0.5	1.5	2.0	5%
Totals	7.8	28.1	35.9	100%
%	22%	78%		

More than three-fourths (78%) of Whatcom's annual water use is consumptive (Table 2). The primary contributors to consumptive use are irrigation (47% of total), industrial (27%) and residential (16%).

[8] Almost 99% of the PUD's sales are to the three large industrial facilities at Cherry Point.

The month-by-month pattern of consumptive use is similar to that for total water use (compare Figs. 1 and 3). However, the share of total water use that is consumptive is slightly higher in the summer, 80% vs. 73% for the rest of the year.

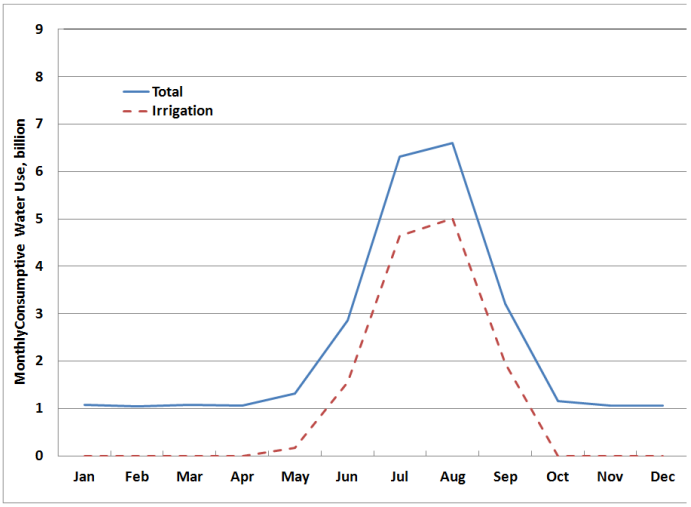

Fig. 3. Month-by-month consumptive water use in Whatcom County, Total and Irrigation.

CONCLUSIONS

This paper provides additional details on water use: monthly estimates and consumptive use vs. return flows. Its overall findings, however, are the same as those from prior studies. Irrigation is, by far, the largest water use in the county and accounts for 68% of the total during the critical summer months.

Some entity, perhaps Whatcom County or Ecology's Bellingham Field Office, should take charge of this data issue, i.e., the collection, organization, analysis and reporting of statistics on who uses water, when, where, and for what purposes. It is remarkable and disappointing that the few studies that identify local water uses are one-off and not repeated at regular intervals. Either state or local government, or both, should allocate money and people for this work.

We also need a corresponding effort to forecast water use. The Coordinated Water System Plan[9] did make forecasts but suffers from two serious defects (1) it excludes agriculture, and (2) its forecast methodology accounts only for population growth and does not consider the possible effects of other factors, such as water-use efficiency and climate change. Spokane County's approach is much more detailed, accounting for several customer classes, indoor and outdoor uses, monthly variations in water use, and considerable geographical disaggregation.[10] A study of the Los Angeles basin forecast future water demands by accounting explicitly for changes in air temperature and precipitation caused by climate change and possible changes in per-customer demand because of efficiency improvements.[11]

Finally, the numbers presented here are primarily estimates because the major water use – irrigation – is not metered.

---

[9] Section 3 of RH2 Engineering, *Whatcom County Coordinated Water System Plan Update*, Aug. 2016.
[10] Spokane County Water Resources, *Spokane County Water Demand Forecast Model, Model 3.0 & 2013 Forecast Update*, June 2013.
[11] http://www.usbr.gov/watersmart/bsp/docs/fy2017/LABasinStudySummaryReport.pdf
U.S. Bureau of Reclamation, Summary Report, Los Angeles Basin Study, Nov. 2016.

APPENDIX: DATA AND ASSUMPTIONS

The primary source for the annual (2010) figures on water use is the U.S. Geological Survey.[12] I modified and supplemented these estimates as explained in prior papers (see footnote 1).

I then developed a method to disaggregate residential, commercial, and industrial water uses into month-specific Base and Seasonal uses. I assume that Base water use is the average of monthly water use for seven months: January – May, November, and December; Seasonal water use is the amount above this baseline during the remaining five months (June through October).

I obtained monthly and daily data from Bellingham, Lynden, Whatcom County PUD #1, and Birch Bay to conduct this analysis and to scale up to the county as a whole.

Lynden: Starting with data on daily water use for the entire system from 2010 through 2015, I created monthly totals and averages, and then used the 6-year averages to define the month-to-month variations in Lynden water use. I used billing data on monthly water consumption for each class (Residential, Commercial, Industrial) to share system totals across months and sectors. The result is a set of shares (% of annual Lynden water use) assigned to each customer class for each month.

Bellingham: I conducted the same kind of analysis, using systemwide data on daily water use for the10-year period from 2006 through 2015. Again, I combined these systemwide monthly totals with customer-class billing data to define customer- and month-specific shares of total water use. Bellingham's data are more complicated than Lynden's for two reasons: (1) the fraction of metered residential customers increased from year to year, and (2) Bellingham bills on a bimonthly basis, which means that the customer-specific shares are off by roughly one month (e.g., the July bills really represent consumption in June). I adjusted for the second factor by moving all the customer-class data back one month.

Birch Bay: I obtained 10 years (2006 through 2015) of daily water use for the entire system. I did not obtain billing data because almost all Birch Bay water use is residential.

PUD #1: Almost 99% of the water sold is used at the three large industrial facilities at Cherry Point. So I assigned all the PUD water sales to the industrial class.

[12] R.C. Lane and W.B. Welch, *Estimated Freshwater Withdrawals in Washington, 2010*, U.S. Geological Survey, Scientific Investigations Report 2015-5037, 2015.

All four systems experience peak usage in July and August and lowest usage during the winter (Fig. 4). The monthly variation is lowest for PUD #1, likely because its large customers use water for industrial purposes that have little seasonal variation. Lynden has the greatest month-to-month variation, likely because its inland location makes it warmer and dryer in the summer than Bellingham and Birch Bay.

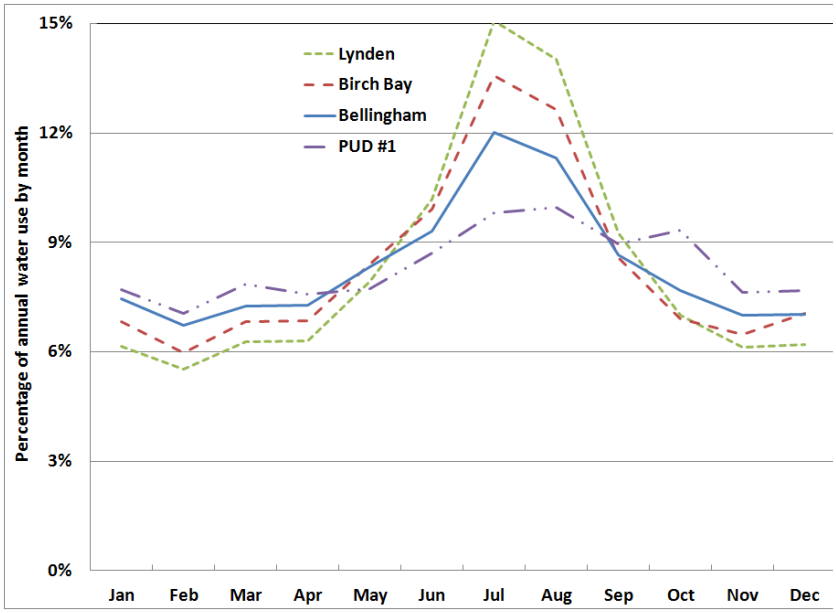

Fig. 4. Month-to-month variation in water use for Lynden, Birch Bay, Bellingham, and Whatcom County PUD #1.

I combined data from these water purveyors to estimate month-to-month allocation factors for each customer class:

- Residential: Public supply 60% Bellingham + 40% Lynden, based on population shares. [13] [14] Self-supplied 100% Lynden.
- Commercial: 70% Bellingham + 30% Lynden, based on shares of county employment for commercial and retail.
- Industrial: 58% PUD #1 + 28% Bellingham + 14% Lynden, based on data showing that PUD sales to Cherry Point account for 58% of industrial water use, and Bellingham accounts for two-thirds of the remainder.
- Irrigation: Based on ET coefficients and crop type, acreage, and irrigation system.[15]
- Livestock, Aquaculture, Mining: For these very small water users (combined less than 10% of total), I assumed no month-to-month variation in water use.

The sector-specific results are similar to those for the four water systems (compare Figs. 4 and 5). Peak usage for the residential and commercial sectors occurs in July, whereas peak usage is about the same in July and August for the industrial sector. The residential sector has the greatest seasonal variation in water use, while the industrial sector has the least.

[13] Berk, *Whatcom County Population and Employment Projections and Urban Growth Area Allocations*, Nov. 1, 2013.
[14] http://www.ofm.wa.gov/pop/april1/hseries/default.asp WA Office of Financial Management
[15] E. Hirst, *Whatcom Irrigation Water Use*, May 2016.

To estimate consumptive and return flows, I assumed that the Base and Seasonal usage figures developed above could be treated as Indoor and Outdoor uses, respectively. [16]

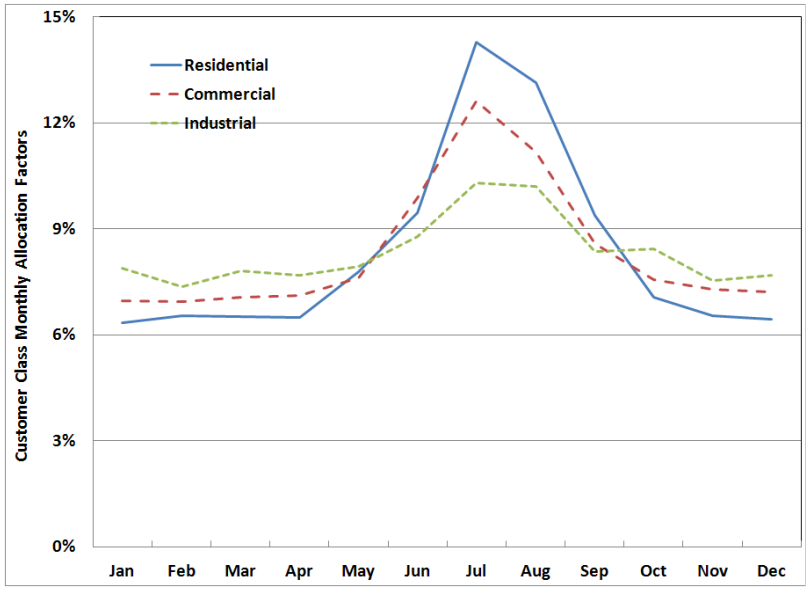

Fig. 5. Variations in month-to-month water use for Whatcom residential, commercial, and industrial sectors.

This distinction is important because indoor and outdoor uses exhibit very different properties in terms of consumptive use vs. return flows. If water used by humans is returned to the system (e.g., infiltrates into the ground and the underlying aquifer or flows into a stream or other surface water body) closely in time, space, temperature and quality to its withdrawal/diversion, then it really has not been "used" and is still available for instream uses or other human uses. Estimates from Ecology[17] and other sources[18] suggest that indoor water use is primarily returned,[19] whereas outdoor water use is primarily consumptive.[20] [21] [22] The current analysis assumes that indoor water use is 10% consumptive, while outdoor water use is 85% consumptive.

[16] This split overestimates outdoor use because, as Steve Banham, Dan Eisses and Eric Johnston pointed out, not all increased use in summer is caused by outdoor water use. Some is related to "snowbirds," who live in Whatcom County during the summer and elsewhere during the winter. This effect increases indoor use in the summer.

[17] http://www.ecy.wa.gov/programs/wr/rules/images/pdf/guid1210.pdf Ecology, GUID-1210, *Water Resources Program Guidance: Determining Irrigation Efficiency and Consumptive Use*, Oct. 11, 2005.

[18] *Lower Nooksack Water Budget Overview*, prepared for the WRIA 1 Joint Board, 2012. July return is 27% of total (including all uses, not just agriculture, p. 11)

[19] T. Culhane, Ecology, personal communication, March 4, 2015: "… assumption we made was that volumetrically 10 percent of indoor use is consumptive water use and 80 percent of outdoor water use is consumptive."

[20] A. Wessel, *Mitigation Options for the Impacts of New Permit-Exempt Groundwater Withdrawals*, Ecology, Draft, Publication No. 15-11-017, Oct. 2015. Page 9 of report "Indoor water use tends to be only 10% consumptive (due to on-site septic systems), and outdoor use tends to be about 80-90% consumptive (due to evapotranspiration)."

[21] T. Culhane and D. Nazy, *Permit-Exempt Domestic Well Use in Washington*, Ecology, No. 15-11-006, February 2015.

[22] http://www.spokanecounty.org/1446/Water-Demand-Forecast-Model Spokane County Water Resources, *Spokane County Water Demand Forecast Model, Model 3.0 & 2013 Forecast Update*, June 2013. Model assumes indoor water use is 5 to 15% consumptive, and outdoor water use is 83% consumptive.