Appendix K

Memorandum

To: David Jostenski, PADEP

From: David Sayers

CC: Ken Najjar, Kent Barr, Greg Cavallo, Curtis Schreffler

Date: June 18, 2007

Re: Self-supplied domestic consumptive use estimate

This memo describes the work undertaken by DRBC to estimate a consumptive use factor for self-supplied residential water use. Consumptive use represents that portion of a withdrawal that is "*evaporated, transpired, incorporated into products, or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment*"[1]. A consumptive use (CU) of 1 % means 99% of the withdrawal volume is returned to the watershed, conversely, a consumptive use of 100% means no water is returned.

Two key assumptions used in this memo are that self-supplied residential water users obtain water from their own well and return water to the ground via a septic system. There are essentially two questions to answer: 1) What portion of residential withdrawals is likely to be used for consumptive purposes (e.g., irrigation). 2) How much of the return flow that enters the septic system will get back into ground water via the drain field.

The approach taken by DRBC was to use reported residential monthly withdrawals from water purveyors to estimate a CU factor, drawing inferences about water use habits from monthly water use patterns. The underlying assumption is that the lowest water use month represents a baseline water use which is 100% non-consumptive. Any water use above that baseline amount could potentially be consumptive water use.

From PADEP statewide databases, 1,025 water purveyors reporting 100% residential use were identified. Of these, 552 had related water use in the Nov, 2006 Act 220 registration database and were therefore able to be utilized in the analysis. Additional information about the type of water purveyor (PF_KIND_DESIGNATION_DESC) was brought into the analysis to allow a breakdown of CU estimates based on the type of water purveyor (municipal, private, mobile home park etc).

Where purveyors had multiple sources these were summed to calculate total monthly water use for each purveyor. Using population served data also from PADEP databases, a per capita use figure was calculated for each purveyor. The purpose of this calculation was to eliminate outliers and data that were deemed to be inaccurate, for example one purveyor's per capita use was in excess of 71,000 gallons per day (gpd); such data were excluded from further analysis as it lacked credibility. A decision was made to

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[1] Solley, W.B., Pierce, R.R., and Perlman, H. A., 2004, Estimated use of water in the United States in 1995: U.S. Geological Survey Circular 1200.

exclude the lowest and highest 5% of per capita values from further analysis, which meant excluding purveyors with per capita use lower than 26 gpd and higher than 170 gpd. This left 468 facilities available for analysis with an average per capita water use estimates of 68 gpd.

For each purveyor, the ratio of monthly use to total annual use was calculated in order to develop a profile of water use throughout the year, this also normalized the data, and avoided weighting estimates based on volume. These monthly ratios were then averaged for each purveyor sub-category (PF_KIND designation). For each sub-category, the lowest water use month was identified, this then became the "baseline" level of water use with the assumption that no consumptive use had occurred during that month. The lowest use is typically during a winter month and gives support to this assumption. Expanding on this assumption, any water use above the baseline amount in other months is potentially consumptive use and was calculated as such. This analysis provided the necessary data to then calculate a CU percentage which is simply:

$$CU = \frac{\text{potential consumptive use}}{\text{total use}} \times 100$$

Figure 1 illustrates the concept graphically.

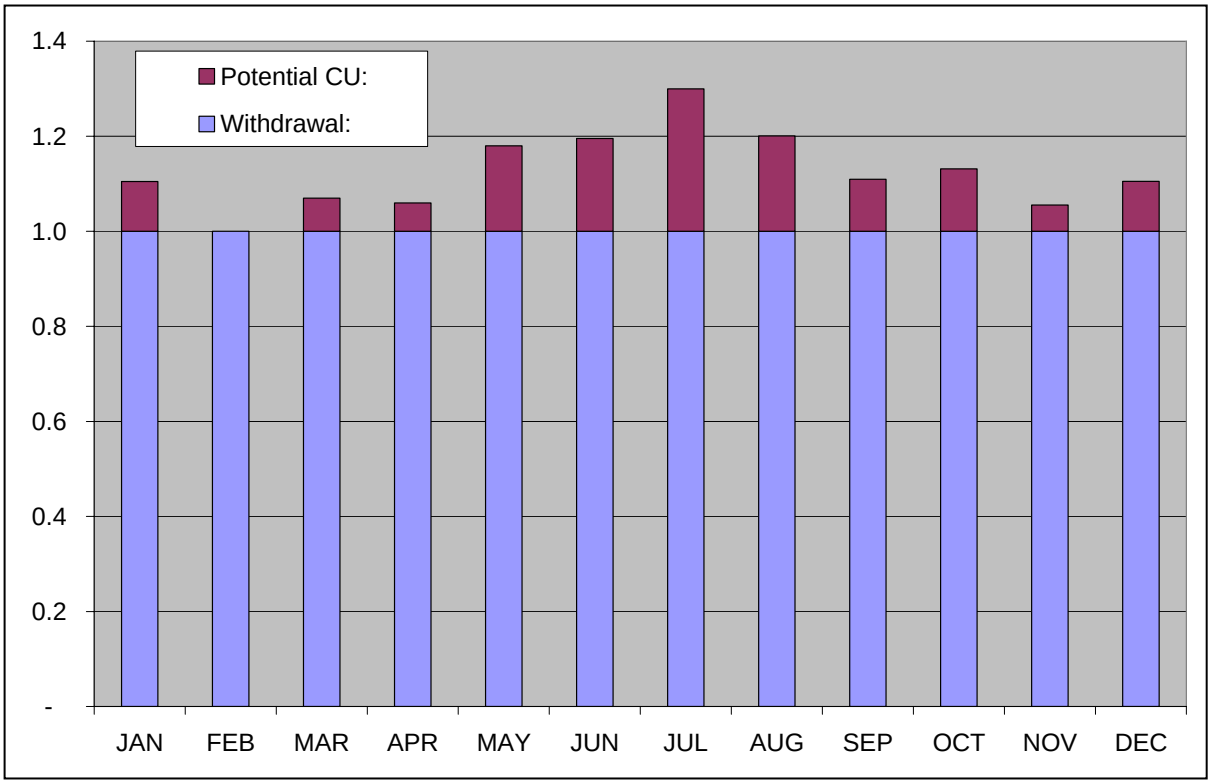
The grouping of data by PF_KIND sub-categories allows further breakdown of CU estimates. A summary of results is shown in table 1. Some of these sub-categories are likely to be more reliable than others. Based on work done by CDM during development of the Lehigh watershed pilot study, a blended sub-category was created comprising municipal, authority and private investor-owned facilities, as these types of facilities will likely report data more accurately. This combined category and its components are highlighted in table 1; an estimate of CU based on these facilities is likely to be more reliable, due to better underlying data.

Table 1. Summary of Results of Consumptive Use Estimates

PF_KIND Sub-Category	Per Capita Use (gpd)	Number of Systems	Annual Withdrawals (gal)	Percent of All Use	Est. % Consumptive Use
Apartments	61.2	23	65,925,436	2.2%	10.9%
Association - Co-Op	78.8	63	603,210,784	20.2%	10.2%
Association (Purchases)	138.0	1	15,109,700	0.5%	61.3%
Auth Leases Back To Mun	49.1	2	33,005,920	1.1%	3.8%
Authority	69.7	22	286,203,768	9.6%	12.0%
Authority - (Purchases)	65.6	3	107,858,415	3.6%	17.2%
Institutional Education	39.8	1	1,454,500	0.0%	27.9%
Institutional Health	59.2	16	92,247,731	3.1%	5.0%
Institutional Military	-	0	-	-	-
Institutional Recreational	-	0	-	-	-
Mobile Home Park	67.2	283	1,246,167,768	41.7%	4.4%
Municipal	64.5	8	146,987,341	4.9%	14.9%
Municipal - (Purchases)	41.2	3	30,087,800	1.0%	12.7%
Priv Investr Owned-(Pu)	48.5	10	105,837,927	3.5%	12.6%
Private Investor Owned	76.9	33	255,114,206	8.5%	10.2%
Unidentified Facility Type	-	0	-	-	-
Selected PF_KINDs	72.1	65	-	0.0%	11.2%
All PF_KINDs	**68.4**	**468**			**4.1%**

Figure 1 is based on the selected PF_KIND sub-categories and visually shows the ratio of potential consumptive use to total withdrawals (and baseline water use). It should be noted that although consumptive use is calculated as 11.2% based on an annual average, peak month consumptive use (as calculated by this method) is in excess of 30%.

Figure 1. Potential consumptive use derived from monthly water use patterns.



A separate issue influencing consumptive use is to quantify how much of the return flow actually recharges groundwater. Wastewater that reaches the septic system may also be consumed by evapotranspiration (ET) from the drain field and is therefore not fully recharged. No estimates of ET from such sources were found in a review of the literature. In areas with a high percentage of failing septic systems, where backup and surfacing of the wastewater occurs the ET rate is likely to be higher.

Estimates of consumptive use based on literature or text book values are hard to find. One recent report on Estimated Ground-Water Availability[2] produced by the USGS for the DRBC used an estimated 10% consumptive use for residential ground-water withdrawals. A separate USGS report[1] noted that the consumptive use of water for domestic purposes in 1995 was estimated at about 26 percent of withdrawals.

In conclusion, an estimated consumptive use of 100% for residential withdrawals does not seem credible. Based on the assumptions utilized in this assessment, a consumptive use of approximately 10-20% seems more realistic. This estimate is based on a conservative estimate of consumptive use (i.e., one

[2] Sloto, R. A. and Buxton, D. E., 2006 , Estimated Ground-Water Availability in the Delaware River Basin, 1997-2000: U.S. Geological Survey Scientific Investigations Report 2006-5125

that assumes all use above a baseline amount is consumptive in nature) and an allowance for some ET from the drain field. The estimate is also in line with the published literature.

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