

BACKGROUND INFORMATION AND
RECOMMENDATIONS FOR EVALUATING
CONSUMPTIVE WATER USE

Water Resource Inventory Area 48
Twisp, Washington

Prepared for: Methow Watershed Council

Project No. 080180-002-01 • June 30, 2010





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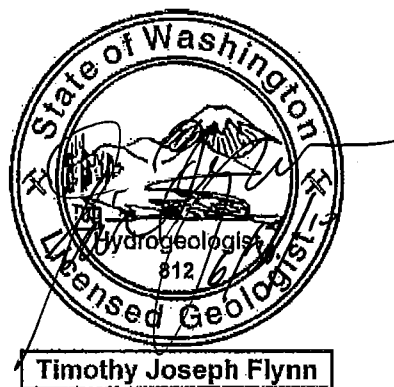
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Introduction

The Instream Flow Rule for the Methow River was established in 1976 and is documented in Chapter 173-548 of the Washington Administrative Code (WAC). The Instream Flow Rule (Rule) established a reservation of 2 cubic feet per second (cfs) of water in each of 7 reaches of the Methow River for future domestic and stock water uses. The 2 cfs reservation in each reach is expressed as a reduction in streamflow and represents an aggregate maximum instantaneous withdrawal.

Updating the estimates of total and consumptive use of water to quantify the unallocated portion of the reservation is a high priority issue identified in the *Methow Basin (WRIA 48) Watershed Plan* (Methow Basin Planning Unit, 2005) and the *Final Detailed Implementation Plan* (Methow Watershed Council, 2009). As part of Phase 4 (Watershed Plan Implementation) of the watershed planning process, the Methow Watershed Council (MWC) directed Aspect Consulting, LLC (Aspect) to provide recommendations for quantifying the consumptive use (total withdrawal minus return flow) of single domestic homes on permit exempt wells in the basin for tracking allocation against the established reserve. Aspect previously prepared the *Water Withdrawal Study Plan* (Aspect, 2009), which defines an approach to estimate total water withdrawals for indoor and outdoor uses for single domestic (residences) within the Water Resource Inventory Area (WRIA) 48.

This report provides information on the return flow recharge components of the water budget associated with single domestic use, to supplement the *Water Withdrawal Study Plan* (Aspect, 2009), and serve as a basis for determining consumptive water use.

Purpose

This report presents a methodology for quantifying consumptive water use of residences served by exempt wells in WRIA 48. The proposed quantification of consumptive use will rely on estimates of total indoor and outdoor water use to be developed under the *Water Withdrawal Study Plan* (Aspect, 2009), consumptive use percentages for indoor water use based on the information provided in this report, and consumptive use percentages for outdoor water use to be evaluated as part of the *Water Withdrawal Study Plan* (Aspect, 2009). The following sections present:

1. A review of available scientific studies of indoor consumptive use and on-site septic system (OSS) return flow and an evaluation of the applicability of these studies to quantifying water use in WRIA 48;
2. A summary of relevant domestic water use and return flow estimates used by the Washington State Department of Ecology (Ecology) in water-resource related policies and as part of instream flow rule making across the state; and

3. A recommended methodology for quantifying consumptive water use for purposes of tracking allocation of the 2 cfs reservation in WRIA 48.

Scientific Studies of OSS Return Flow

The majority of consumptive use in the Methow River Basin is likely associated with outdoor water use, primarily watering of lawns, gardens, and other vegetation. Although indoor water use is a relatively small percentage of annual water use, it is still a significant component of total domestic use. Given the rural nature of the Methow River Basin, most homes rely on OSS for wastewater disposal. As a result, estimating return flows from OSS is an important component of evaluating consumptive use from residences served by exempt wells.

Aspect conducted a literature search to identify scientific studies providing information regarding OSS return flow for domestic water use. These studies indicate consumptive use ranging from about 10% to 20% of water delivered for indoor uses. A brief summary of relevant research is provided below.

Consumptive Use of Water by Homes Utilizing Leach Fields for Sewage Disposal (Van Slyke and Simpson, 1974).

Based on estimates for in-house consumption and evaporation, this study conducted in the State of Colorado estimated that 8.4 percent (%) of the indoor water use within a home (assuming an average of four residents) is consumptively used. Based on a field investigation and consumptive use determinations using the Blaney-Criddle or similar methods for estimating evapotranspiration, the study found that during the growing season an additional 9.6% of the indoor water was consumed within the OSS drainfield. On an annual basis, this amounted to only 3.9%. An important assumption used in the study is that no outdoor watering occurred over the drainfield, consistent with a limitation on outdoor watering in this portion of Colorado.

Summing the in-house consumptive use and the drainfield evapotranspiration (ET) provides an average annual consumptive use of 12.3% with a maximum of 18% during the growing season. This study was conducted in Colorado, with a climate that is comparable to the Methow Valley. However, most people in the Methow Valley plant grass over their drainfield and water the grass during the summer months. This practice would significantly reduce ET of drainfield discharge.

Consumptive Use and Resulting Leach-Field Water Budget of a Mountain Residence (Stannard, et al., 2010).

This Colorado study measured ET above the drainfield at one house to estimate the amount of OSS return flow. Two different families lived in the house during the study. Actual evapotranspiration (AET) was measured on an intermittent basis using a plastic, hemisphere-shaped chamber that monitored humidity. Potential evapotranspiration (PET) was calculated using data from an on-site meteorological station. Then, the continuous

PET data was calibrated with the intermittent AET data to estimate continuous AET throughout the study period.

The consumptive use prior to discharge to the septic leach field was estimated to average 18.7% during the study. Although outdoor water use was prohibited, it is likely that much of the consumptive use was due to outdoor water use. Other possible losses include significant evaporation loss in the home and leakage in the pipe between the house and the septic tank.

The percent of water pumped to the home that was lost to ET from the drainfield was estimated to average 1.1% of annual water supply, but this value was believed to be low due to several factors:

1. Fill had been placed on much of the drainfield, thereby reducing the amount of ET.
2. A recurring leach field malfunction resulted in direct discharge to the surface.

The authors of this study estimate that a more typical leach field would have a higher ET on the order of 6.8% of annual water use.

Although the study results indicate a total consumptive use of 19.8% (18.7% prior to reaching the drainfield, 1.1% from increased ET), this estimate may overestimate the losses inside the house and underestimate the losses in the leach field. One important conclusion of this study is that the amount of ET from the leach field is closely related to the area of the leach field. In other words, discharge to a large drainfield will result in a higher percentage of ET than the same discharge to a smaller leach field. Consistent with Van Slyke and Simpson (1974), these estimates assumed no watering over the drainfield. This study did not provide peak consumptive use during the summer.

Return Flow to Ground Water from Onsite Wastewater Systems (McQuillan and Bassett, 2009).

In approving a water-rights permit for the diversion of groundwater in Roswell, New Mexico that included credit for return flow from OSS, the New Mexico State Engineer estimated that 50% of the water delivered to households in a public drinking-water system was discharged to the consumers' septic system leach fields. Presumably, the remaining 50% was lost to outdoor use and indoor consumptive use. Furthermore, the State Engineer estimated that 85% of the water discharged to the leach fields percolated through the vadose zone to the shallow aquifer and the remaining 15% was lost to ET. The basis for these estimates is not provided. Therefore, this assessment is not considered a scientific analysis but rather an example of what states have assumed for OSS return flow in the past.

Estimates of Ground-Water Recharge to the Yakima River Basin Aquifer System, Washington, for Predevelopment and Current Land-Use and Land-Cover Conditions (Vaccaro and Olsen, 2007).

Based on data from public water supply systems, this report estimates that 63% of water supply is used for indoor use and about 90% of indoor use is returned to the ground through OSS. The 90% return flow was based on consumptive use coefficients for

domestic use presented in Solley, et al. (1988 and 1993). The origin of the consumptive use coefficients for domestic water use in these references is not documented.

Consumptive Water-Use Coefficients for the Great Lakes Basin and Climatically Similar Areas (Shaffer and Runkle, 2007).

This report is a compilation of consumptive-use coefficients provided by others for the Great Lakes Basin and climatically similar areas. It does not include any new scientific data nor does it attempt to evaluate the validity of the data provided by others. Although they present a range of 10% to 15% consumptive use for domestic and public supply, it appears that this estimate includes both indoor and outdoor consumptive use.

Methods to Evaluate Influence of Onsite Septic Wastewater-Treatment Systems on Base Flow in Selected Watersheds in Gwinnett County, Georgia (Landers and Ankcorn, 2007).

This is a general analysis with no specific information on OSS return flow, although it does reference earlier publications of the work performed in Colorado (Stannard, et al., 2010).

Estimates of Domestic Water Use in Washington State

Estimates of domestic water use are available from a variety of sources and are summarized in Table 1. Most of the estimates combine indoor and outdoor use as a single value. The estimates are also primarily for average daily demand (ADD), which represents the average year-round use on a daily basis and does not reflect seasonal peak use. Exceptions are noted in the table.

These estimates provide context for decisions regarding water use within WRIA 48 and are discussed below.

Table 1 - Selected Water Use Estimates in Washington State

Estimated Use (gpd)	Region	Source
220-260 ADD	Methow	Town of Twisp data (Highlands Associates, 1993)
185 ADD (indoor)	Methow	Dept of HUD (Highlands Associates, 1993)
360 ADD	Nationwide	American Water Works Association (Highlands Associates, 1993)
403 ADD	Statewide	Washington Rural Water Association (Highlands Associates, 1993)
490-980 ADD	Spokane	Watershed Plan – WRIA 55/57
367 ADD	Waterville	Watershed Plan – WRIA 44/50
670 ADD	Mansfield	Watershed Plan – WRIA 44/50
900 ADD	Yakima	Watershed Plan – WRIA 37/38/39
380 ADD	Wenatchee	Watershed Plan – WRIA 45
950 MDD	Wenatchee	Watershed Plan – WRIA 45
700-900 ADD	Okanogan	Watershed Plan – WRIA 49
1,500 MDD	Eastern WA	WDOH Water System Design Manual (2009)
350 MDD	Statewide	WDOH WSDM statutory minimum for analogous system design
200 ADD	Statewide	WDOH WSDM minimum observed
175/350 ADD (consumptive with and w/o OSS)	Skagit River	Skagit River Management Rule – WRIA 3&4, WAC 173-503 (5/15/06)
250 growing season (consumptive, with OSS)	Quilcene–Snow	Water Management Rule – WRIA 17, WAC 173-517-160 (11/30/09)
13 (consumptive, indoor use only with OSS)	Quilcene–Snow	Water Management Rule – WRIA 17, WAC 173-517-160 (11/30/09)
240/800 (with and w/o OSS)	Grays-Elochoman	Proposed Water Management Rule – WRIA 25, WAC 173-525 (4/19/2010)
240/800 (with and w/o OSS)	Cowlitz	Proposed Water Management Rule – WRIA 26, WAC 173-526 (4/19/10)
240/800 (with and w/o OSS)	Lewis	Instream Flow Rule – WRIA 27, WAC 173-527 (12/19/08)
240/800 (with and w/o OSS)	Salmon Washougal	Instream Flow Rule – WRIA 28, WAC 173-528 (12/19/08)

ADD – Average daily demand

MDD – Maximum daily demand

WDOH – Washington Department of Health

Previous Estimates from WRIA 48, other Watershed Plans, and Department of Health

Highlands Associates (1993) provided a summary of several water use estimates, including an estimate of 220 gallons per day (gpd) to 260 gpd, based on Town of Twisp water use data. Other estimates provided by Highland Associates include an estimate for indoor water use of 185 gpd by the United States Department of Housing and Urban Development for the Methow, an estimate of 360 gpd (ADD) by the American Water Works Association for the entire nation, and an estimate of 403 gpd (ADD) by the Washington Rural Water Association for Washington State.

Water use estimates from watershed plans for WRIsAs in eastern Washington are also summarized in Table 1. These estimates of total water use range from 367 gpd to 980 gpd. All of these estimates represent total water use, combining indoor and outdoor uses as a single value. With the exception of the Wenatchee Watershed, these estimates are for ADD and generally did not account for seasonality or attempt to estimate peak water use. The Wenatchee Watershed Plan provides an ADD of 380 gpd and a MDD of 950 gpd.

Estimates of water use are also included in Ecology's rule making for water management and instream flows for a number of WRIsAs. As shown in Table 1, combined indoor and outdoor water use estimates range from 175 to 250 gpd assuming OSS. For residences with OSS, the Quilcene-Snow water management rule provides an indoor consumptive use of 13 gpd and a combined indoor and outdoor use of 250 gpd. WRIsAs 25 through 28 assume water usage of 240 gpd for residences with OSS and 800 gpd for residences without OSS. The reason for this large increase is not known. All of these estimates appear to reflect average daily use rather than peak water use.

The Washington Department of Health (DOH) provides estimates of water use, including a statewide ADD of 200 gpd, a statewide MDD of 350 gpd, and a MDD of 1,500 gpd for eastern Washington.

Water Use and Consumptive Use Factors Adopted in Rule

Administrative rules adopted for several watersheds in Washington State specify water use and/or consumptive use factors for either determining mitigation requirements or managing reservations similar to the reservation in the Methow Rule. The following briefly summarizes relevant information in these rules.

Upper Kittitas Ground Water Rule: Under an emergency rule, all new groundwater appropriations in Upper Kittitas County, including exempt wells, require mitigation of consumptive use impacts to the Yakima River. The current emergency rule (WAC 173-539A, dated 3/23/10) specifies the following factors for determining consumptive use:

“Consumptive use will be calculated using the following assumptions: Thirty percent (30%) of domestic in-house use on a septic system is consumptively used; ninety percent (90%) of outdoor use is consumptively used; twenty percent (20%) of domestic in-house use treated through a wastewater treatment plant which discharges to surface water is consumptively used.”

The basis for these assumptions is not provided. No assumptions for total indoor or outdoor water use are specified in the rule.

Dungeness River Basin: A draft rule is under development for the Dungeness River Basin (WRIA 18) in Clallam County. This rule would establish a surface water reservation for future domestic uses, similar to the Methow Rule. The draft proposed rule (WAC 173-518-080, dated 11/24/09) specifies the following factor for determining consumptive use:

“For water users using individual and community on-site septic systems, ten percent of the indoor water used is assumed to be consumptive and will be added to the cumulative impact amounts for each subbasin impacted.”

The basis for this assumption is not provided and no estimate of total indoor or outdoor water use is provided.

Quilcene Snow Watershed: The instream flow rule (WAC 173-517) for the Quilcene-Snow watershed (WRIA 17) in Jefferson and Clallam Counties establishes a surface water reservation to serve future exempt well uses. For permit-exempt domestic uses, the instream flow rule specifies a consumptive use of 250 gpd per single domestic use including outdoor uses be debited to the reservation. Where use is limited to indoor use only, the reservation is debited 13 gpd per single domestic use. Ecology provides the basis for the consumptive water use assumption of 10% of indoor use and 90% of outdoor water use in the *Final Cost Benefit, Maximum Net Benefit, and Least Burdensome Analyses* (Ecology, 2009):

“In the absence of any published value, an average irrigation season withdrawal rate of 400 gpd was assumed. In order to estimate the percentage of that 400 gpd that does not return to the groundwater system after domestic use, the following assumptions were made:

- Assuming 60 gpd use per person and 2.21 people per household, there will be about 133 gpd indoor use per household.
- During the growing season, the average use per household assumes 133 gpd indoor use and 267 gpd outdoor use.
- Consumptive growing season use associated with indoor use will be 10% of 133 gpd or about 13 gpd.
- Consumptive growing season use associated with outdoor use will be 90% of 267 gpd or about 240 gpd.”

The 60 gpd per person estimate comes from an American Water Works Association Research Foundation study (Mayer, et al., 1999), which physically measured indoor water use in 100 single-family homes (selected to be statistically representative of all single family homes) in 12 municipal areas including Seattle. Based on those data, average total indoor per capita water use was estimated to be 72.5 gpd, although Seattle had an average use of 57.1 gpd. The Seattle data was considered more representative of

usage with a moderate amount of water conservation and a value of 60 gpd per person was used for the Quilcene-Snow analysis.

Entiat River Basin: The instream flow rule (WAC 173-546) for the Entiat River Basin (WRIA 46) establishes a surface water reservation for future beneficial uses. The rule specifies per capita indoor consumptive water use of 35 gpd. This estimate is based on an analysis provided in the water management plan for WRIA 46 (Chelan County Conservation District, 2004). This analysis used the difference between supplied public water and treated water for the City of Entiat to estimate consumptive use. The winter average consumptive use, which is assumed to represent primarily indoor use, was 35 gpd per person. The average July/August consumptive usage was 98 gpd per person with the additional 63 gpd assumed to represent primarily outdoor use.

Lower and Upper Skagit River Basin: The instream flow rule (WAC 173-546) for the Skagit River Basin (WRIs 1 and 2) establishes a surface water reservation for future beneficial uses. The rule specifies a 350 gpd debit to the reservation for each domestic well or residential service connection in a group domestic water system. For water users using individual and community on-site septic systems, 50% of the water used will be credited to the reservations for recharge from on-site septic systems. These values combine indoor and outdoor water uses and return flows.

Methodology for Quantifying Consumptive Use

The recommended methodology for quantifying consumptive use will rely on results of work to be completed under the *Water Withdrawal Study Plan* (Aspect, 2009) and a consumptive use factor for indoor water use based on the information summarized above. Based on the review of scientific literature, approximately 10% to 20% of water delivered for indoor uses is lost in-house and through increased ET from the OSS drainfield. The upper end of the range is representative of the growing season (with higher ET); however, these values derive from studies in the State of Colorado and assume no watering or irrigation on the OSS drainfield. Typical water use in the Methow Basin does include outdoor watering of landscaping which in many cases includes areas used for the OSS drain field. Consequently, we recommend using the middle of this range, or a consumptive use factor of 15% (i.e., return flow of 85% of indoor domestic use) as representative of conditions in WRIA 48.

The *Water Withdrawal Study Plan* (Aspect, 2009) includes compiling and evaluating residential water use data from analogous public water systems that are representative of residences served by exempt wells in WRIA 48. As discussed in the study plan, indoor water use will be estimated based on water use during the winter, when outdoor uses are expected to be minimal. The consumptive portion of indoor use will be calculated by multiplying the estimated total indoor use by the 15% consumptive use factor.

Outdoor use will be estimated based on the difference between total use during the summer and the estimated indoor use. Estimated outdoor water use will be further confirmed by using aerial photographs to identify the irrigated area on representative

parcels served by exempt wells and calculating the total water use associated with irrigating that area. The consumptive portion of outdoor water use will be estimated on a monthly basis based on irrigation requirements for a reference crop (e.g., pasture or turf), typical irrigation efficiencies, and the estimated total outdoor use.

The month with the highest consumptive use is of primary interest for the purposes of evaluating potential debits to the surface water reservations. The peak month of consumptive use for residences served by exempt wells in WRIA 48 will be estimated by adding the indoor consumptive use and the peak month of outdoor consumptive use values.

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Limitations

Work for this project was performed and this report prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of Methow Watershed Council for specific application to the referenced property. This report does not represent a legal opinion. No other warranty, expressed or implied, is made.