5 Hydrology and Water Use

5.1 Introduction

The Hydrology / Water Use assessment consists of several separate sections. Flood History is discussed in section 5.2. Land use effects on peak and low flows (section 5.3) form the bulk of the discussions, and rely on new data and analyses completed as part of this assessment. Water use is discussed in section 5.4 – DHSVM Future Modeling of the report, and is largely summarized from the *Wilson River Watershed Assessment* (E&S Environmental Chemistry, Inc. 2001), with supplemental data (where appropriate) from the Oregon Department of Water Resources (OWRD). Methodologies are discussed within each subsection. Note: Land Use is usually presented in this portion of the analysis when following the OWEB protocol, however, in this assessment land use is presented in sections 3.3.1, 3.3.2 and 3.5.1, above.

5.2 Flood History

5.2.1 Methods

The flood history of the Wilson River watershed is based on long term records available for a single USGS stream gage (#14301500, Wilson River near Tillamook), located within the Lower Wilson River subwatershed. Flood history at the gage is summarized in Figure 1 and Table 6 located in section 3.4.2 of this report. The purpose for assessing the flood history was to evaluate temporal trends in annual peak flows at the Wilson River stream gage. Trends were investigated in the residual variation after accounting for the influence of precipitation.

Regression analysis was used to examine the relative significance of precipitation on stream flow, following which time trends were evaluated in the residual variation. The residual variation was plotted against time to determine if there was a time trend in the unexplained variation. Kendall's rank-order correlation (Kendall and Gibbons 1990) was used to test for trends over time in the residual variation. Kendall's test is a non-parametric method of determining an increasing or decreasing trend in a paired data set. Values of the trend coefficient range from –1.0, which indicates a perfect inverse correlation, to 1.0, which indicates a perfect positive correlation. For this analysis, significance was defined at the $p < 0.05$ level.

Precipitation records from the Seaside climate station[24] were used for this portion of the analysis. The Seaside station was chosen because it was the only climate station in the vicinity of the watershed whose period of record coincides with the period of record for the Wilson River gage. The Seaside station is located approximately 33 miles NNW of the center of the watershed. Missing values in the Seaside record were estimated from records from the Tillamook 1W and Newport climate stations using regression analysis.

The effect of precipitation on annual peak flow was evaluated using an antecedent wetness index as the precipitation variable. The antecedent wetness index was derived using daily precipitation values from the Seaside climate station following the approach used by Lewis and others (2001). The underlying assumption of the antecedent wetness index is that precipitation occurring prior to time "t" influences the runoff efficiency at time "t", and that this influence decays over time. Put another way, the runoff associated with today's precipitation will be strongly influenced by yesterday's precipitation, slightly less by precipitation from the day before yesterday, and so on. The antecedent wetness index was calculated as follows:

$$\mathbf{W_i = C*W_{i-1} + P_i}$$

Where: C = wetness constant
W_i = antecedent wetness index on day i (inches)
W_{i-1} = antecedent wetness index on day i-1 (inches)
P_i = precipitation on day i (inches)

The value of the wetness constant is the value that satisfies the relationship $C^{half\text{-}life} = 0.5$, where half-life is in days. The value of C used was arrived at iteratively by trying several values for C, and finding the value that gave the best solution (i.e., highest r^2 value) for the equation:

$$\mathbf{Q_p = f(W_i)}$$

Where: Q_p = Annual peak flow
W_i = Wetness index on day of the peak flow

A final C value of 0.7000 was chosen, which resulted in a half-life of approximately 2 days, which makes intuitive sense for a watershed of the size and location of the area upstream of the Wilson River stream gage.

Additionally, we qualitatively evaluated how the effects of major storms of the past ten years impacted the various subwatersheds of the Wilson River by

[24] http://www.ocs.oregonstate.edu/page_links/climate_data_zones/daily_precip/precip_filesz1.html

evaluating changes in channel area for eight reference stream reaches. The eight reaches were located at or near the downstream end of each subwatershed, and were ½ mile in length[25]. All reaches were in areas mapped as low-gradient with valley widths five or more times wider than active channel widths. Channel areas in the reference reaches was measured on aerial photos taken during summer 1994. The 1994 values were used as the reference for comparison with later years. Ideally, a reference condition from the 1950's would have been used, as this would have represented a period of relative quiet with respect to large flood events (Figure 1). However, the 1994 photos were the earliest geo-referenced photos available for the project area. Furthermore, the 1994 photos represent conditions prior to the large flood events of 2/8/1996, and 12/27/1998 (Figure 1). Active channel area was measured on photos taken in Summer 2000, and Fall 2005.

5.2.2 Results

The relationship between annual peak flow and wetness index at the Wilson River stream gage is shown in Figure 3. Residual variability in the relationship is plotted over time in Figure 4. No statistical trend was detected in the residual variability ($p = 0.0842$). Based on these results there is no statistical time-related trend in peak flow magnitude at the Wilson River stream gage.

[25] With the exception of the reach along the Wilson River in the Lower Wilson subwatershed, which was located upstream of the confluence with the Little North Fork, and was one mile in length.

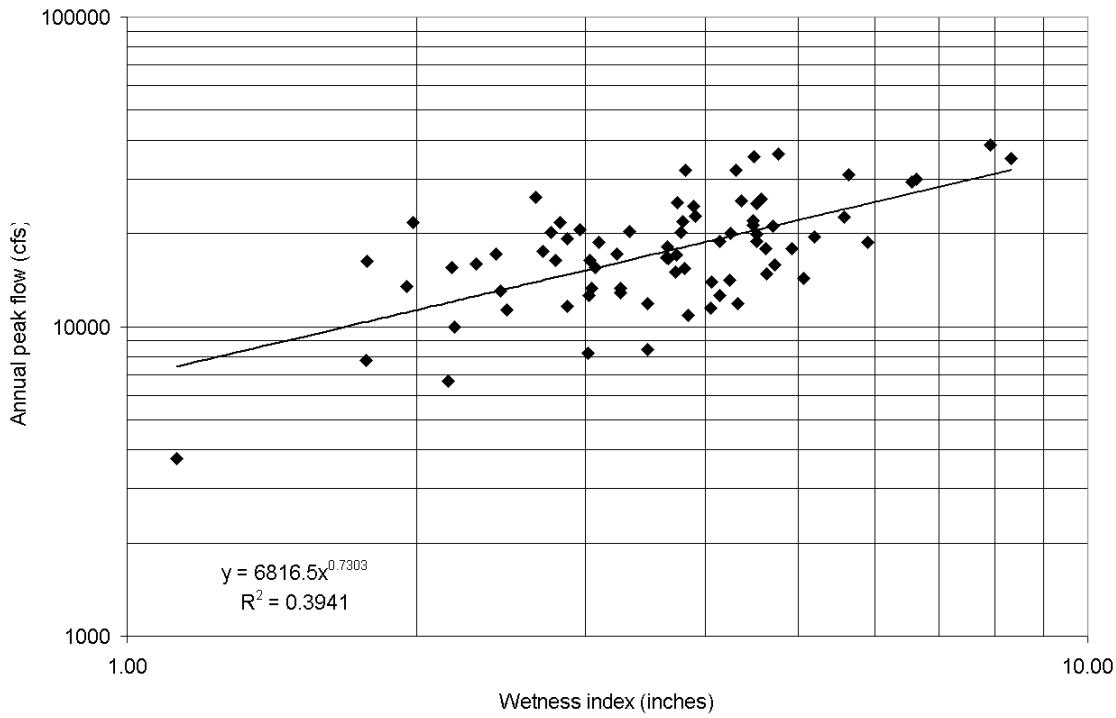

Figure 3. Relationship between annual peak flow and wetness index at the Wilson River stream gage.

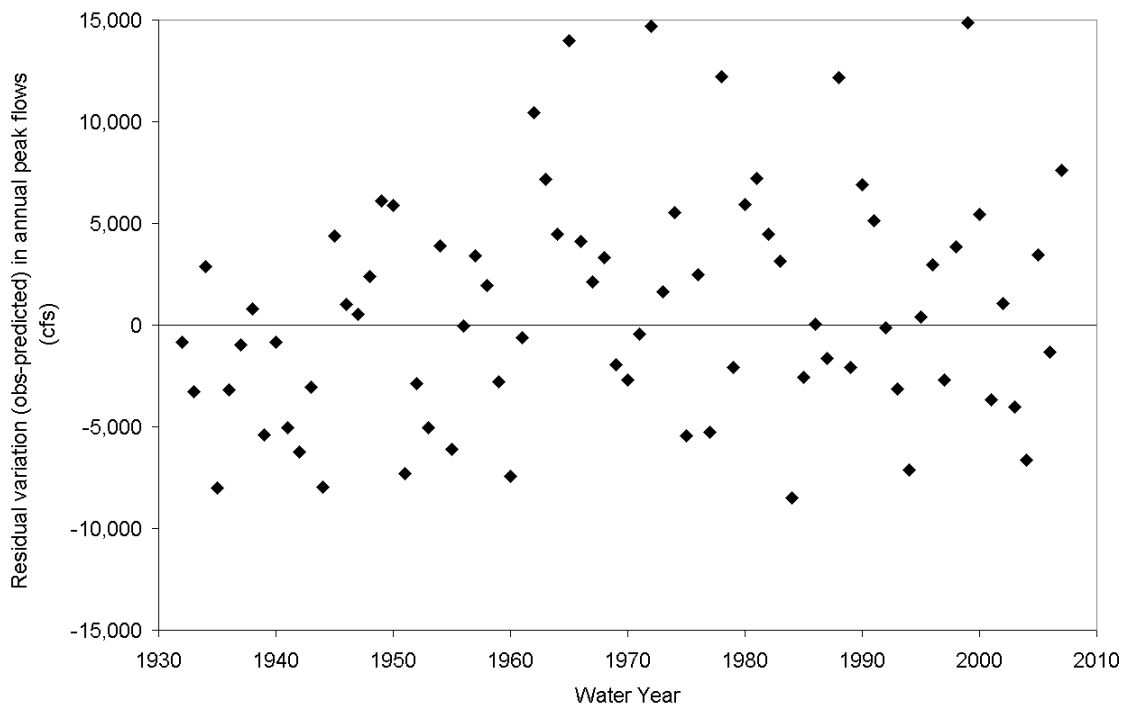

Figure 4. Residual variability in the relationship between annual peak flow and wetness index at the Wilson River stream gage.

We would expect that a long-term trend in channel narrowing is occurring in the Wilson River mainstem, as the channel recovers from past log drives. However, this is not visible over the eleven year period represented by this assessment. The ratio of active channel area in 2000 and 2005 to area in 1996 are shown in Figure 5. Higher-elevation subwatersheds (Jordan Creek, Devils Lake Fork, Upper Wilson/Cedar Creek, and North Fork Wilson) showed the greatest relative channel widening in the 1994 to 2000 period, while the lower elevation showed relatively minor changes (Figure 5). Widening in reference reaches over the 1994-2000 period was probably a result of the 1996 flooding. Annual peak flows were relatively small in the period from 2000 to 2005 (Figure 1), and most reference reaches showed a decrease in width over this period, or remained relatively constant. The Little North Fork stands out as an exception in that it increased dramatically in area from 2000 to 2005. Increases in channel width in the North Fork Wilson reference reach may be due to elevated sediment inputs due to mass wasting or other disturbances.

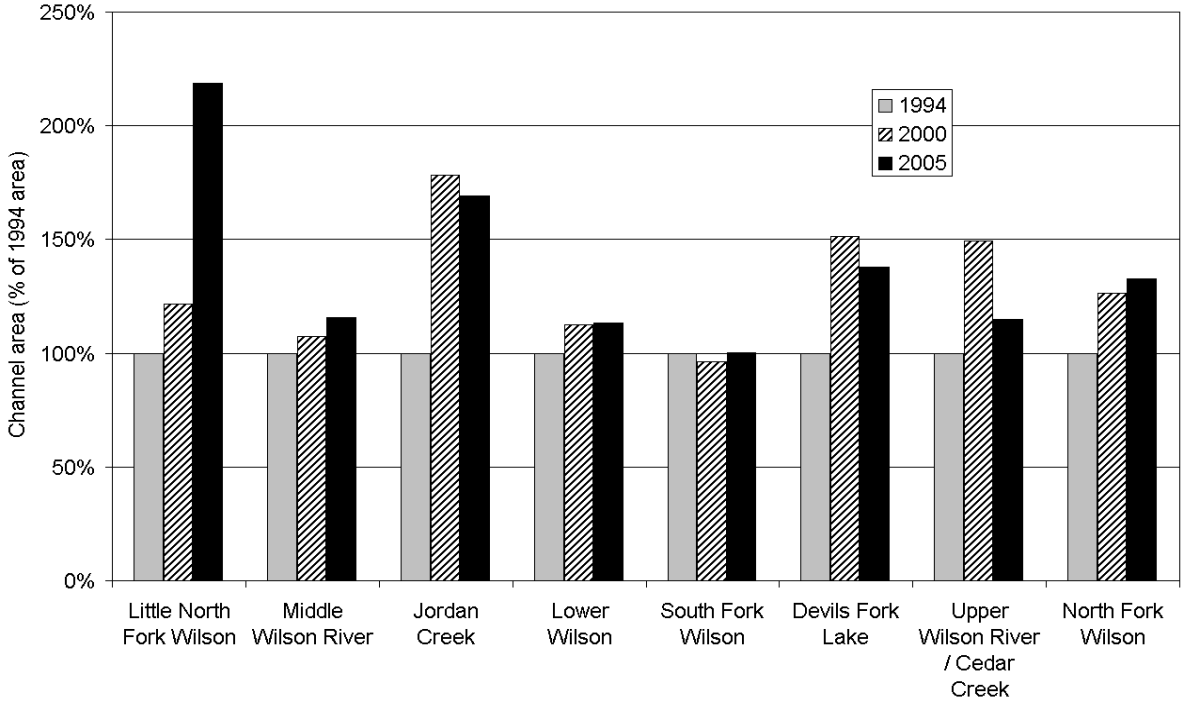

Figure 5. Change in channel area in reference reaches. As measured from 1994, 2000, and 2005 aerial photographs. Changes are relative to the 1994 condition.

5.3 Land Use Effects on Peak and Low Flows

5.3.1 Overview

The Distributed Hydrology Soil Vegetation Model[26] (DHSVM) was developed to evaluate the effects of topography and vegetation on water movement through a watershed (Wigmosta et al. 1994). Spatially distributed models such as DHSVM provide a dynamic representation of the spatial distribution of soil moisture, snow cover, evapotranspiration, and runoff production, at the scale of digital elevation model (DEM) pixel (Figure 6). DHSVM has been used to assess changes in flood peaks due to enhanced rain-on-snow and spring radiation melt response (e.g., Thyer et al. 2004), effects of forest roads and road drainage (e.g., Lamarche and Lettenmaier 2001), and the prediction of sediment erosion and transport (Doten and Lettenmaier 2004).

5.3.2 Methods

We used the DHSVM model to assess management- and wildfire-related impacts on stream flows at the outlets of the eight sixth-field subwatersheds within the Wilson River watershed. In addition, flows at the outlets of ten randomly selected small catchments were also evaluated. For the purpose of this assessment, however, the portion of the Lower Wilson subwatershed below the confluence of the Little North Fork Wilson River was not included (Figure 7) because the topographic relief was too low to accurately capture the location in the mainstem Wilson River with the DEM used[27]. This area that was omitted is approximately 10 mi^2 in size and represents ~5% of the entire assessment area. The assessment area includes USGS stream gage #14301500, the Wilson River near Tillamook, OR (drainage area = 161 mi^2; period of continuous record = 1931-present; Figure 7).

The DHSVM was first constructed for current conditions (i.e., current vegetation and current road network), and calibrated using the Wilson River stream gage record. We then evaluated management-related impacts on stream flows by selectively removing each management impact (e.g., replacing areas currently occupied by roads and harvest units with the potential land cover appropriate for the area), and re-running the model. Results from these allowed us to compare peak flow magnitudes for selected storm events under four scenarios:

- Current conditions (i.e., existing vegetation and road conditions)

[26] An overview of the DHSVM model, source code, and details of the model application, can be found at http://www.hydro.washington.edu/SurfaceWaterGroup/Models/DHSVM/index.shtml
[27] The digital elevation model used is discussed further in subsequent sections.

- Current vegetation conditions with road effects removed
- Potential vegetation conditions (no management) and no roads
- Post wildfire (1939 and 1945 fires)

The DHSVM model requires several types of spatial and temporal data inputs. Detailed discussions on how the spatial and temporal data were derived can be found in Appendix E – Detailed Methodologies.

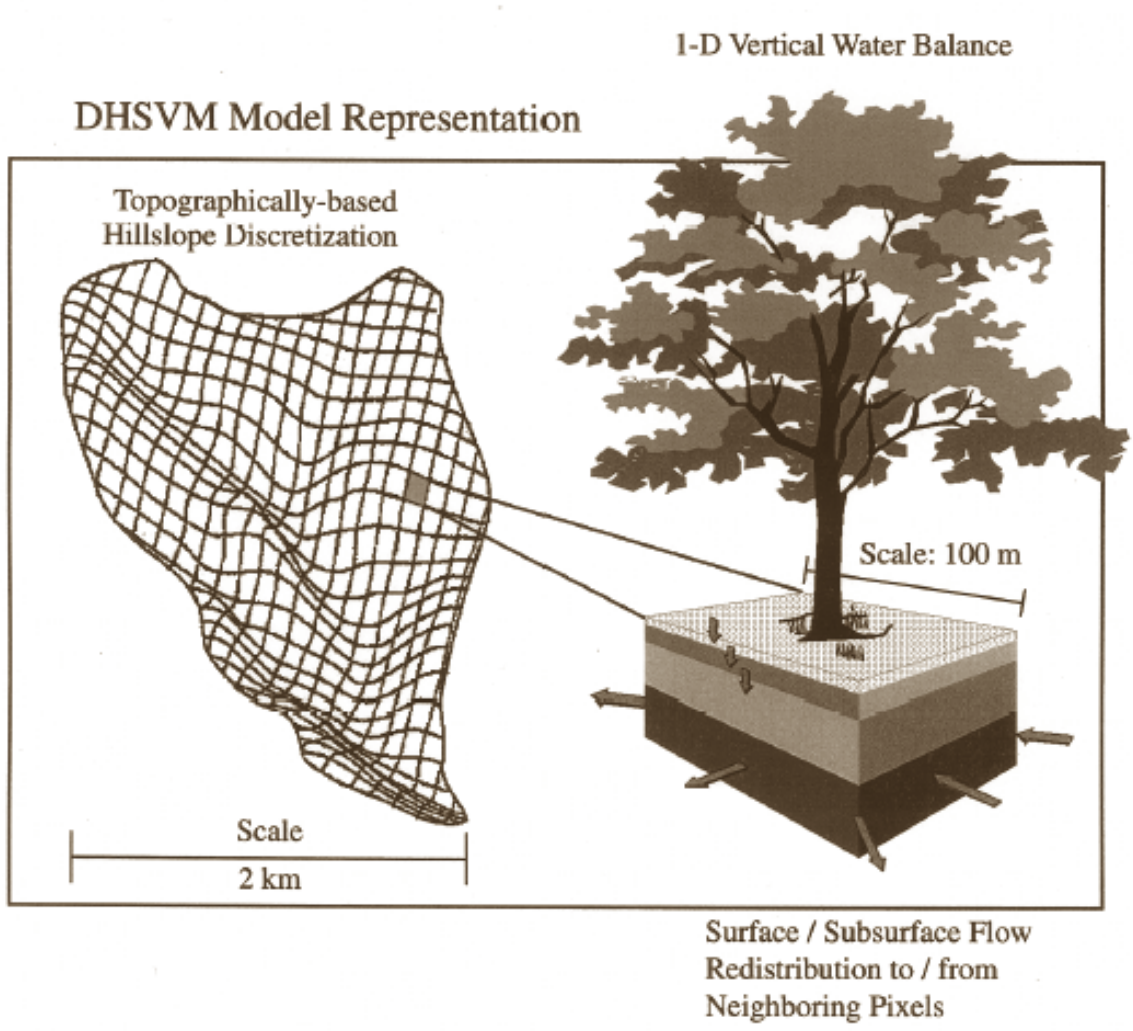

Figure 6. Schematic of the DHSVM model. Model representation of watershed soil, vegetation and topography as discrete pixels (from Vanshaar and Lettenmaier 2001).

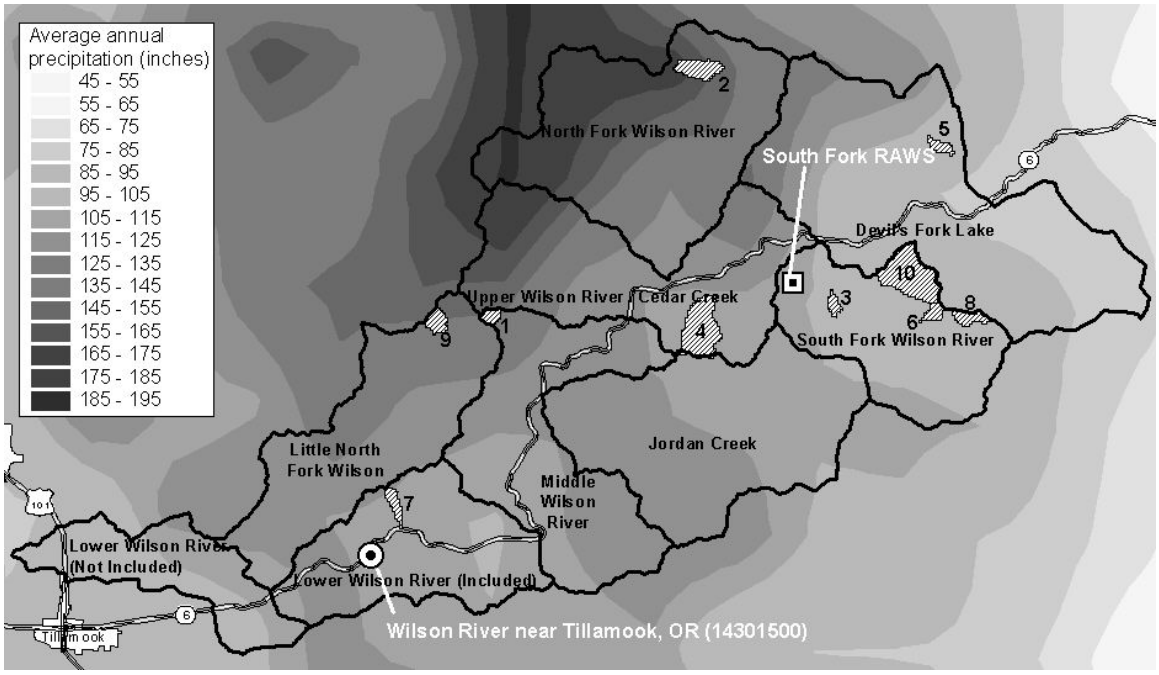

Figure 7. Ten randomly selected small catchments (cross-hatched), the South Fork RAWS climate station, USGS stream gage 14301500 (Wilson River near Tillamook), and average annual precipitation[28].

5.3.3 Results

The DHSVM model was run using data for the period 10/1/2004 to 5/1/2007[29]; the longest continuous time period with available climate data. Results were evaluated by comparing the fifteen largest peak flow events[30] over the modeling period across the range of modeled scenarios. The potential vegetation model that did NOT include roads was used as the baseline model against which all other model iterations were compared.

The fifteen events chosen for analysis all occurred within one or two days of each other at the outlets of the eight sixth-field subwatersheds, and within 5 days of each across all analysis locations (i.e., at the outlet of each subwatershed, at the

[28] http://www.ocs.oregonstate.edu/prism/state_products/maps.phtml?id=West

[29] The climate record used was applied to all modeling scenarios. Given that our question is how will the watersheds respond to the same climatic conditions given varying vegetation, roads, and soil conditions. It does not matter from what time period the climatic data is from, as long as it is representative of conditions experienced in the watershed.

[30] This was the largest number of independent events that could be extracted from the modeled period. Each event was separated from the next by a minimum of two weeks.

gage location, and at the outlets of the ten small subwatersheds; Figure 7). At the gage location modeled peak flows were all within one or two days of observed events. The corresponding observed peak flows at the gage location were equivalent in magnitude to an annual recurrence interval of 2 years or less for twelve of the events, between 2 and 5 years for two of the events, and approximately a 100-year recurrence interval for one event (i.e., the November 2006 event). A summary of results for all analysis locations are provided in Table 9, and output for all fifteen storms at each location are provided in Appendix I, DHSVM Peak Flow Output.

Table 9. Summary of DHSVM results. Values are averages for fifteen storm events (values in parentheses represent the range of observations). Refer to Figure 7 for analysis locations. Refer to Appendix I – DHSVM Peak Flow **Output** for full results.

	Location	% Δ due to vegetation changes	% Δ due to vegetation & roads	% Δ due to historic fires
	USGS Gage	0.2% (-0.4% to 1.2%)	0.3% (-0.4% to 1.3%)	-0.9% (-10.8% to 6.6%)
6th-field HUCs	Devils Lake Fork	0.1% (-0.1% to 0.7%)	0.0% (-0.2% to 0.7%)	-1.4% (-11.5% to 4.6%)
	South Fork Wilson	0.1% (0.% to 0.7%)	0.0% (-0.1% to 0.5%)	-2.2% (-14.7% to 4.2%)
	North Fork Wilson	0.1% (-0.5% to 0.8%)	0.1% (-0.5% to 0.8%)	-1.6% (-10.3% to 3.6%)
	Upper Wilson/Cedar Creek	0.1% (-0.3% to 1.%)	0.2% (-0.3% to 1.1%)	-1.3% (-10.8% to 5.1%)
	Jordan Creek	0.2% (-0.5% to 1.3%)	0.3% (-0.4% to 1.4%)	-0.9% (-11.4% to 7.6%)
	Middle Wilson	0.2% (-0.4% to 1.1%)	0.2% (-0.4% to 1.1%)	-1.% (-10.9% to 5.7%)
	Little NF Wilson	0.9% (0.1% to 5.6%)	1.1% (0.1% to 6.%)	6.3% (-2.7% to 40.3%)
	Lower Wilson Below Little NF	0.2% (-0.4% to 1.2%)	0.3% (-0.3% to 1.3%)	-0.8% (-10.5% to 7.2%)
Small catchments	Small Shed 01	0.3% (-0.1% to 1.3%)	0.3% (0.% to 1.3%)	-0.2% (-8.7% to 5.7%)
	Small Shed 02	0.0% (0.% to 0.%)	0.0% (0.% to 0.%)	-3.5% (-9.% to 0.9%)
	Small Shed 03	0.3% (-0.4% to 2.2%)	0.3% (-0.3% to 2.2%)	1.4% (-27.3% to 11.3%)
	Small Shed 04	0.6% (-0.4% to 3.%)	0.3% (-0.7% to 3.2%)	6.3% (-3.1% to 44.2%)
	Small Shed 05	0.1% (-0.1% to 0.9%)	0.1% (-0.1% to 1.%)	-2.1% (-11.1% to 2.2%)
	Small Shed 06	0.2% (-0.7% to 2.2%)	1.0% (-0.2% to 3.6%)	-1.0% (-11.5% to 8.6%)
	Small Shed 07	0.5% (-0.3% to 2.6%)	0.5% (-0.3% to 2.6%)	4.7% (-2.9% to 16.5%)
	Small Shed 08	0.2% (-0.2% to 2.2%)	0.2% (-0.2% to 2.2%)	-1.1% (-10.% to 7.6%)
	Small Shed 09	0.1% (0.% to 1.3%)	0.2% (0.% to 1.4%)	2.6% (-3.1% to 11.%)
	Small Shed 10	0.2% (-0.1% to 0.7%)	-1.6% (-2.1% to -0.1%)	1.0% (-11.7% to 8.9%)

Neither changes in vegetation or roads appear to have a significant effect on modeled changes in peak flows at the outlets of any of the eight 6th-field subwatersheds, or the ten small catchments. Modeled changes for individual storm events ranged from -0.5% to 5.6%, with an average value of 0.2%, due to differences in vegetation conditions alone. Modeled changes due to vegetation and roads combined ranged from -0.5% to 6.0% for individual storm events, with an overall average value of 0.3%. The largest changes in peak flow magnitude were in the mainstem Wilson below the confluence of the Little North Fork, where modeled peak flow increases due to vegetation changes alone were 140 cfs during one storm, and 150 cfs for the current condition scenario (i.e., current vegetation and roads). These modeled changes were associated with the tenth largest event out of the 15 storm events that were analyzed.

Results for the post-fire modeling scenario indicate a wide range of variation across the 15 modeled storm events. Modeled changes for individual events ranged from a 15% decrease in peak flow magnitudes to a 40% increase. In terms of the absolute magnitude of modeled change, the largest decrease in peak magnitude was 1,699 cfs at the outlet of the Middle Wilson subwatershed (6th-largest event out of the 15), which equated to a 10.9% decrease in the size of the peak. The largest increase was 767 cfs in the mainstem Wilson below the confluence of the Little North Fork Wilson (10th ranked event out of 15), which represented a 6.8% increase in the size of the peak.

Total modeled volume of discharge at the USGS gage location is given in Table 10. The total volume for the baseline condition were compared to the other three modeling scenarios. The post-fire scenario showed a large increase (6.4%) associated with the loss of forest cover, and reduced evapotranspiration losses.

Table 10. Modeled increases in total volume of discharge over the modeling period (10/1/2004 to 5/1/2007) at the USGS gage location on the Wilson River.

Scenario	Modeled discharge (cubic feet) over modeling period	Percent increase over baseline
[Baseline] Historic vegetation, no roads	1.06E+11	-
Current vegetation, no roads	1.07E+11	1.3%
Current vegetation, current roads	1.08E+11	0.7%
Post fire	1.15E+11	6.4%

Mean low flow values for the month of August are given in Table 11. As with peak flows the modeled flows for the lowest-flow month of the year appear to be

little affected by current vegetation conditions or roads. Minor increases are probably due to lower modeled ET losses from existing vegetation as compared to the potential future condition, and the lack of ET losses in roaded areas. Many of the smaller drainages show large percent increases (e.g., the Little North Fork); however, the magnitude of change is very small (hundredths of a cfs).

Table 11. Modeled mean monthly flows for the month of August. Values are given by subwatershed.

Location	[Baseline] Historic vegetation - no roads	Current vegetation - no roads	Current vegetation - current roads	Post fire	% Δ due to vegetation changes	% Δ due to vegetation & roads	% Δ due to fire
Devils Lk Fk	43	46	46	59	5.0%	5.5%	35.5%
Jordan Ck	17	18	18	24	2.9%	3.9%	35.9%
Little N Fk Wilson	0.006	0.006	0.011	0.021	9.6%	81.4%	260.2%
Lower Wilson below Little N Fk	101	105	106	131	3.7%	4.5%	28.8%
Middle Wilson	98	102	103	126	3.7%	4.5%	28.8%
N Fk Wilson	33	33	34	38	2.5%	3.4%	16.8%
S Fk Wilson	15	17	17	24	7.3%	8.1%	55.5%
Upper Wilson/Cedar Ck	78	81	82	99	4.0%	4.6%	27.2%
USGS Gage	100	104	105	129	3.7%	4.5%	28.7%
Small Shed 01	0.0002	0.0003	0.0003	0.0004	11.3%	11.3%	73.8%
Small Shed 02	1.8217	1.8217	1.8217	2.5692	0.0%	0.0%	41.0%
Small Shed 03	0.0001	0.0001	0.0002	0.0003	7.1%	50.4%	145.4%
Small Shed 04	0.0005	0.0005	0.0007	0.0017	9.0%	44.4%	242.7%
Small Shed 05	0.1083	0.1219	0.1299	0.0562	12.6%	20.0%	-48.1%
Small Shed 06	0.0003	0.0003	0.0005	0.0006	6.7%	50.2%	97.8%
Small Shed 07	0.0001	0.0001	0.0001	0.0002	11.8%	11.8%	205.7%
Small Shed 08	0.0005	0.0005	0.0007	0.0008	4.2%	43.7%	57.6%
Small Shed 09	0.0002	0.0002	0.0012	0.0004	4.0%	524.9%	124.6%
Small Shed 10	0.0019	0.0020	0.0029	0.0040	7.2%	54.9%	111.4%

5.4 DHSVM Future Modeling

The current vegetation types and stand-level field data were used to model the future, reference, or *desired* conditions within the watershed. The primary

watershed-scale categorical basis in assessing the potential future conditions was the *structural range of variability*, or the SRV.

5.4.1 Structural Range of Variability

As part of the evolution of the *desired future condition* (DFC) for riparian zones, a series of watershed-level conditions were developed for the Elliot State Forest Habitat Conservation Plan (HCP; refer to Appendix J – Desired Future Conditions) that included a range of stand structures that provide structural diversity and continuity for achieving *ecosystem services* for the aquatic system. Specifically, these ranges of structures were presented in terms of *early, intermediate and advanced* structures.

Structural classifications for this assessment were made on the basis of the FPS size class determinations (1-5; refer to Appendix G – Current and Potential Future DHSVM Vegetation Types) found in the photo-interpreted riparian coverages for ODF lands and the watershed as a whole. These structural classes included the following diameter ranges:

- **Early Structure.** Representing size classes 1 and 2, or where the largest 40 trees (L40) had a mean diameter of <14 inches DBH.
- **Intermediate Structure.** Includes size class 3, with an L40 size range of 14 – 20 inches DBH.
- **Advanced Structure.** Includes size classes 4 and 5, where L40 exceeds 20 inches DBH.

The range of structural conditions, expressed as a percentage of land area, is referred to here as the "*Structural Range of Variability*" (SRV) to describe the current and desired ranges of stand structures on the landscape. These ranges and the current structural distribution are presented in Table 12 and Map 21.

Table 12. Current and Desired Structural Distribution. The acres and percentage of riparian zone acres on ODF and the watershed as a whole exhibiting each broad-scale structural characteristics. Target ranges are also presented.

SRV	Structural Description	Desired Range	ODF Acres	% ODF Lands	Watershed Acres	% Watershed
ES	Early Structure	5 - 15%	7,062	73%	8,738	67%
IS	Intermediate Structure	15 - 45%	2,356	24%	3,351	26%
AS	Advanced Structure	45 - 70%	45	<1%	90	1%
NF	Non-Forest	Non-forested	241	2%	859	7%
	Total		**9,704**		**13,037**	

As was the case with stand composition, the structural trends of the riparian zones do not differ markedly between ODF managed lands and the distribution of the watershed as a whole. In both cases, the riparian zones are dominated by early forest structures (73% and 67%, Table 12) that are well outside the desired range (5 - 15%).

Stand metrics data were examined to evaluate if there are ranges of measurable benchmarks (i.e., basal area, large trees, etc.) that could be developed for determining the transitioning of early and intermediate to advanced structure in the Wilson watershed. Because the majority of the land area is within size classes 2 and 3 (early/intermediate structure[31]), and the stand metrics data were collected to capture current conditions, the available stand metrics reflect the variable range of early stand structure. In addition, there are few advanced structure areas (45 acres) available in the watershed to calibrate and validate against growth modeling using FPS.

Stands in current early, intermediate and advanced structures were assigned a potential *future* classification based upon the logical growth patterns of the dominant and co-dominant species. Specifically, data within the growth-modeled stand metrics dataset were used to evaluate the potential trajectories of vegetation types. For example, stands in a current (early structure) condition of mixed conifer, early seral (L40 DBH 8-14 inches) would progress to an advanced stage structure (L40 DBH, 20-30 inches) over the course of the ~100 year model period.

The current condition of riparian stands (ODF and watershed-level) was analyzed to create a "target distribution", following the SRV proportions of early, intermediate and advanced structural types. This was done by creating a random matrix of stands and reclassifying structural types based upon the likely shift in L40 size over time. Target acres were set to "grow" the early stages to intermediate structures, and intermediate structures to advanced structures following the distribution described in the Elliot HCP (Table 12). Stands were selected at random to provide a landscape-level view (at the watershed- and ODF-scales) for a potential future distribution of structures. This method allowed for a coarse-scale view to alter FPS codes on the basis of size only, and not composition. For example, this assumes a selected HX2H coded stand would eventually become a HX3H or HX4H and would assume attributes of changing heights and diameter classes. This second set of "target distribution" conditions ("future conditions") was applied to all riparian stands, and this set provides the

[31] No statistical differences were found between size class 2 and 3 from the field data. This is likely due to the 14 inch diameter cutoff between the classifications; the QMD values for all sampled stands was within 1-2 inches of the 14 inch diameter cutoff.

basis for comparison with DHSVM modeling (as discussed in section 5.3 and Appendix E), and stream shading (as discussed in section 8.4), and other landscape-level analyses.

5.5 Water Uses

5.5.1 Methods

Information from the 2001 Wilson River Watershed Assessment (E&S Environmental Chemistry 2001) was used to answer the general questions about water use in the Wilson River watershed. Current Oregon Water Resources Department (OWRD) records were reviewed, and changes from the 2001 assessment are noted. Additional analysis on the effects of consumptive water uses on water availability is discussed at the end of this section.

5.5.2 Results

5.5.2.1 Beneficial Uses

A review of water rights records from the OWRD[32] indicate that only four new water rights have been applied for in the Wilson River watershed since publication of the 2001 Wilson River Watershed Assessment. Three are for manufacturing-related use of water, and the fourth (from a well) is for irrigation. Collectively these new application are for less than 0.01% of the total instantaneous withdrawal rate already allocated. Consequently, the values reported in the 2001 Wilson River Watershed Assessment, and summarized below, will not be modified from what was originally reported.

The majority (~70%) of water appropriated in the Wilson River watershed is used for irrigation. The majority of this is diverted in the downstream end of the watershed (below the confluence with the Little North Fork), and is used to irrigate farmland in the Lower Wilson River subwatershed and in the adjacent Trask River watershed (Map 22). The second largest use for appropriated water (~30%) is for municipal and domestic water supplies, which is also withdrawn primarily in the Lower Wilson River subwatershed. The City of Tillamook receives the majority of its water from the Tillamook River watershed, from Fawcett and Killam Creeks, and several small individual withdrawals occur as well. Remaining uses (fish ponds, industrial uses, power generation) account for only a minor amount of the total withdrawals. The majority (> 90%) of appropriated waters are from surface, rather than groundwater, sources.

[32] http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_summary_pod.aspx

5.5.2.2 Storage, Withdrawals and Transfers

No significant water storage has been constructed in the watershed, and no inter-basin transfer occurs, beyond the application of water withdrawn from the Wilson River to irrigated lands in the adjacent Trask River watershed. It is not known to what extent (if at all) un-permitted uses of water are occurring in the basin.

The OWRD also approves instream water rights for fish protection, minimizing the effects of pollution or maintaining recreational uses. Instream water rights set flow levels to stay in a stream reach on a monthly basis, have a priority date, and are regulated the same as other water rights. Instream water rights do not guarantee that a certain quantity of water will be present in the stream; under Oregon law, an instream water right cannot affect a use of water with a senior priority date. Nine locations within the Wilson River watershed have designated instream water rights for "supporting aquatic life" and "anadromous and resident fish rearing" (Table 13). All instream water rights have priority dates of 1973 or 1991, and are junior to most other water rights in the watershed.

Table 13. In-stream water rights in the Wilson River watershed. Table taken from E&S Environmental Chemistry (2001); data originally obtained from the Oregon Water Resources Department. See Map 22 for locations of water availability basins.

Water Availability Basin	Priority date	Purpose
Wilson River @ mouth	1991 1973	Anadromous and resident fish rearing; Supporting Aquatic Life
Little N. FK. Wilson @ mouth	1991 1973	Anadromous and resident fish rearing; Supporting Aquatic Life
Fall Cr. @ mouth	1991	Anadromous and resident fish rearing
S. Fk. Wilson @ mouth	1991	Anadromous and resident fish rearing
Cedar Creek @ mouth	1991	Anadromous and resident fish rearing
N. Fk. Wilson River @ mouth	1991 1973	Anadromous and resident fish rearing; Supporting Aquatic Life
Elk Cr. @ mouth	1991	Anadromous and resident fish rearing
Devil Lake Fork @ mouth	1991	Anadromous and resident fish rearing
Jordan Cr. @ mouth	1991	Anadromous and resident fish rearing

5.5.2.3 Effects on Peak and Low Flows

Two pieces of information are needed to estimate the net effects of water use on stream flows at any given location; 1) an estimate of the natural stream flow

volume, and 2) an estimate of the consumptive portion of all upstream water withdrawals. Unfortunately, only one gage is located within the Wilson River watershed, and it is located upstream of most points of diversion. The OWRD has estimated natural monthly stream flows at the mouths of several water availability basins (WABs) within the Wilson River Watershed (Map 22). The natural streamflow estimates available from the OWRD are the monthly 50% and 80% exceedance flows. The 50% exceedance stream flow is the stream flow that occurs at least 50% of the time in a given month. Conversely, the stream flow is also less than the 50% exceedance flow half the time. The 50% exceedance flow can be thought of as representing a "normal" stream flow for that month. The 80% exceedance stream flow is exceeded 80% of the time. The 80% flow is smaller than the 50% flow, and can be thought of as the stream flow that occurs in a dry month[33]. These exceedance stream flow statistics are used by the OWRD to set the standard for over-appropriation: the 50% exceedance flow for storage and the 80% exceedance flow for other appropriations. These estimates of natural monthly stream flows were made by the OWRD using statistical models derived from multiple linear regressions.

A consumptive use is defined as any water use that causes a net reduction in stream flow. These uses are usually associated with an evaporative or transpirative loss. The OWRD recognizes four major categories of consumptive use: irrigation, municipal, storage, and all others (e.g., domestic, livestock). Uses are not estimated to be 100 percent consumptive, and are estimated by multiplying a consumptive use coefficient (e.g., for domestic use, the coefficient is 0.20) by the maximum diversion rate allowed for the water right. The OWRD assumes that all of the non-consumed part of a diversion is returned to the stream from which it was diverted. The exception is when diversions are from one watershed to another, in which case the use is considered to be 100 % (i.e., the consumptive use equals the diversion rate). Consumptive use estimates available from the OWRD through the Water Availability Reporting System (WARS)[34] were used in this assessment. The net effect of water withdrawals on monthly stream flows were estimated in the following manner:

- The estimated monthly natural stream flows for average and dry years (represented by the 50% and 80% exceedance flow respectively) were first plotted for each location.

[33] For example, the 50% exceedance flow at the mouth of the Wilson River in the month of December is estimated to be 2,050 cfs, while the 80% exceedance flow for the same month is estimated as 1,050 cfs. The 50% and 80% exceedance flows at the same location for the month of August are 104 and 78.7 cfs
[34] telnet://wars.wrd.state.or.us/

- The portion of all water withdrawals that does not return to the stream (i.e., the consumptive uses) was added to water diverted for storage for each month and plotted on the same graph.
- Instream water rights for the watershed were also shown on the graph
- Finally, the sum of instream water rights and consumptive uses was plotted on the graph.

The estimated net effect of water withdrawals on monthly stream flow is shown for the mouth the Wilson River watershed in Figure 8. These estimates indicate that consumptive water use does not exceed the estimated volume of natural stream flow in any month, either in average (50% exceedance flows) or dry (80% exceedance flows) years. Consumptive use of water is far below the amount available in all months. However, when the instream water right is added to consumptive uses there is insufficient flow to meet all uses in the months of August – October in average years, and in May, July – October in dry years.

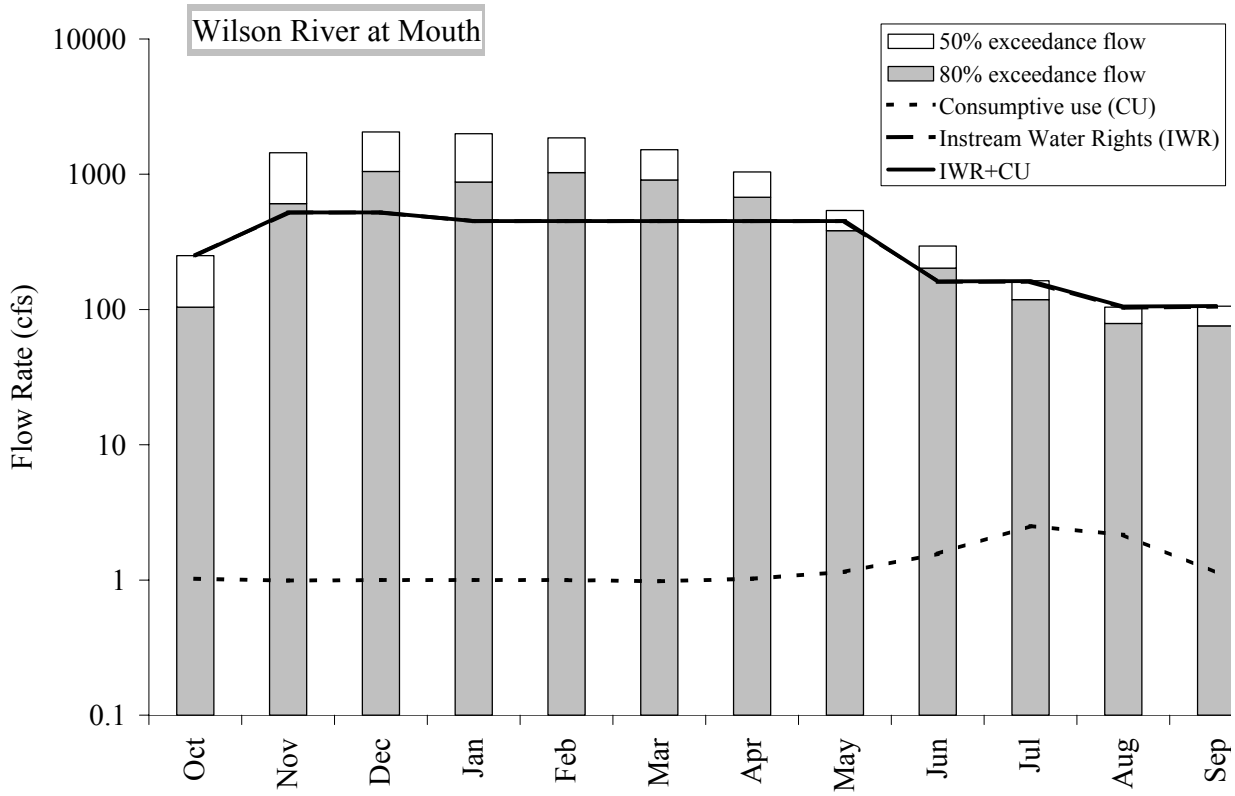

Figure 8. Estimated net effect of water withdrawals on monthly stream flows at the mouths of Water Availability Basins. Shown are estimated natural stream flows for average and dry years (50% and 80% exceedance flows); the sum of consumptive uses (CU); instream water rights; and the sum of instream water rights (IWR) and consumptive uses (CU). Data source: OWRD.

The pattern shown in Figure 8 is the "worst case" scenario among the WABs in the Wilson River watershed. Consumptive uses in the watershed are relatively low as compared to the total water available in any given month. Instream flow rights, although they have a late priority date, should be adequate in maintaining ample flows needed by salmonids and other aquatic species.

5.6 Limiting Factors

The Distributed Hydrology Soil Vegetation Model (DHSVM) was used to evaluate the effects of vegetation and road conditions on peak and low flow magnitudes at the outlets of the eight sixth-field subwatersheds, at the location of the Wilson River stream gage, and at the outlets of ten randomly selected small headwater watersheds.

Model results suggest that peak flow conditions due to current vegetation conditions and current road densities and road drainage conditions are not significantly different than under the baseline condition. Vegetation changes and roads appear to result in an increase of 1% or less over the baseline condition. There was no correlation between percent change in peak flow value and flood size.

These results are consistent with other Northwest forest published results pertaining to peak flow responses after forest harvest that indicate that forest-harvest and road-drainage related peak flow changes are negligible in rain-dominated areas similar to the Oregon Coast Range (e.g., Duncan, 1986; Golding, 1987; Harr, 1979; Wright et al., 1990; Storck et al., 1995; Ziemer, 1996). Aquatic resource degradation associated with peak flow increases must be evaluated on a site-specific basis. However, it is generally not considered to be a concern until peak flow increases are in the magnitude of 10% or greater (Washington Forest Practices Board, 1997). Furthermore, hydrologic connectivity of the road drainage system is generally low within the Wilson River watershed, and DHSVM results indicate that road drainage effects on peak flows are negligible.

Given these results, management related hydrologic impacts are rated as currently having a low impact on proper function of aquatic systems throughout the Wilson River watershed. Furthermore, given that future harvest intensity is unlikely to exceed present practices, and that road construction and maintenance standards are likely to reduce hydrologic connectivity, it is likely that planned management activities and restoration projects will have a positive or neutral effect on hydrologic response over time.

5.7 Confidence in the Assessment/Analysis

Confidence in the Hydrology / Water Use assessment and analysis is high. Water availability estimates from the OWRD were used to evaluate the extent to which consumptive water use (and resultant diminished base flows) are limiting in the Wilson River watershed. The OWRD results indicate that water use is relatively low as compared to the total water available in any given month, and that instream flow rights should be adequate in maintaining ample flows needed by salmonids and other aquatic species. The relative abundance of water adds to the confidence in the results; given that minor to moderate errors in calculations are unlikely to change the overall interpretation.

Confidence is also high in the peak and base flow modeling done as part of this assessment. Data on vegetation and road drainage is recent and appears to adequately represent current condition. Output from the hydrologic modeling matched observed gage records fairly well, further increasing our overall confidence in the results.

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