Upper Rogue Watershed Assessment

Chapter 2 Hydrology

Upper Rogue Watershed Association

- Bringing people and natural resources together since 1994 -

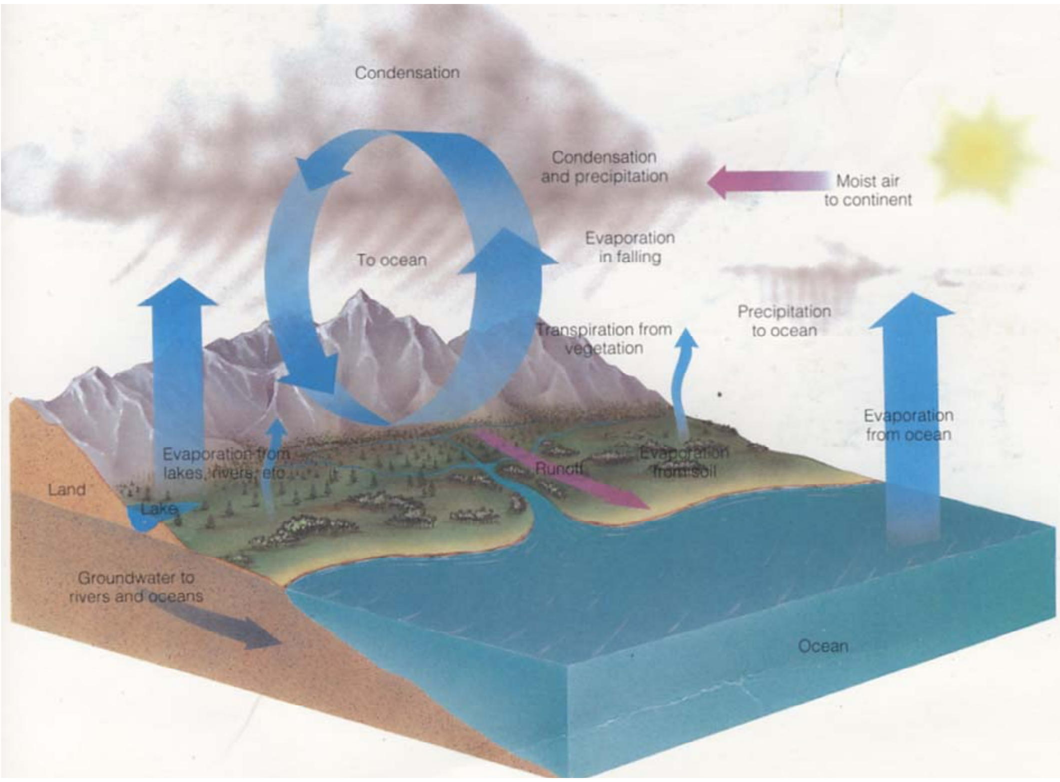
TABLE OF CONTENTS

2 HYDROLOGY

2.1 Introduction

In this chapter, we assess how water flows onto, and through, the Upper Rogue Watershed. Figure 2-1 is a diagram of the basic hydrologic cycle, which will be a helpful reference in understanding the concepts to follow. The figure illustrates the combination of water coming in, water going out, and any changes in storage in lakes and reservoirs over time. Important input sources are rain and snowfall, streamflow from upstream subwatersheds, and discharge from shallow groundwater. Important outflow sources include downstream flow, percolation to deep groundwater, evaporation, plant transpiration, water withdrawals by humans, and interbasin transfer out of the watershed.

Figure 2-1. The Hydrologic Cycle



Source: Monroe 1995.

2.2 Water Use

Understanding human usage of surface water is an important aspect of understanding the overall water budget in the Upper Rogue Watershed. The bulk of the water rights and water-use data presented in this report were obtained from the Oregon Water Resources Department (OWRD) website at <http://www.wrd.state.or.us>. Discussion of water use in this chapter refers to known diversions for consumptive use, which means the volume of water that, once used or applied, will not return to the stream. Consumptive uses fall into the following categories: storage, irrigation, municipal use, industrial/manufacturing, commercial, domestic, agricultural, and other uses. The OWRD has estimated flow rates at specific levels, called the 80% exceedence level and the 50% exceedence level, to assist in understanding flow throughout the watershed. This is especially helpful in areas where real flow data do not exist. The 80% exceedence level is the flow rate that is exceeded at a stream location 80% of the time; likewise, the 50% exceedence level is the flow rate that is exceeded in the stream 50% of the time (OWRD, 2006). The 50% exceedence level is used to determine water available for storage; the 80% exceedence level is used to determine water availability for all other consumptive uses (OWRD, 2005; OWRD, 2006).

Water law is a critical issue in the west and Oregon water law is said to be a "first in time, first in right" law. This means that water users with a water right filed prior, or at an earlier date than other users are able to use the full permitted water volume before the next in date, or junior user, can receive their water. Most water rights in Oregon were filed prior to the 1920s before these streams became over-appropriated (more water rights allocated than what typically flows in the stream) in their water usage. In comparison, instream water rights, intended to preserve streamflow for fish habitat and other aquatic wildlife, were not issued until the early 1990s. Several species of Pacific salmon and trout are designated as endangered or sensitive species under the Endangered Species Act of 1973. However, the instream right was filed so late that often all available instream flow is used by only a few senior rights holders before the stream runs dry (over-appropriated) in some watershed basins. Streams that are over-appropriated often do have flow during the summer because not everyone uses their share of water continuously. Because instream usage is not considered a consumptive use, instream rights are not included in OWRD analysis (OWRD, 2005).

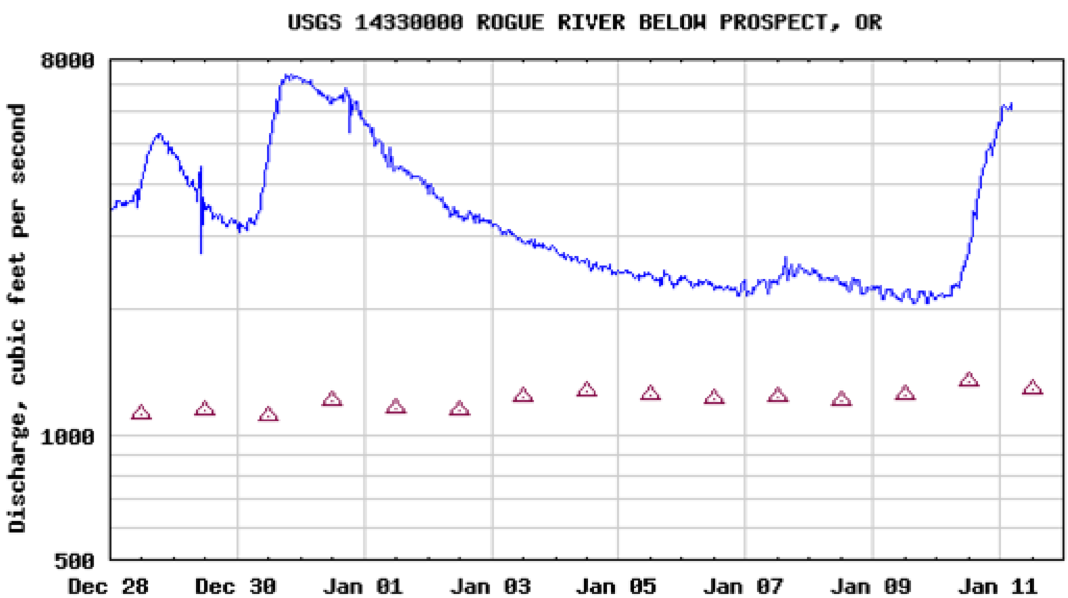
The OWRD identifies 1,565 points of diversion for permitted water uses within the Upper Rogue River Watershed, which are shown on Map 4. This does not mean there is a physical diversion structure at each of these locations. Some users my not be exercising (using) their water rights. In other cases, more than one water right may be extracted from one point of diversion. Also, approximately 576 of the points are the non-consumptive instream water rights discussed above.

2.3 Streamflow Data

Review of the data show that streamflow has been closely monitored at some locations and some sites lack data. Sources of continuous streamflow data for the Upper Rogue Watershed are the United States Geologic Survey (USGS) and the OWRD. Other agencies have collected a great deal of good-quality information, although it has not been continuous over time. Known sources of non-continuous streamflow data for the Upper Rogue Watershed include the Oregon Department of Environmental Quality (ODEQ), the Medford Water Commission and Eagle Point Irrigation District, PacifiCorp, as well as local organizations and individuals. Sources of streamflow data (referred to in the text as streamflow data tables) for each subwatershed are located in Appendix A. Map 4, the Hydrology/Water Use Map features gauging station locations in the Upper Rogue Watershed, OWRD Water Availability Basin boundaries, and water use points of diversion.

The USGS provides a database of real-time streamflows on their website at <http://waterdata.usgs.gov/or/nwis/rt>. There are presently five operating stream gauges in the Upper Rogue Watershed, which include Big Butte Creek near McLeod, Elk Creek near McLeod, the Rogue River near McLeod, the Rogue River below Prospect, and the Rogue River at Dodge Bridge (Map 4). Historical streamflow, peak events, gauge height, and water quality data are available on the real-time website in various statistical formats as graphs and tables. Figure 2-2 is an example of real-time, daily discharge plotted[1] for a two-week period in January 2006 at the Rogue River below the Prospect gauging station (Map 4). Current flow volume as well as daily mean for the period of record is also available in several statistical formats, including daily minimum, maximum and mean, and exceedence levels of 80%, 50% and 20%. The blue line shows the daily flow for two weeks measured at the station. The plotted triangles show the daily median values. Figure 2-2 shows that the streamflow measured on January 11, 2006, at this site was 4.5 times the daily median streamflow. Review of other statistics at the USGS website for this gauging station shows that the January 11th flow was also greater than 13 times the minimum recorded flow and exceeds the maximum flow ever recorded at this site on that same date in previous years (USGS, 2006).

Figure 2-2. Streamflow on the Mainstem Rogue River for a 2-Week Time Interval



The OWRD provides a water availability calculation for individual Water Availability Basins. The Water Availability Basins used by the OWRD are smaller basins within each of the seven subwatersheds of the Upper Rogue Watershed. Each of the Water Availability Basins is color coded and identified on Map 4. Each Water Availability Basin is also identified in Appendix A on the streamflow data table for each subwatershed.

[1] Discharge (the 'Y' axis) is plotted on a logarithmic scale.

Water availability calculations are used to determine the available streamflow for water use permits, and are estimated by the OWRD using various physical parameters including rainfall, basin area, and elevation. The final estimation for streamflow includes storage, or water that is held by the land and released slowly to instream flow. For each site, water availability calculations are calibrated by a basin stream gauge, if available, or by a nearby stream gauge in a basin of similar characteristics (OWRD, 2006). Water availability tables are presented on the website for 50% and 80% exceedence levels. The exceedence levels are good tools to use for comparative purposes in areas where actual measured data do not exist. However, they are only estimates. As mentioned, the 80% exceedence level is the estimated flow rate that is exceeded at a stream location eighty-percent of the time; likewise, the 50% exceedence level is the estimated flow rate that is exceeded in the stream fifty-percent of the time. In addition, the water availability tables are calculated each time they are downloaded (OWRD, 2006a). The values shown for each location in the water availability tables include all of the consumptive uses and water availability for the entire basin above that point.

Table 2-1 shows the relative contribution of flow from each of the seven subwatersheds to the Upper Rogue Watershed as a percentage of the whole. The percentages were obtained from USGS average, monthly streamflow data. Data from the Rogue River at Dodge Bridge (USGS gauging station #14339000) were used as the point of comparison. Streamflow volumes are controlled by the Lost Creek Dam. As a result, the total subwatershed contributions do not equal 100 percent. Only those basins with current real-time streamflow data were included in the calculation. Streamflow for the Shady Cove subwatershed was calculated using streamflow on the Rogue River for the USGS gauging station at Dodge Bridge and subtracting the average, monthly streamflow obtained from the gauging station near McLeod.

Table 2-1. Calculated Subwatershed Streamflow Contribution to Upper Rogue Watershed

Month	Subwatershed							
	Trail Creek	Elk Creek	Upper Rogue River	South Fork Rogue River	Big Butte Creek	Shady Cove	Lost Creek	Sum Total
January	?	15%	40%	13%	13%	30%	*	111%
February	?	15%	45%	14%	14%	40%	*	128%
March	?	13%	49%	15%	15%	26%	*	118%
April	?	9%	55%	16%	11%	22%	*	113%
May	?	5%	57%	19%	7%	12%	*	100%
June	?	2%	57%	19%	5%	4%	*	87%
July	?	1%	56%	11%	4%	-8%	*	64%
August	?	0%	51%	8%	4%	-14%	*	50%
September	?	0%	56%	9%	5%	-8%	*	62%
October	?	2%	61%	10%	9%	7%	*	89%
November	?	9%	52%	12%	9%	18%	*	100%
December	?	14%	40%	13%	12%	32%	*	110%
Average	?	7%	52%	13%	9%	13%	*	94%

? = No streamflow data exists for this subwatershed.
** = Water flowing into this subwatershed is held in a reservoir. Streamflow is controlled by a dam.*

Review of Table 2-1 indicates that the Upper Rogue River subwatershed contributes the significant majority of streamflow with an average of 52% per year. Note that no streamflow data are available for the Trail Creek subwatershed. Therefore, the relative contribution to the whole is unknown. Average flows for the Shady Cove subwatershed are negative from the period of mid-July to mid-September indicating more water is coming into the Subwatershed than leaving it through the Rogue River. This is likely due to filling of the Lost Creek Reservoir (storage).

2.4 Peak Discharge

Flood recurrence intervals for the Upper Watershed have been estimated by the OWRD for each Water Availability Basin as peak discharge for the 2-, 5-, 10-, 20-, 25-, 50-, 100-, and 500-year events. Individual precipitation gauges collecting data through time do not exist for each subwatershed. Therefore, precipitation data were obtained from the Oregon State University metadata website.[2] Values are average, monthly precipitation from the period 1961 to 1990.

Estimated peak discharge for each Water Availability Basin in each subwatershed is shown in Appendix B. The "Year Event" indicates the probability that a flow event of the given magnitude will occur in any given year. For example, a flood event recorded at the mouth of Big Butte Creek in 1955 was 8,950 cubic feet per second (cfs) (USGS, 2006). Comparison to the peak discharge estimates for Big Butte subwatershed in Appendix B shows that this was a 100-year flood event, or an event that would occur an average of once every 100 years. Because the USGS does not calculate flood recurrence intervals for its gauging stations (Miller 2006), high-flow records are discussed.

We have used the hydrologic data and information presented above to help summarize the hydrology of the subwatersheds.

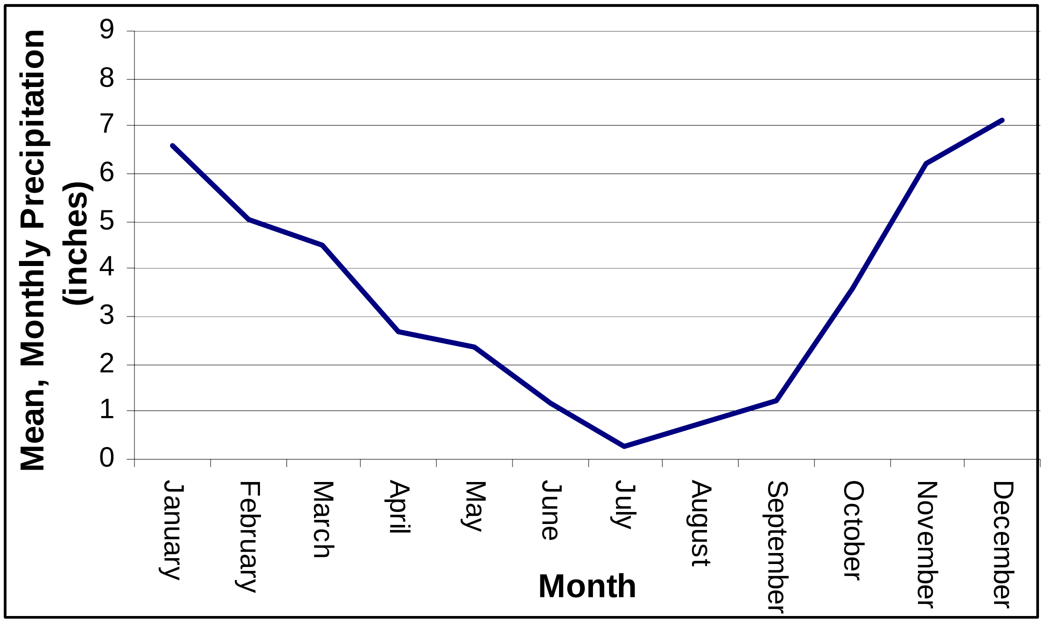
2.4.1 Trail Creek Subwatershed

The Trail Creek subwatershed covers an area of 55 square miles. It is the westernmost subwatershed in the Upper Rogue Watershed (Map 2). Elevations within the subwatershed range from 1,440 feet above mean sea level (msl) at the mouth of Trail Creek to 4,700 feet above msl at Threehorn Mountain.

Mean monthly precipitation values for each of the seven subwatersheds are listed in Appendix C. Figure 2-3 shows the mean monthly precipitation for the Trail Creek subwatershed.

[2] The website is located at <http://www.ocs.orst.edu/pub/maps/Precipitation /Total/States/OR/or_vect_meta.html>.

Figure 2-3. Mean Monthly Precipitation for the Trail Creek Subwatershed



Source: OSU 2005.

The mean precipitation fluctuates from a high of approximately 7 inches in the winter months to almost 0 inches in mid-summer. Because individual precipitation gauges do not exist for each subwatershed, the precipitation data shown in Appendix C were extrapolated from the Oregon State University metadata website. Therefore, the graphs for each of the other subwatersheds would look similar to Figure 2-3 and are not included. In general, precipitation increases with elevation in the watershed. The highest amount falls in the Upper Rogue River subwatershed, which flanks the northern and western edges of Crater Lake. More of the precipitation falls in the form of snowfall in the winter months in the higher elevations. The lowest amount falls in the Shady Cove subwatershed in the lower elevations to the southwest. In all subwatersheds, the average low drops to less than 1 inch in July.

Precipitation in the form of snowfall has a significant effect on the runoff timing, runoff rate, infiltration, and subsequent discharge into the watershed. However, the relative amounts of snowfall contribution to total precipitation are not available.

Streamflow

Streamflow is of great concern in the Trail Creek subwatershed. The streambed is often dry in the late summer months in the lower reaches below the confluence of the West Fork.

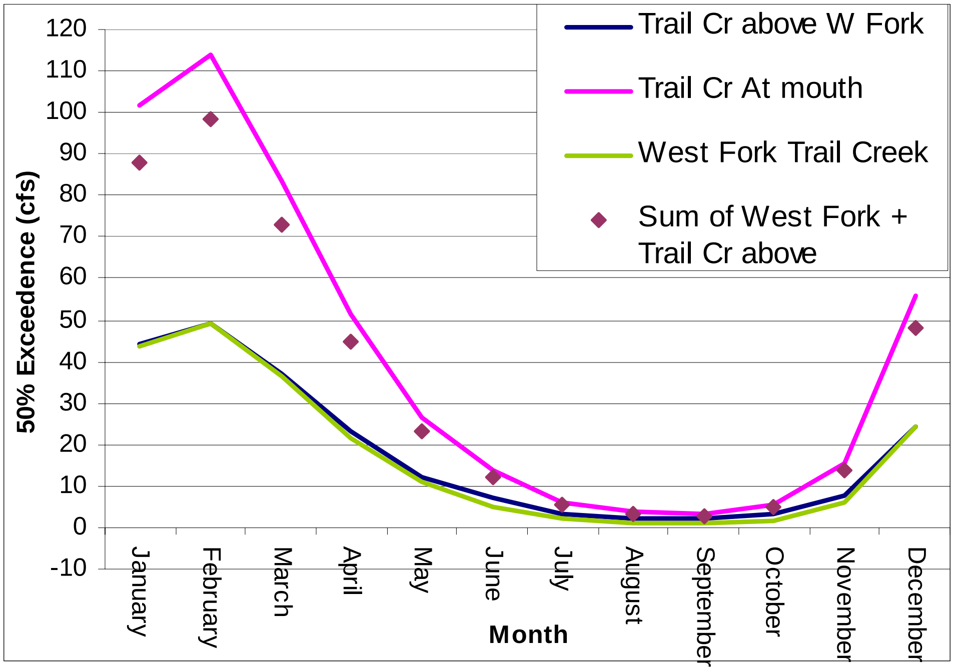
Stakeholders and the watershed assessment team are inspecting the dry streambed (upstream to the right) in a lower reach of Trail Creek in October 2005.

Some water still flows in the upper reaches of Trail Creek and the West Fork, thereby trapping fish in the upper reaches. Appendix A includes the streamflow data table for the Trail Creek subwatershed. The OWRD Water Availability Basin data is the only source of continuous streamflow data for this subwatershed; there are no real-time stream gauges. Several individuals and organizations have recognized the need for real-time streamflow data at specific locations in Trail Creek and have made an effort to collect it (Nawa 2005, URWA 2000). However, spot measurements of a stream have limited use in assessing flow conditions and are very difficult to compare to the monthly flows provided by the OWRD. Nonetheless, this information is available for use.

Figure 2-4 shows the average monthly streamflow estimates at a 50% exceedence level for the three individual Water Availability Basins in the Trail Creek subwatershed. The 50% exceedence estimation was used because these values are closest in comparison to actual streamflow averages in other basins of the assessment area.

Review of Figure 2-4 shows that the streamflow estimates for the two Water Availability Basins, i.e., the portion of Trail Creek above the confluence of the West Fork of Trail Creek and actual West Fork of Trail Creek, are almost identical. The OWRD estimates show that each of these streams runs nearly dry July through October. Visual observations of dry conditions have corroborated this on several occasions in recent years. The diamond points on the graph are the sum of the 50% exceedence level for these two Water Availability Basins. Note that the total streamflow contribution from the two forks never exceeds 90% of the total flow at the mouth at any time during the year. More than 10% of the total streamflow estimated at the mouth of Trail Creek is unaccounted for.

Figure 2-4. 50% Exceedence Level for the Trail Creek Water Availability Basin



Peak Discharge

Peak discharge estimations for the Water Availability Basins in this subwatershed are listed in Appendix B. Estimated peak discharge at the confluence of Trail Creek with the mainstem of the Rogue River range from 2,150 cfs for the 2-year event, to 6,590 cfs for the 100-year event. The relative contributions to peak discharge from West Fork Trail Creek and Trail Creek above the West Fork confluence are similar.

Water Use

OWRD consumptive water use for this basin is listed in Appendix D. The majority of consumptive use for this basin is for irrigation. The totals for all consumptive uses are shown for each month in the far right column. The greatest allocated usage is in July at 1.02 cfs. Irrigation accounts for 0.9 cfs, or 88% of the total for that month. There are 159 diversion points in the OWRD database within the Trail Creek watershed (Map 2-1). Only seven of these are located on the West Fork Trail Creek. The remaining are located along Trail Creek above and below the confluence of the west Fork.

Consumptive uses on the West Fork Trail Creek account for approximately 30% of the total consumptive use during the irrigation season. Approximately 59% of the consumptive uses are on Trail Creek above the confluence of the West Fork, and approximately 11% are on the mainstem of Trail Creek below the confluence of the West Fork.

2.4.2 Elk Creek Subwatershed

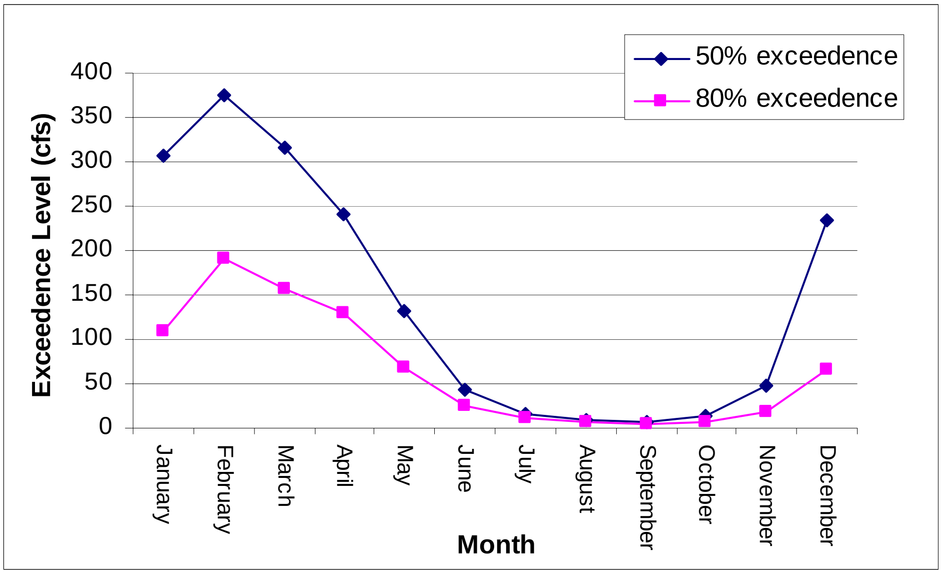
The Elk Creek subwatershed is approximately 134 square miles in area and is located on the western edge of the assessment area, between the Trail Creek subwatershed to the west and the Upper Rogue River subwatershed to the east (Map 2). Elevation within the subwatershed ranges between 1,459 feet above msl at the mouth of Elk Creek to 5,804 feet above msl at Whaleback Mountain. Review of precipitation values in Appendix C shows that the subwatershed typically receives the greatest amount of precipitation during the winter months, averaging a little over 8 inches in January, and drops to less than 1 inch during the lowest point in July.

Streamflow

The streamflow data table for this subwatershed is located in Appendix A. There are seven OWRD Water Availability Basins in the Elk Creek subwatershed, several historic USGS gauging stations, and one real-time station at the mouth of Elk Creek. Exceedence levels are calculated for each Water Availability Basin at the mouth. This includes all stream inputs above this point; therefore, it is not necessary to evaluate each Water Availability Basin listed in Appendix A.

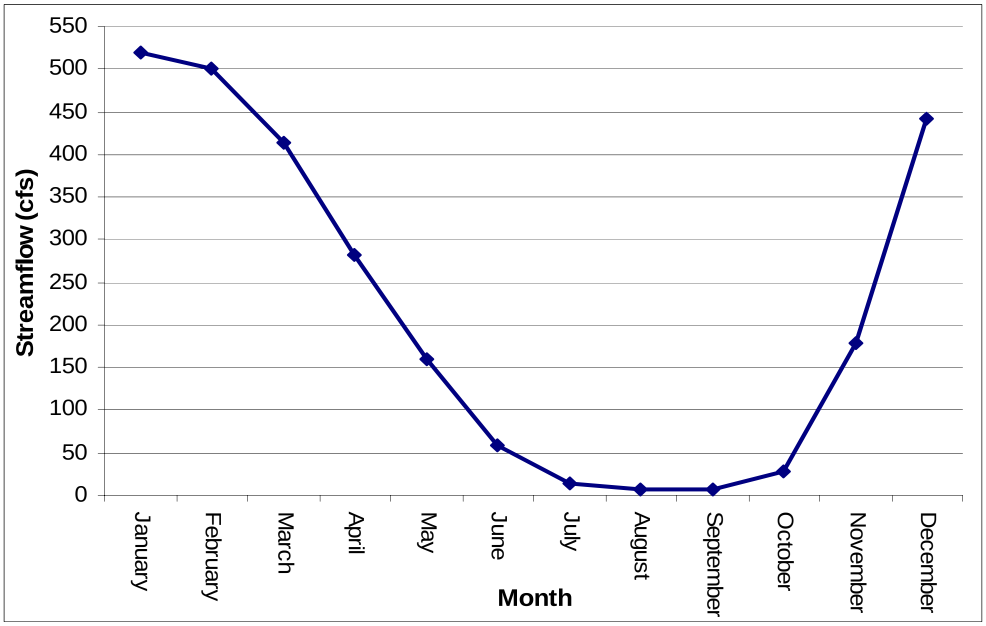
Unlike the Trail Creek subwatershed, in the Elk Creek Subwatershed we can compare estimated streamflow data to real-time data collected at a gauging station. Figure 2-5 shows monthly streamflow *estimates* at the mouth of Elk Creek (Map 4). Figure 2-6 shows the average monthly streamflow *measured* at the USGS gauging station at the mouth of Elk Creek. The estimated and the measured data are combined in Figure 2-7. Comparing the estimated vs. measured results in Figure 2-7 shows that the estimated data calculated by the OWRD model significantly under predicts flow during the winter months. For example, the estimated 50% exceedence level (234 cfs) is only half the actual measured flow (443 cfs) in December. Furthermore, there is an estimated drop in streamflow during January, which does not agree with an actual peak in measured flow. Low flows in the summer are nearly comparable.

Figure 2-5. Monthly Streamflow Estimates for Water Availability Basin #71023, Elk Creek at Mouth



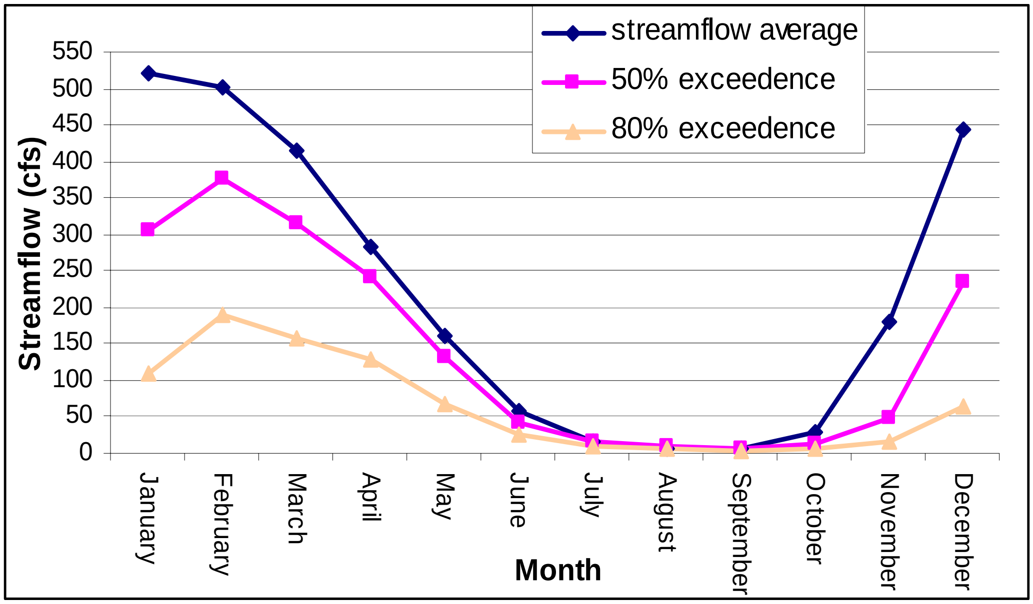
Source: OWRD 2006.

Figure 2-6. Mean Monthly Streamflow at Gauging Station #14338000, Elk Creek Near McLoed



Source: USGS 2006.

Figure 2-7. Comparison of Estimated Exceedence Level and Average Monthly Streamflow at the Mouth of Elk Creek



Source: USGS 2006.

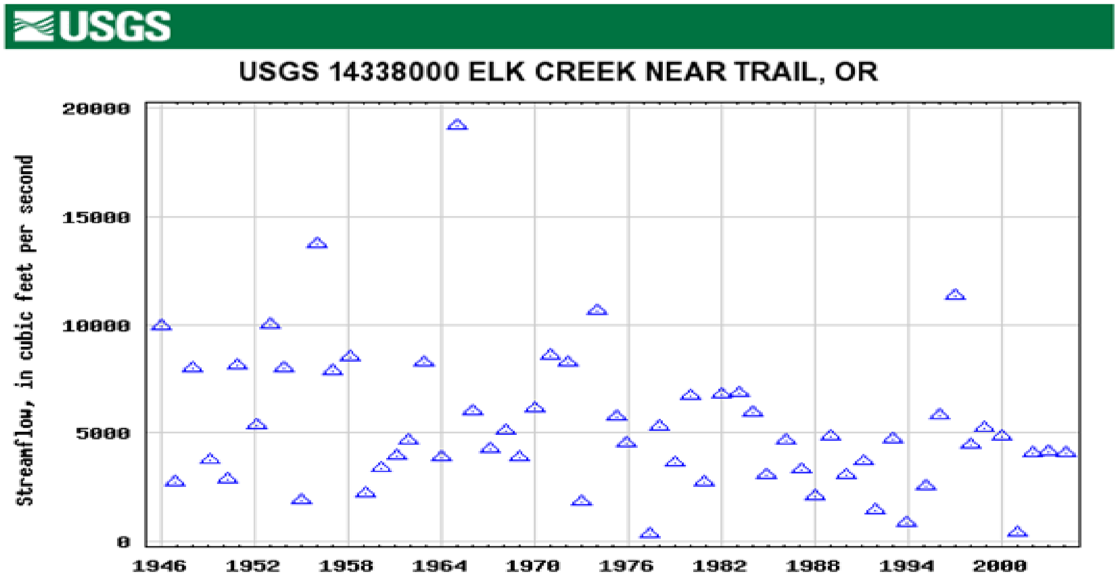
Peak Discharge

OWRD peak streamflow estimates calculated for Elk Creek and the other subwatersheds are listed in Appendix B. Maximum and minimum recorded discharge for the USGS gauging stations are available on the website, although flood recurrence intervals have not been calculated for these stations (Miller 2006). The maximum discharge recorded at USGS gauging station #14338000, Elk Creek near McLeod, was 19,200 cfs on December 22, 1964.

Comparison to the peak discharge in Appendix B shows that this would be between a 100-year and 500-year flow event. The minimum recorded discharge was 0.01 cfs on October 8, 1987, the result of dam construction 1.30 miles upstream. Peak discharges recorded by the USGS for this site are shown in Figure 2-8. Trends or changes in peak discharge over time are difficult to determine.

The Elk Creek Dam project began in 1971 and was halted in 1988 with only one-third of the dam completed (Corps 2006). It was initially begun as part of the larger Rogue River Basin Project to provide flood control to the reaches further down and relieve water requirements for instream use and water users in the vicinity (Ryan 2000).

Figure 2-8. Peak Streamflow Events at Gauging Site #14338000, Elk Creek Near McLeod



Source: USGS 2006

Water Use

Consumptive water uses for each Water Availability Basin are listed in Appendix D. Note that the values reported at the mouth of the subwatershed (the most downstream portion) include the value totals from each of the upstream Water Availability Basins. For example, the total consumptive use reported in June for the Water Availability Basin station #71023 at the mouth of Elk Creek is 1.57 cfs. This includes the values reported at the upstream Water Availability Basins of Flat Creek, Sugarpine Creek, Dodes Creek, Elk Creek above Dodes Creek, and Button Creek. Allocated usage increases from a low of 0.08 cfs in November to 2.22 cfs in July. Almost all of the consumptive use is allocated for irrigation.

2.4.3 Upper Rogue River Subwatershed

The Upper Rogue River Subwatershed is located in the northeast portion of the assessment area along the western flanks of Crater Lake. It is the largest subwatershed in the entire Upper Rogue Watershed Assessment area at 384 square miles. The minimum elevation is 1,878 feet above msl near Prospect to 8,139 feet above msl at Hillman Peak, with a mean of 4,655 feet above msl.

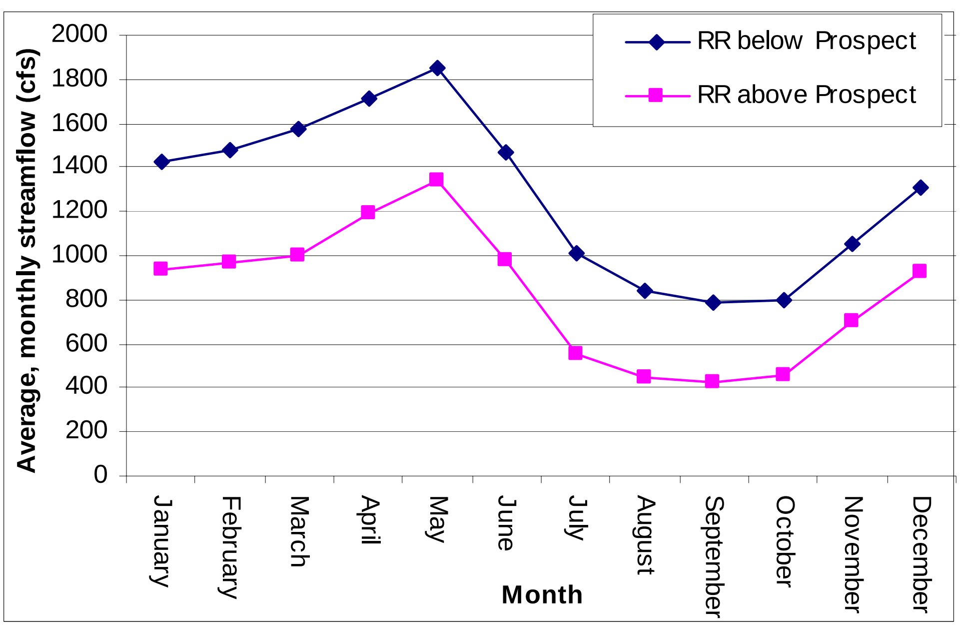
Precipitation values are listed in Appendix C. From a high of 8.5 inches to 0.7 inches during July, the driest month of the year, the Upper Rogue River has the highest annual precipitation of the seven subwatersheds. Values begin to climb in August and peak for the year in November (OSU 2005).

Streamflow

The Upper Rogue River subwatershed includes a total of 14 Water Availability Basins. The streamflow data table for the Upper Rogue River subwatershed is shown in Appendix A. Ginkgo Creek and Rogue River Water Availability Basins are not used in this assessment. Ginkgo Creek (#73381) is a 7th field stream (a smaller subwtershed within the Upper Rogue River subwatershed) and its contribution is included in the Mill Creek exceedence level calculations. The boundaries of the Rogue River above Red Rock Canyon Water Availability Basin #272 are different than those of this subwatershed, making the data set difficult to use for evaluation. It is unclear why the boundaries of the OWRD water allocation basins are different from the boundary for this subwatershed.

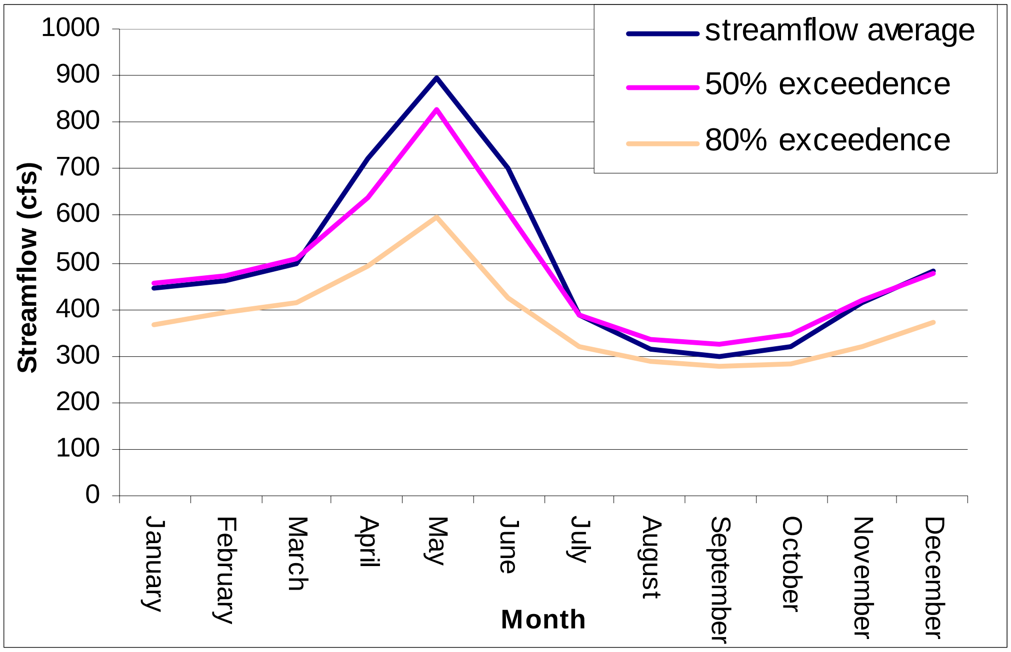
There are seven historical USGS gauges and one real-time gauge operating in this subwatershed (#14330000). Figure 2-9 shows average monthly streamflow for the period of record at two USGS gauging sites in the Upper Rogue River subwatershed, one above Prospect (station #14328000) and one below Prospect (station #14330000). Though there is a relatively constant difference of approximately 450 cfs between the two stations, the trend, or changes in flow, over the year at the two sites is almost identical. Much of the increased flow is due to an interbasin transfer of water from the South Fork subwatershed. Three-hundred fifty cfs per month are diverted from the South Fork subwatershed to a small reservoir on the North Fork Rogue River and then released into the Rogue River via penstocks below the PacifiCorp power plant in Prospect (PacifiCorp 2005). This is discussed in greater detail in the Water Use section below. The remaining 100 cfs difference between the upstream and downstream gauges is from the cumulative water contribution of Mill Creek, Schoolma'am and Barr Creeks.

Figure 2-9. Average Monthly Streamflow at Gauged Sites #14330000 and #14328000 on the Rogue River



Source: USGS 2006.

Figure 2-10. Comparison of Gauged Streamflow and Estimated Exceedence Levels for Rogue River above Bybee Creek



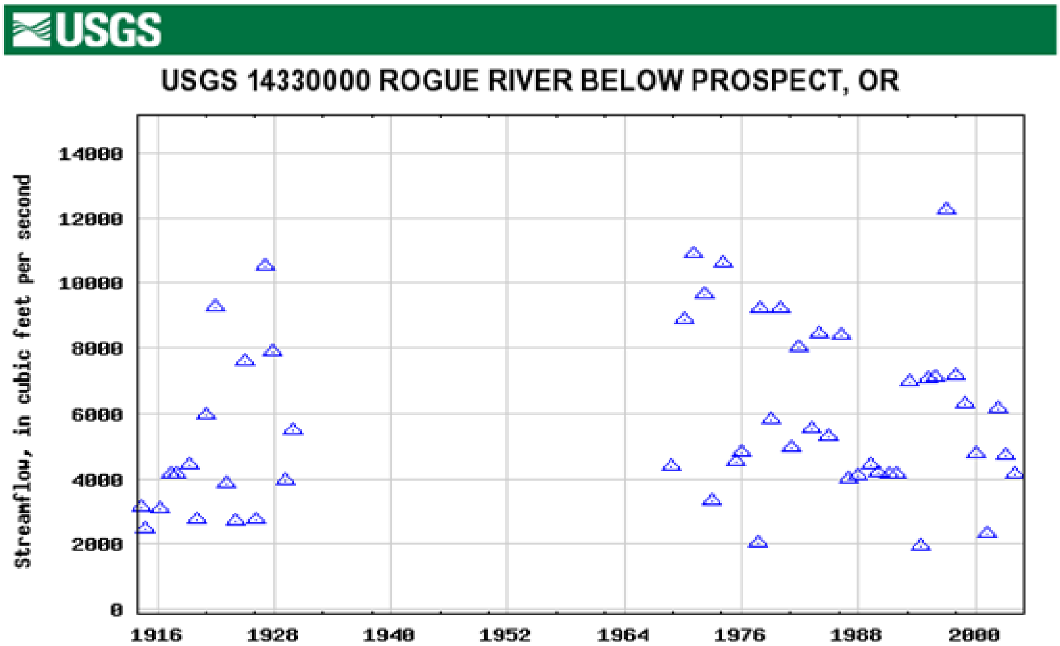
OWRD flow estimations and USGS gauged data exist for the Rogue River mainstem above Bybee Creek. Figure 2.10 combines exceedence levels and mean, monthly streamflow from historical gauged data at #14327500, Rogue River above Bybee Creek near Union Creek (USGS, 2006). Review of Figure 2.12 shows that there is fairly good correlation between the measured values and the 50% exceedence levels over time. The measured peak in May is under-estimated by 66 cfs, and the low in September is over-estimated by 30 cfs.

Peak Discharge

OWRD peak discharge estimations for the 6th field basin tributaries in the Upper Rogue River subwatershed are listed in Appendix B. The USGS has recorded peak discharge data from their gauging station on the Rogue River mainstem below Prospect (#14330000). This is the best site from which to evaluate the water contribution of the Upper Rogue River subwatershed. The maximum recorded discharge was 12,200 cfs on January 1, 1997. The lowest recorded discharge was 166 cfs on September 29, 1992, the result of regulation by upstream diversion gates (USGS 2005).

Figure 2-11 shows annual peak discharge measured at gauging station #14330000. Peak discharge ranges from 1,930 cfs in April 1994 to 12,200 cfs in January 1997. Records at this gauging station are discontinuous for the period between 1930 and 1968. The maximum recorded discharge for station #14328000, Rogue River above Prospect, was 25,000 cfs on December 22, 1964, roughly a 500-year flood event for streams in this watershed. Due to large data gaps, trends or changes in peak discharge are not apparent over time.

Figure 2-11. USGS Annual Peak Events for the Rogue River below Prospect. #14330000



Source: USGS 2006.

Water Use

To evaluate water use in the Upper Rogue River subwatershed, we must look at each of its smaller components as listed in Appendix D. The data show consumptive uses in those OWRD Water Availability Basins having consumptive use water permits. However, the most significant water use in this subwatershed is for the generation of hydroelectric power by PacifiCorp, which is not shown in the water use tables because it is not a consumptive use. PacifiCorp has permits for 275 cfs on Schoolma'am Creek, 400 cfs on Kiter Creek, and 275 cfs on the North Fork Rogue River below Kiter Creek (OWRD 2006). Because Kiter Creek is not considered a Water Availability Basin, the point of diversion is listed as the Rogue River mainstem (North Fork), the next Water Availability Basin hydrologically down stream. As mentioned, PacifiCorp also has a permit to divert an additional 375 cfs into the Upper Rogue River subwatershed from the South Fork subwatershed. The next largest water use is for irrigation, ranging from 1.7 to 3.9 cfs in the summer months.

PacifiCorp diverts water from the South Fork subwatershed (looking upstream on the mainstem of the Rogue River). Water diverted from the South Fork subwatershed discharges into the mainstem below the power station.

2.4.4 South Fork Subwatershed

The South Fork subwatershed covers a 249 square mile area and is located along the eastern edge of the Upper Rogue Watershed. Elevation ranges from 7,699 feet above msl at Union Peak to 1,879 feet above msl at the mouth of the South Fork.

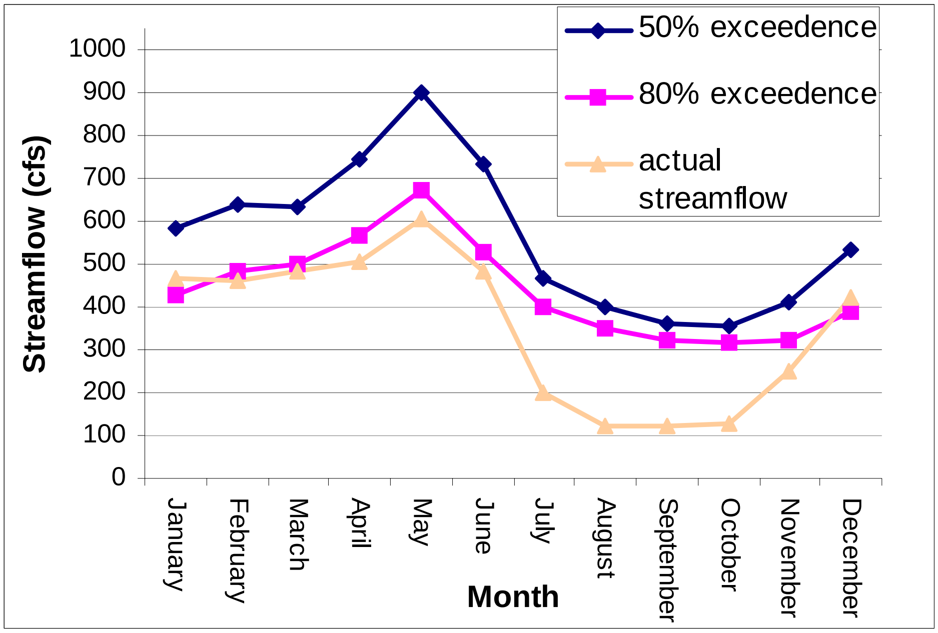
Review of precipitation values in Appendix B shows that annual precipitation peaks at 7 inches during November and drops to 0.7 inch in July. These values are only slightly lower than the average annual precipitation for the Upper Rogue River subwatershed.

Streamflow

Refer to Appendix A for the Streamflow data table for this subwatershed. Figure 2-12 compares the 50% and 80% exceedence levels calculated for the mouth of the South Fork Rogue River with the mean monthly flow data recorded at gauging station #14334700, the South Fork Rogue River south of Prospect. The estimated flows (the 50% and 80% exceedence levels) tend to significantly over estimate the measured flow by an average of 200 cfs during any given month for the entire year.

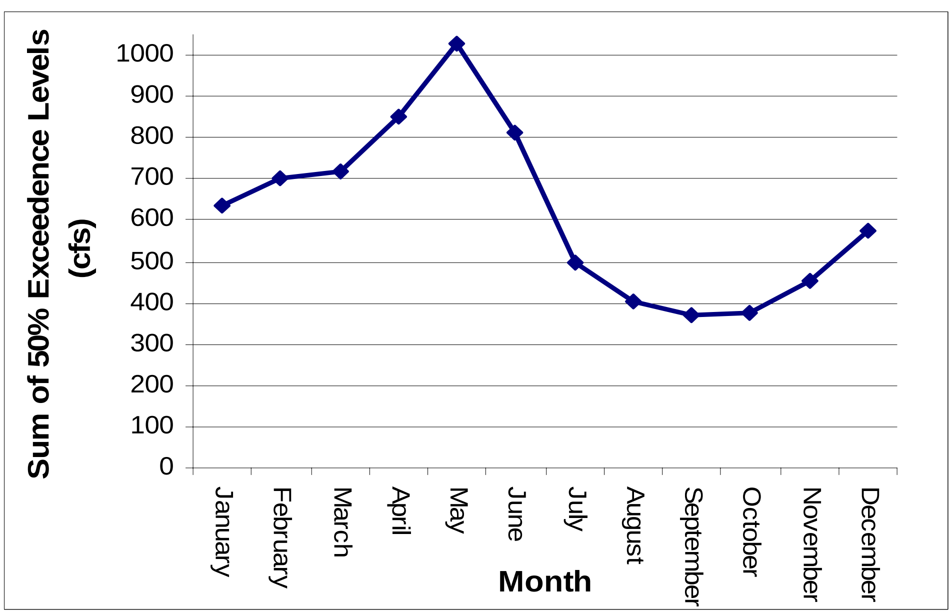
The OWRD divides the South Fork subwatershed into five Water Availability Basins: the South Fork at mouth, Middle Fork, South Fork above Middle Fork, Imnaha Creek, and Red Blanket Creek. Figure 2.13 shows the calculated sum of the 50% exceedence level for each of the subwatershed Water Availability Basins. These values are located in Appendix A. These should total the 50% exceedence level estimated for South Fork Rogue River, but comparison to Figure 2-12 shows that the total exceeds this estimation and far exceeds the actual streamflow for the period of record. In other words, the OWRD model used to estimate flows (the 50% and 80% exceedence levels) significantly over-estimates streamflow in comparison to measured flow (by an average of 200 cfs) in the South Fork subwatershed.

Figure 2-12. Comparison of Exceedence Levels and Average Actual Monthly Streamflow for the South Fork Rogue River



Sources: OWRD 2006, USGS 2006.

Figure 2-13. Total Sum of 50% Exceedence Levels for South Fork Subwatershed Water Availability Basins



Peak Discharge
USGS peak discharges recorded annually for the USGS gauging site #14330000 on the South Fork Rogue River south of Prospect for the time period 1914 through 2004 range from 2,010 cfs (September 1977) to 12,200 cfs (January 1, 1997) (USGS, 2006a). Estimated peak events for the Water Availability Basins in this subwatershed are summarized in Appendix B.

Water Use
Appendix D contains consumptive water use data for this subwatershed. PacifiCorp diverts a total of 375 cfs from the South Fork subwatershed into the Upper Rogue River subwatershed to generate hydroelectric power. For that purpose, it diverts 150 cfs from the South Fork Rogue River, 150 cfs from the Middle Fork Rogue River, and 75 cfs from Red Blanket Creek (PacifiCorp 2005). Interestingly, the amount being diverted from the South Fork subwatershed is reported by the OWRD in its water use tables. However, the amount is not shown as being included in the Upper Rogue subwatershed (shown going out of South Fork, but not shown going into Upper Rogue). In other words, the amount is shown going out, but not going in. This disparity is currently being reviewed by the OWRD (OWRD 2006a).

The second largest water use in the South Fork subwatershed is for irrigation averaging 2.43 cfs in July, the month of greatest allocation.

2.4.5 Big Butte Creek Subwatershed

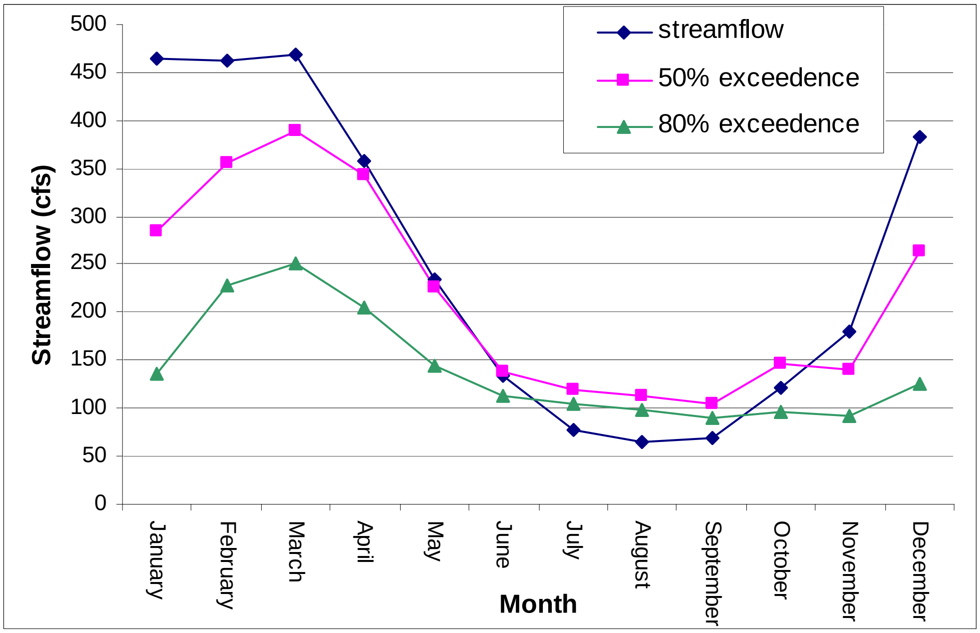
The Big Butte Creek Subwatershed encompasses approximately 247 square miles and is located in the southeast portion of the Upper Rogue Watershed. Elevations range from 1,534 ft above msl at the mouth of Big Butte Creek, to the highest elevation in the Upper Rogue Watershed, 9,495 ft above msl at Mount McLouglin. Tabulated mean monthly precipitation values are listed in Appendix B.

Annual precipitation in the Big Butte subwatershed is lower than the other eastern, high-elevation subwatersheds, with an average total of 39.92 inches per year. Like the other subwatersheds, precipitation peaks in November and drops to its lowest during the month of July.

Streamflow
There is only one OWRD Water Availability Basin in this subwatershed, Big Butte Creek at the mouth. The USGS also has a real-time gauging station near the mouth of Big Butte Creek so that we are able to compare exceedence levels and actual flow for this subwatershed (Appendix A).

The period of record for gauging station #14337500, Big Butte Creek near McLeod (Map 4) is from October 1945 to the present with a data gap between September 1957 and October 1967.

Figure 2-14. Comparison of Exceedence Levels to Average Monthly Streamflow at the Mouth of Big Butte Creek



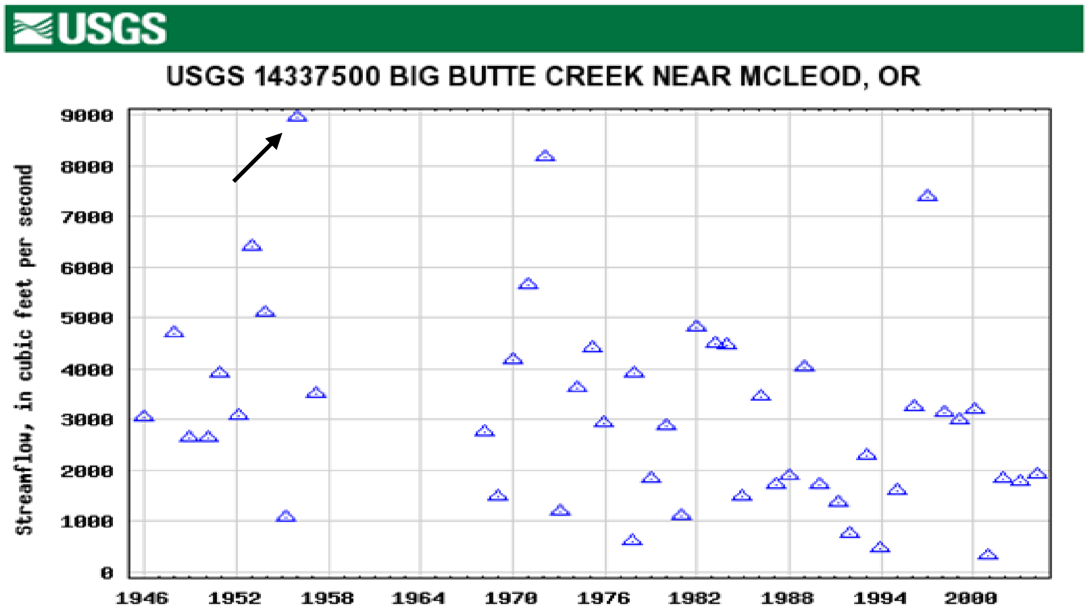
Source: OWRD 2005; USGS 2006,

Figure 2-14 compares average, monthly streamflow to exceedence levels calculated for the Big Butte subwatershed. Periods of low flow (July-September) are over-estimated by the exceedence model while high winter flows (December-March) are underestimated when compared to the actual flow data.

Peak Discharge

USGS peak discharges recorded for Big Butte Creek are shown in Figure 2-15.

Figure 2-15. Historical Peak-Flows for the Period of Record on Big Butte Creek Near McLeod



The highest stream discharge *recorded* at this site was 8,950 cfs on December 22, 1955. Comparison to the OWRD peak discharge calculation for the Big Butte Water Availability Basin (Table 2-2 and, also, in Appendix B) would place this as about a 100-year storm event. The December 22, 1964, flood was the highest, *unrecorded* water event (therefore no plotted point above) outside of the period of record. The lowest recorded discharge was 6.4 cfs on June 23 and 24, 1977.

Table 2-2. OWRD Peak Discharge Estimates for Big Butte Creek

Year Event	Streamflow (cfs)
2	3050
5	4400
10	5360
20	6340
25	6660
50	7700
100	8810
500	11700

Water Use

Table 2.3 below shows the consumptive water uses for the Big Butte Creek Water Availability Basin (OWRD, 2005). Table 2.3 is a copy of one of the consumptive water use tables for each subwatershed in Appendix D. By far, the largest consumptive use is municipal, which includes the out-of-basin transfer of water by the Medford Water Commission and the Eagle Point Irrigation District.

The Medford Water Commission has water rights for 30 to 60 cfs of water in the Big Butte Creek subwatershed and typically transfers 40 cfs from the Big Butte Springs system via the Medford Aqueduct for communities in the Bear Creek Watershed to the south. These communities include Medford, Talent, Phoenix, Jacksonville, Central Point, White City, and Eagle Point.

The Eagle Point Irrigation District, which is located in the Little Butte Creek Watershed, also has the right to divert water from the Big Butte Creek subwatershed. This right was granted in 1915 at the same time as the Medford Water Commission right was filed (EPID 2005). The Eagle Point Irrigation District has permits to transfer more than 100 cfs via the Eagle Point Irrigation Canal for irrigation use in the Little Butte Creek Watershed. Upgrades to the diversion and fish passage infrastructure along Big Butte Creek have recently been made. The Eagle Point Irrigation District also can (and does) divert water in the non-irrigation season, November through March, to generate power at their hydroelectric power plant. If the water is being used for power generation, 10 cfs must be left in Big Butte Creek for instream use. This is not considered a consumptive use because the water is returned to a stream. However, in this case, the water returns to a different watershed in the Rogue Basin.

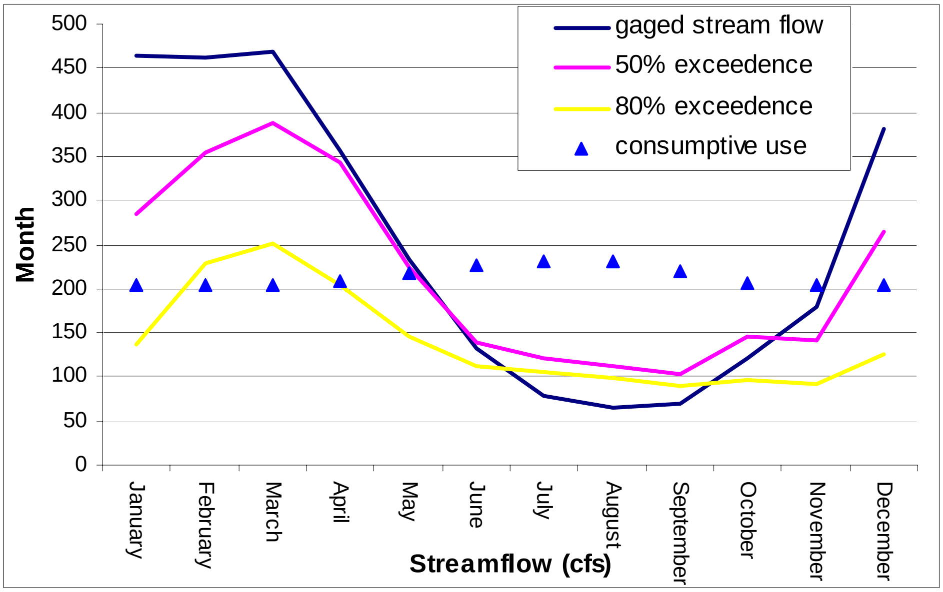
Table 2-3. Consumptive Water Uses in the Big Butte Subwatershed

Big Butte Creek above Mouth Water Availability Basin #31530710 12/27/05									
Month	**Storage**	**Irrigation**	**Municipal**	**Ind/ Man**	**Commercial**	**Domestic**	**Agricultural**	**Other**	**Use Totals**
January	0.04	0.00	203.00	0.00	0.00	0.33	0.00	0.00	**203.37**
February	0.08	0.00	203.00	0.00	0.00	0.33	0.00	0.00	**203.41**
March	0.10	0.00	203.00	0.00	0.00	0.33	0.00	0.00	**203.43**
April	0.07	6.13	203.00	0.00	0.00	0.33	0.00	0.00	**209.53**
May	0.00	14.10	203.00	0.00	0.00	0.33	0.00	0.00	**217.43**
June	0.00	22.70	203.00	0.00	0.00	0.33	0.00	0.00	**226.03**
July	0.00	32.50	199.00	0.00	0.00	0.33	0.00	0.00	**231.83**
August	0.00	26.40	204.00	0.00	0.00	0.33	0.00	0.00	**230.73**
September	0.00	16.30	204.00	0.00	0.00	0.33	0.00	0.00	**220.63**
October	0.00	1.42	204.00	0.00	0.00	0.33	0.00	0.00	**205.75**
November	0.00	0.00	203.00	0.00	0.00	0.33	0.00	0.00	**203.33**
December	0.03	0.00	203.00	0.00	0.00	0.33	0.00	0.00	**203.36**

NOTES:
All values are shown as cubic feet per second continuous through the month.
Ind/Mfg = Industrial/Manufacturing.

Figure 2-16 illustrates water over-allocation in the Big Butte Creek subwatershed. Actual streamflow is graphed with 50% and 80% exceedence levels, and total consumptive uses in the Big Butte Creek Water Availability Basin plotted as points. As mentioned above, streams that are over appropriated often do exhibit higher flows than estimated because not everyone uses their share of water continuously. However, comparison to the actual streamflow gauge shows that in this case, summer flows are lower than estimated flows, and the stream is clearly over allocated. The total consumptive use exceeds all streamflow by as much as 100 cfs from June to November.

Figure 2-16. Demonstration of Water Over-Allocation in Big Butte Subwatershed: Consumptive uses Compared to Streamflow



Source: OWRD 2006; USGS 2006.

2.4.6 Lost Creek Lake Subwatershed

The Lost Creek Subwatershed covers approximately 57 square miles and is located in the center of the Upper Rogue Watershed. Elevation ranges from 5,055 feet above msl at Olson Mountain to 1,547 feet above msl at McLeod. As with each of the subwatersheds in the Upper Rogue Watershed, average monthly precipitation in the Lost Creek subwatershed peaks in November and falls to a yearly low during July.

Streamflow

The Lost Creek Lake subwatershed is primarily occupied by Lost Creek Reservoir, which covers approximately 3,430 acres and receives drainage from 674 square miles. Construction began on the dam in 1972 as part of the Army Corps of Engineers Rogue Basin Project to control flooding events. Streamflow as part of the mass balance equation is difficult to evaluate as flows in the Rogue River below Lost Creek reservoir are controlled by releases from the dam. There are five historical gauging stations in this subwatershed that are no longer operating (Appendix A).

Water Use

There are a number of points of diversion in the Lost Creek Lake subwatershed (Map 4). As this is not an OWRD Water Availability Basin, consumptive uses are not tallied for this area and it is difficult to determine the cumulative water withdrawals and primary usage. Water storage in the reservoir is of primary concern.

2.4.7 Shady Cove Subwatershed

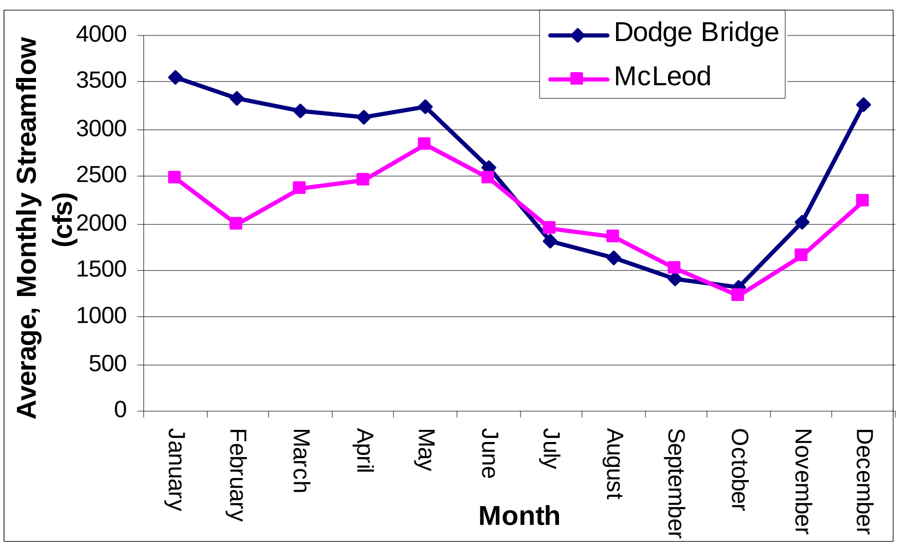
The Shady Cove subwatershed encompasses approximately 91 square miles. With a mean elevation of 1,986 feet above msl, it is the lowest subwatershed in the Upper Rogue Watershed. Review of precipitation values in Appendix C show that this subwatershed has the lowest annual precipitation in the Upper Rogue Watershed, with an average total of 30.63 inches per year (OSU, 2005).

Streamflow

There are a total of four Water Availability Basins and six USGS gauging stations in the Shady Cove subwatershed, two of which are currently operating, real-time stations (Appendix A). Station #14339000 is located at the bottom (downstream end) of the Shady Cove subwatershed on the Rogue River at Dodge Bridge, and #14337600, Rogue River near McLeod, is located where the Rogue River enters the subwatershed at the northeast (upstream) end. Figure 2-17 compares the average monthly streamflow at the two gauging stations. The exceedence levels estimated for the Water Availability Basins are not shown because the Water Availability Basin boundaries do not coincide with the subwatershed boundary.

Review of Figure 2-17 shows that for the period mid-June through mid-September there are overall losses to the system. That is, streamflow entering the subwatershed at the McLeod station is greater than the amount of water exiting the subwatershed at the Dodge Bridge station. This reduction in flow rate is likely due to irrigation uses and withdrawals in Shady Cove for domestic use.

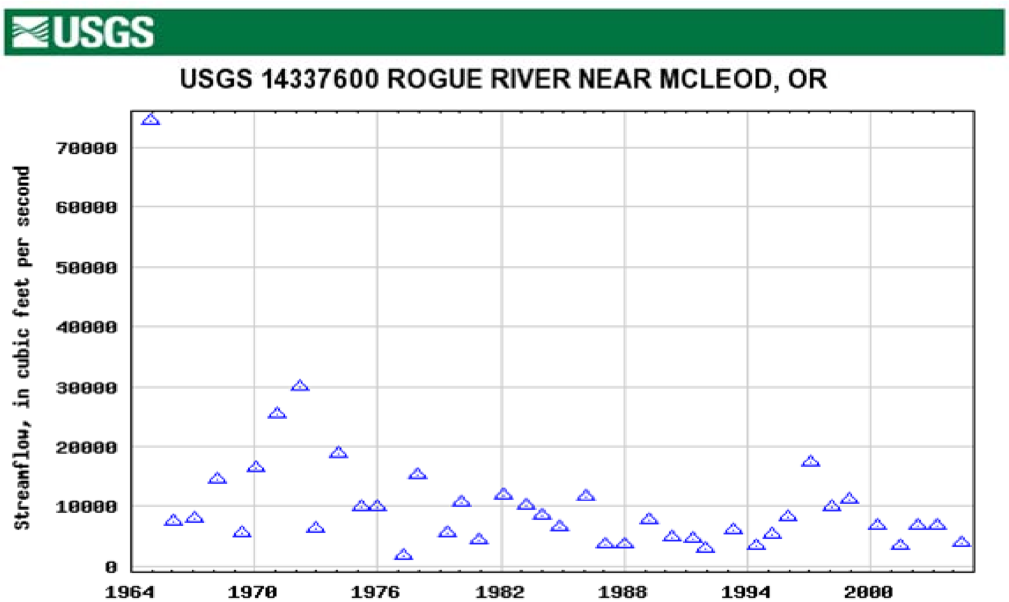
Figure 2-17. Average Monthly Streamflow at Gauging Station #14339000, Rogue River at Dodge Bridge, and #14337600, Rogue River Near McLeod



Peak Discharge

The maximum recorded discharge on the Rogue River at Dodge Bridge USGS gauging station #14339000 was 87,600 cfs on December 22, 1964. The lowest recorded flow was 567 cfs on February 18, 1977, which was likely due to low precipitation during the preceding winter months and subsequent restricted flows from the Lost Creek Dam. Figure 2-18 is a graph of peak discharge at gauging station #14337600, Rogue River at McLeod, from the USGS website. The maximum recorded discharge for was 30,000 cfs on March 3, 1972 prior to regulation by the Lost Creek dam. The period of record for this gauging station begins October 1965, after the flood of 1964. Estimations for streamflow during that event are at 74,300 cfs. The minimum recorded discharge was 468 cfs on February 18, 1977, the result of a temporary closure on the Lost Creek Dam (USGS, 2006).

Figure 2-18. Peak Discharge Recorded for USGS Gaging Site #14337600, Rogue River Near McLeod



Source: USGS 2006.

Water Use

There are four Water Availability Basins within this Subwatershed for which consumptive use tables are available (Appendix A). These are for Indian Creek, Long Branch Creek, Dry Creek and Reese Creek. Water Availability Basin #31530708 (Rogue River above Hog Creek) is also located partially within the Shady Cove Subwatershed. Consumptive uses for this Water Availability Basin also include the cumulative uses for all points above Hog Creek, therefore, it is difficult to use that comparison for this Subwatershed.

2.5 Summary

The OWRD model used to estimate flows (the 50% and 80% exceedence levels) tends to underestimate streamflow during high flows and overestimate streamflow during low flow in several of the subwatersheds, including Elk Creek, Upper Rogue, Big Butte, and Shady Cove. However, the estimated flows significantly overestimate the measured flow (by an average of 200 cfs) in the South Fork subwatershed. The OWRD method is a predictive tool involving a significant amount of interpretation and statistical manipulation. Real-time data from calibrated gauging stations are much more reliable for predictions and decision-making.

The Upper Rogue subwatershed consistently provides the greatest contribution to flow (averaging 52% of the total through the year) in the Upper Rogue Watershed. The Trail Creek and Elk Creek subwatersheds often run dry each year during the late summer months of July through October.

There is no USGS gauging station in the Trail Creek subwatershed with which to compare the OWRD exceedence model estimates, making it difficult to compare flows from this subwatershed to others in the watershed.

Most water rights in Oregon were filed prior to the 1920s before these streams became over-allocated in their water usage. In comparison, instream water rights (to preserve streamflow for fish use) were not issued until the early 1990s. The instream right was filed so late that if the senior rights are exercised, often all available instream flow is used and the stream runs dry. This may be the case for several summer months each year in the Big Butte subwatershed. The existence of instream water rights effectively prevents the issuance of additional water rights.

REFERENCES

EPID, 1997. *Preliminary Design Status:* Eagle Point Irrigation District, September 22, 1997. (21)

EPID, 1998. *Preliminary Engineering Report; South Fork Big Butte Creek Diversion Fish Screen Modifications:* Eagle Point Irrigation District, February 1998. (25)

EPID 2005. Telephone conversations with Hazel Brown, Director of the Eagle Point Irrigation District. October-November 2005.

Miller, 2006. Several conversations with Suzanne J. Miller, USGS regarding on-line database.

Nawa, 2005. *Turbidity Monitoring in the Rogue River basin, Oregon during winter 2003-2004*. Richard K. Nawa, Cave Junction, Oregon 2005.

OSU, 2005. Mean monthly precipitation data for the Upper Rogue River Watershed 1961-1990 <http://www.ocs.orst.edu/pub/maps/Precipitation/Total/States/OR/or_vect_meta.html >

OWRD, 2005. Conversation with Larry Menteer, Jackson County Water Master. December 14th and 28, 2005.

OWRD, 2006. website at < http://www.wrd.state.or.us/>

OWRD, 2006a. Conversations with Ken Starr at Oregon Water Resources Water Availability Tables. Oregon Water Resources Department, 2006.

PacifiCorp, 2004. *Prospect Nos. 1,2, and 4 Hydroelectric Project, FERC No 2630 PacificCorp Response to FERC:* PacificCorp, Portland, Oregon, 2004. (5)

Ryan, 2001. *Jackson County Water Resources Study*. Bill Ryan and Eric Dittmer, November 27, 2001.

URWA, 2000. Upper Rogue Stream Monitoring Program data for Trail Creek.

USGS, 2006a. Real-time data for Oregon website at < http://waterdata.usgs.gov/or/nwis/rt>

USGS, 2006b. Conversations with Suzanne Miller at United State Geologic Survey regarding USGS website data.