

CHAPTER 2.

REVIEW OF DATA FROM EXISTING AND HISTORICAL USGS GAUGE STATIONS

This chapter evaluates historical flow data collected at former and currently operating USGS gauge stations for Chehalis basin control points. Historical records were obtained from the USGS web site and other sources. Records are reviewed here to assess their suitability in determining whether streams are meeting the regulatory minimum flows at control points during the low-flow season.

INFORMATION PROVIDED

The historical data are presented in the summary sheets that follow. Each summary sheet provides the following information:

- The location of the historical gauge relative to the regulatory control point
- The period of record of the historical gauge
- Gaps in the record
- A chart showing the 10-percent, mean, and 90-percent exceedance flow curves, plotted with the regulatory minimum flows for the low-flow season
- A brief, qualitative assessment of the adequacy of the historical data for evaluating whether regulatory minimums are being met.

FACTORS IN ASSESSING DATA SUITABILITY

Gauge Location

The proximity of the historical gauge to the control point is important in determining whether flows recorded at the historical gauge represent most or all of the flow at the control point. In general, regulatory control points of tributaries are located at the Chehalis River confluence. However, several gauges were located some distance upstream, and therefore did not record surface or groundwater inflow that entered the tributary between the gauge and the control point.

Length of Record

The exceedance curves presented in this report are the values of 10-, 50-, and 90-percent exceedance probabilities plotted for each day of the low-flow season. Exceedance probabilities are computed from the record of daily mean flows. The length and completeness of the gauge record determines the range over which valid exceedance curves can be developed. The reciprocal of the exceedance probability is the recurrence interval, which indicates how often, on average, a specific flow will be equaled or exceeded. For example, 90-percent and 10-percent exceedance flows are discharges that, on average, would be equaled or exceeded once every 1.1 and 10 years, respectively.

It is generally accepted that exceedance probabilities estimated by extrapolation are subject to greater uncertainty. This means a 10-percent exceedance flow should be derived from gauge record with a minimum of 10 years of data. An even longer period of record is desirable, as this is more likely to capture cyclical variation in annual precipitation. Wet and dry years often occur in runs lasting several years; the longer the record, the more likely the computed exceedance flows will represent typical flow conditions.

Flow Diversions

Diversion of stream flow at a point between the control point and the historical gauge would affect how well the historical record represents flows at the control point. Flow diversions upstream of the historical gauge would introduce variability to the data set, in turn affecting the values of exceedance flows. Information on flow diversions was not available for consideration in the assessment of historical data for this study.

REVIEW OF CURRENTLY OPERATING USGS GAUGE STATION DATA

The following sections summarize data obtained from the eight USGS gauge stations that are currently in operation at or near Chehalis Basin control points. These gauge stations are referred to by the control point name.

Stream gauge data from USGS is published annually and is made available sooner as provisional data. Provisional data is considered preliminary by USGS and is checked by USGS staff prior to final approval and publishing by USGS. Published data was used for this Instream Flow Study and was available through 2001, at the time the analysis for this report was performed.

South Fork Newaukum River

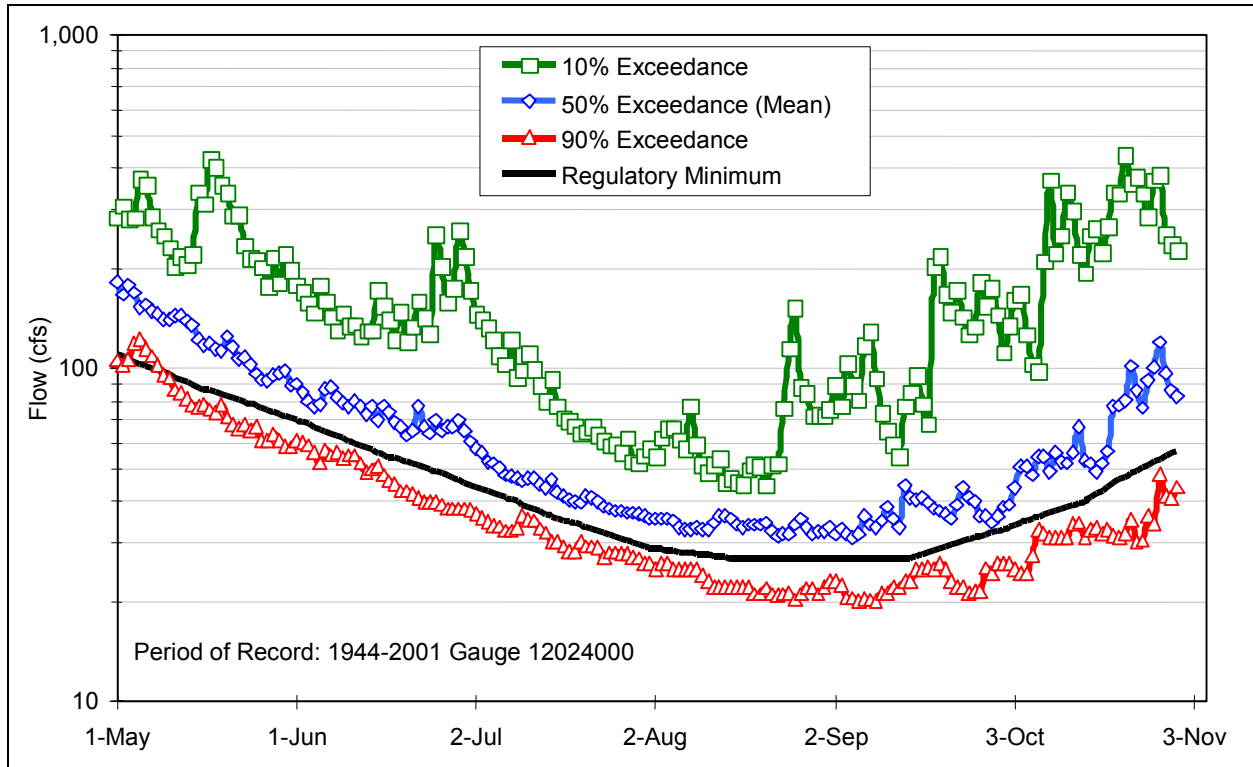


Figure 2-1. Dry-Weather Flow Exceedances and Regulatory Minimum, South Fork Newaukum River

- Location of Regulatory Control Point—Lost Creek Confluence
- Location of Existing Gauge—Approximately 1 mile upstream of Lost Creek confluence
- Period of Record—1944-2001

The regulatory control point is just downstream of the existing gauge. The record is complete for the years 1945-47 and 1958-70. The record should be sufficient in length to provide a good representation of flows at the gauge.

Chehalis River Confluence with Elk Creek

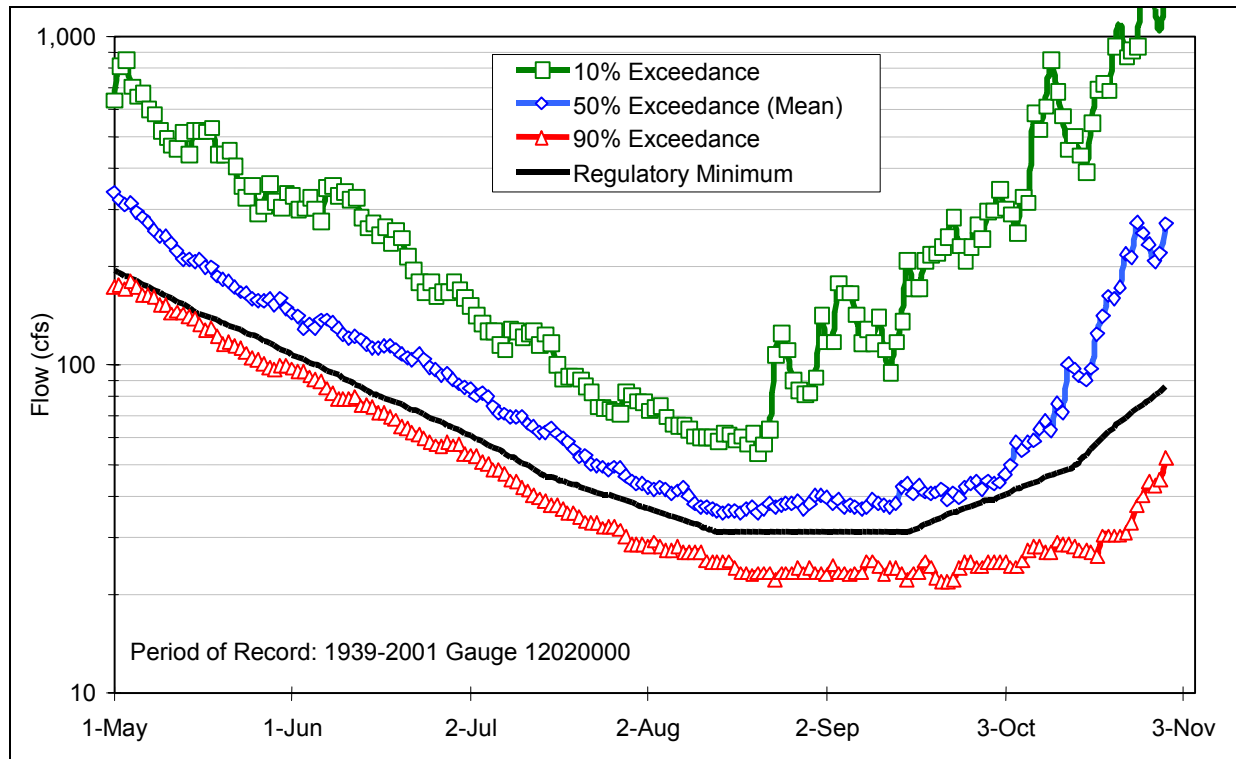


Figure 2-2. Dry-Weather Flow Exceedances and Regulatory Minimum, Chehalis River Confluence with Elk Creek

- Location of Regulatory Control Point—At Elk Creek confluence (excludes Elk Creek)
- Location of Existing Gauge—Chehalis River at river mile 108, just upstream of the Elk Creek confluence
- Period of Record—1939-2001

The USGS gauge is a short distance upstream of the Elk Creek confluence and the regulatory control point. The regulatory flows exclude the Elk Creek contribution, and no major tributaries contribute flow to the Chehalis River between the gauge and the control point. Flow statistics are based on a 60-year period of record, which is assumed to include cyclical runs of wet and dry years. Thus, data from this gauge should be a good indicator of discharge at the control point.

Gauge data through 2001 indicate that the mean flow is above the regulatory minimum by 5 to 25 cubic feet per second (cfs) in the early summer. The difference decreases beginning in about August and continues for the remainder of the low-flow season. The 90-percent exceedance flows are consistently below the regulatory minimums, by 5 to 10 cfs in the early season and more after September. The difference between the mean and 10-percent exceedance flows is greater than that between the mean and 90-percent flows, indicating that the data set is skewed. This is common in hydrologic data, and suggests the median flow is a better indicator of central tendency than the mean flow. The spread in flow

becomes more pronounced in the late season (September through October), indicating more variability in discharge.

Because the period of record at this gauge is long, data could be used as an indicator of discharge at the summer 2002 gauge at the Highway 603 bridge (near Chehalis River control point). It may be possible establish a correlation and thus extend the record of the summer 2002 station. Such a correlation would require additional data collection at the new gauge and consideration of the variability of inflows and/or diversions between the gauges.

Skookumchuck River

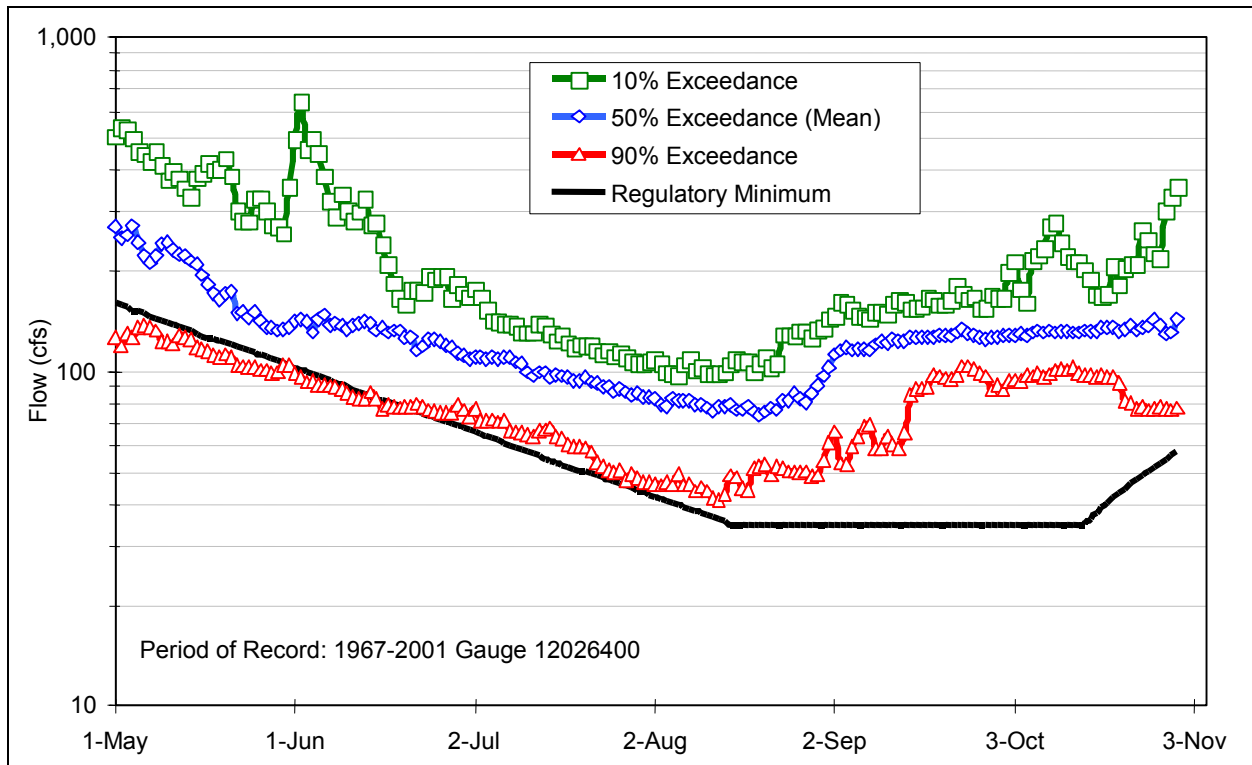


Figure 2-3. Dry-Weather Flow Exceedances and Regulatory Minimum, Skookumchuck River

- Location of Regulatory Control Point—Chehalis River Confluence
- Location of Existing Gauge—Approximately 4 miles upstream of the Chehalis River confluence
- Period of Record—1967-2001

No data are missing from the record. The gauge is upstream of the control point but no major tributaries contribute flow in between. The exceedance curves are noteworthy because of the increase in flows near the end of August with respect to the regulatory minimums, which stay at 35 cfs through mid-October. It should be noted that Skookumchuck Reservoir is located several miles upstream and its operation would influence stream flow statistics.

Chehalis River at Grand Mound

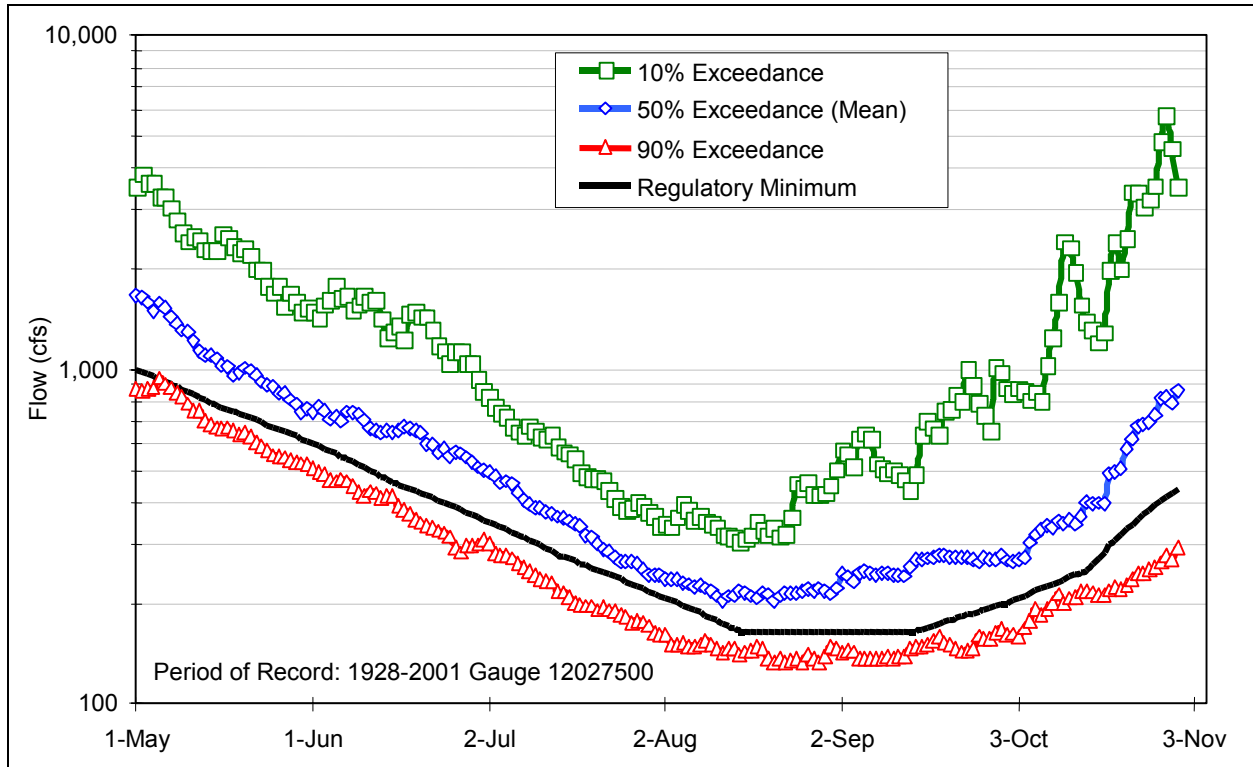


Figure 2-4. Dry-Weather Flow Exceedances and Regulatory Minimum, Chehalis River Near Ground Mound

- Location of Regulatory Control Point—Prairie Creek confluence
- Location of Existing Gauge—At Prather Road bridge near confluence with Prairie Creek
- Period of Record—1928-2001

The record is complete for all years and the gauge location coincides with the regulatory control point; therefore, the data provide a good indication of typical flow conditions at the control point. The regulatory minimums are consistently above the 90-percent exceedance curve and consistently below the mean curve.

Chehalis River at Porter

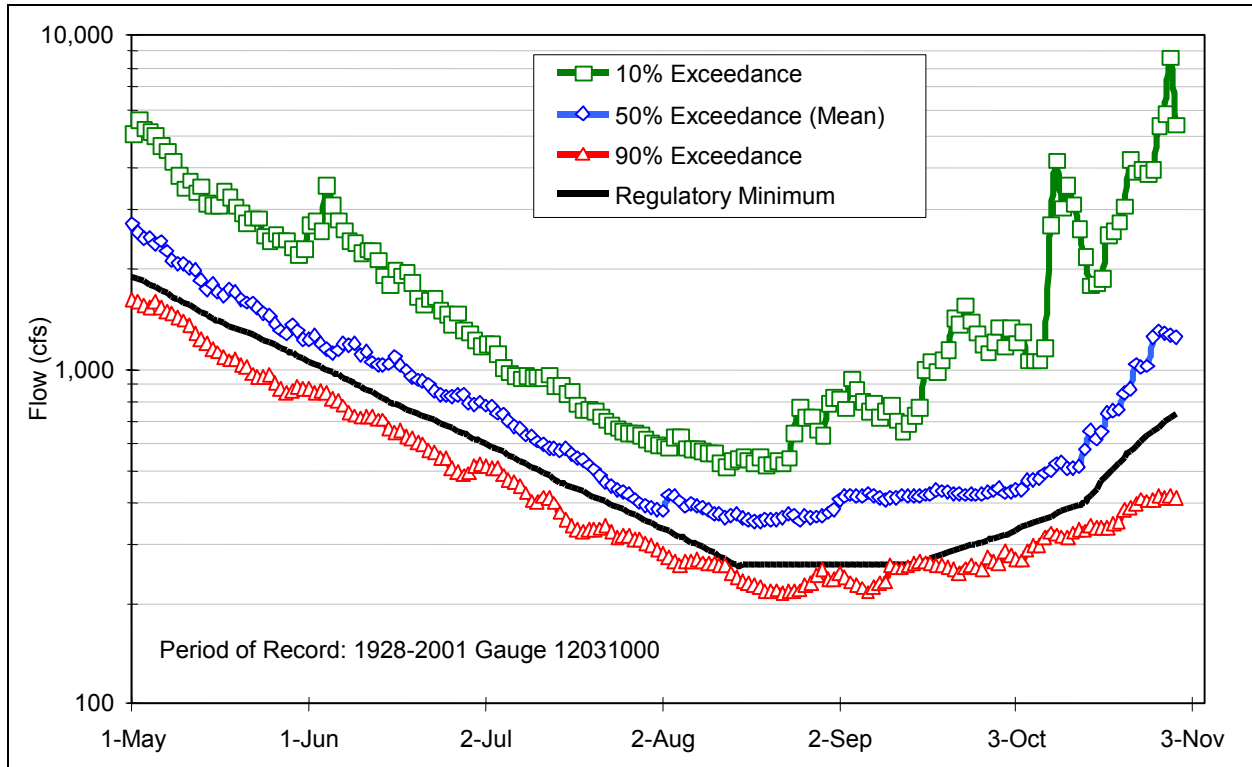


Figure 2-5. Dry-Weather Flow Exceedances and Regulatory Minimum, Chehalis River at Porter

- Location of Regulatory Control Point—At Porter Creek confluence
- Location of Existing Gauge—At Porter Creek confluence
- Period of Record—1952-2001

The USGS gauge and the regulatory control point are in the same approximate location. It is assumed that both points exclude Porter Creek flow. A gap in the USGS record exists between 1972 and 1975. Still, statistical summaries of the 44-year period of record provide a good overall assessment of flow conditions. Given the proximity to the regulatory control point, the gauge record should be adequate in assessing whether instream flows are being met.

The flow exceedance curves for the Porter gauge are about an order of magnitude higher than the Chehalis River Confluence with Elk Creek gauge (page 2-4). This is because several major tributaries contribute flow downstream of the Chehalis River Confluence with Elk Creek gauge, including the South Fork Chehalis River, the Newaukum River, and the Black River. The positions of the exceedance curve relative to the regulatory minimums are also similar. The regulatory minimums are above the 90-percent exceedance curve during the low-flow season.

Satsop River

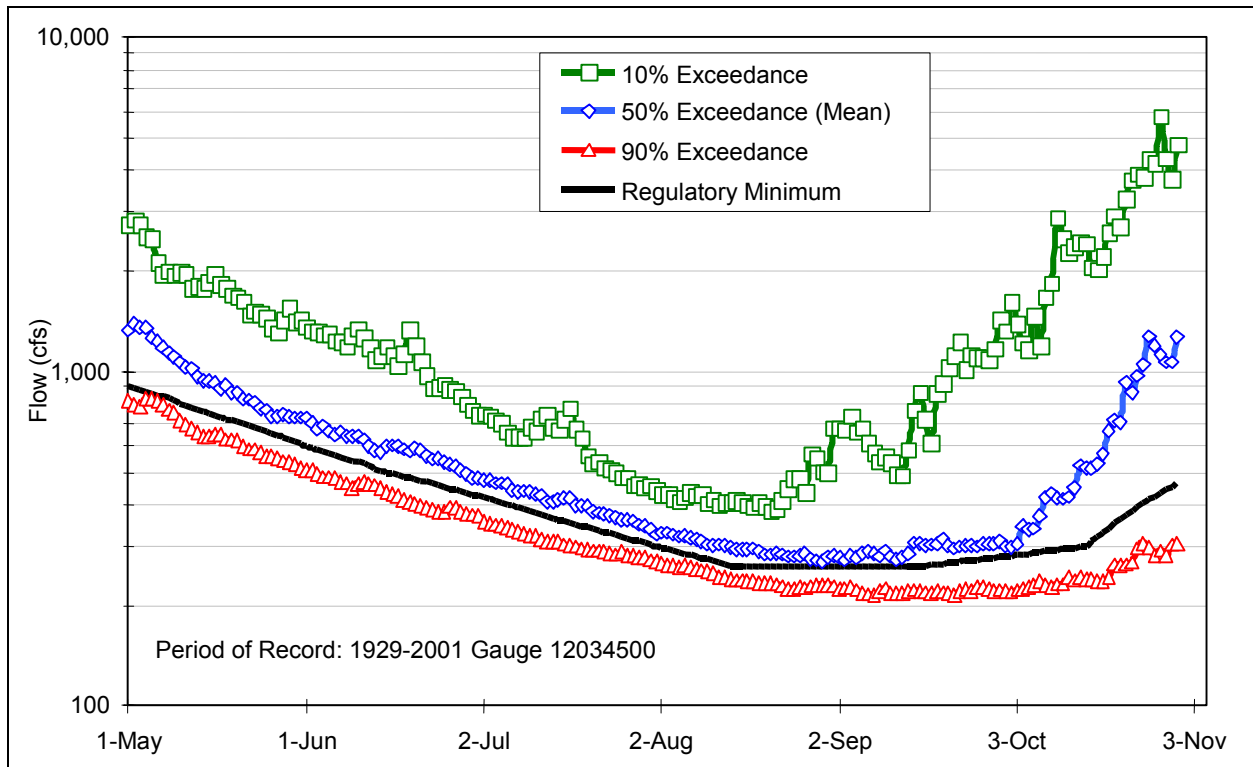


Figure 2-6. Dry-Weather Flow Exceedances and Regulatory Minimum, Satsop River

- Location of Regulatory Control Point—Chehalis River confluence
- Location of Existing Gauge—At Highway 12 bridge
- Period of Record—1929-2001

The gauge is located a short distance upstream of the Chehalis River confluence, and is assumed to operate free of tidal effects. The record is complete for all years. The regulatory minimum flows are about midway between the mean and 90-percent exceedance flows throughout the low-flow season.

Wynoochee River

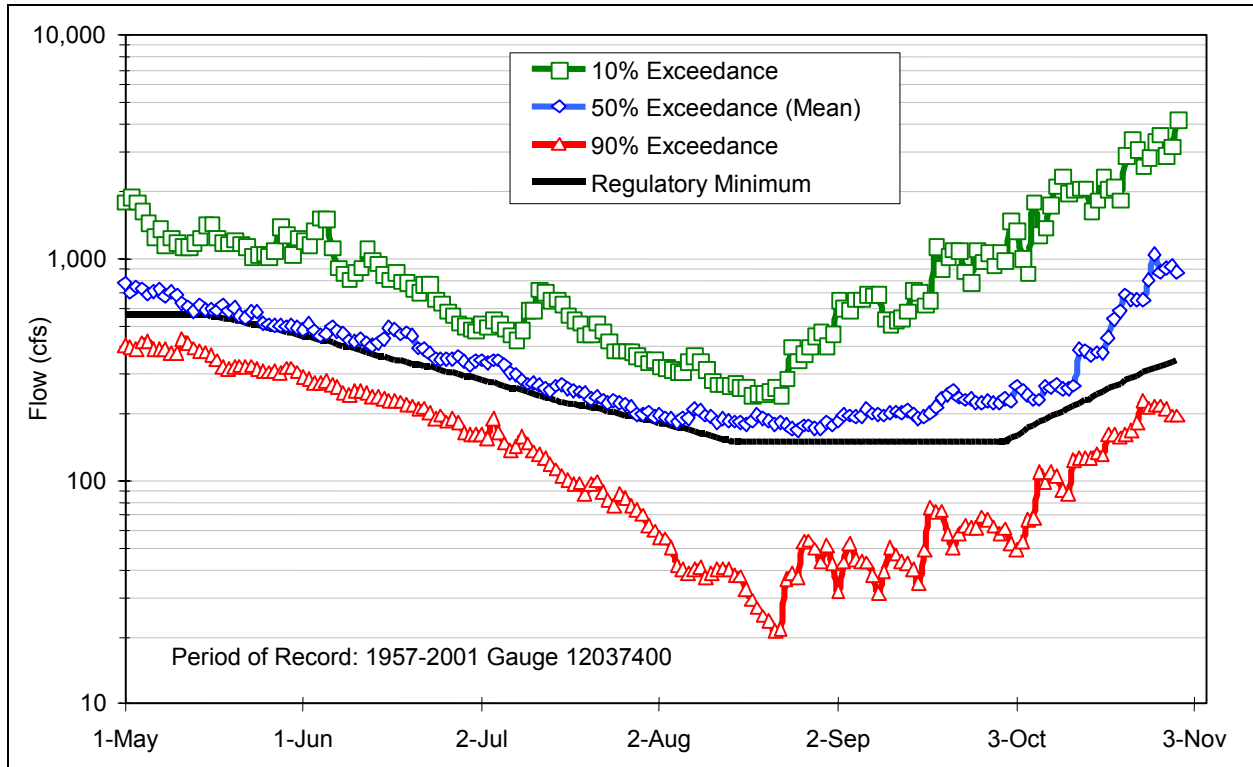


Figure 2-7. Dry-Weather Flow Exceedances and Regulatory Minimum, Wynoochee River

- Location of Regulatory Control Point—Confluence with Chehalis River
- Location of Existing Gauge—Just upstream of Black Creek
- Period of Record—1957-2001

No data are missing from the record. The existing gauge is about 4 miles upstream of the regulatory control point. Black Creek is a significant tributary that the gauge does not measure, and there may be other intervening sources of inflow. The regulatory minimum flows are much closer to the mean flow than the 90-percent exceedance flows, especially late in the summer. The flow gauge is probably not totally representative of the flow at the control point, because of the distance and inflow between the two points. Wynoochee Lake is several miles upstream and operation of the reservoir influences the stream flows.

Newaukum River

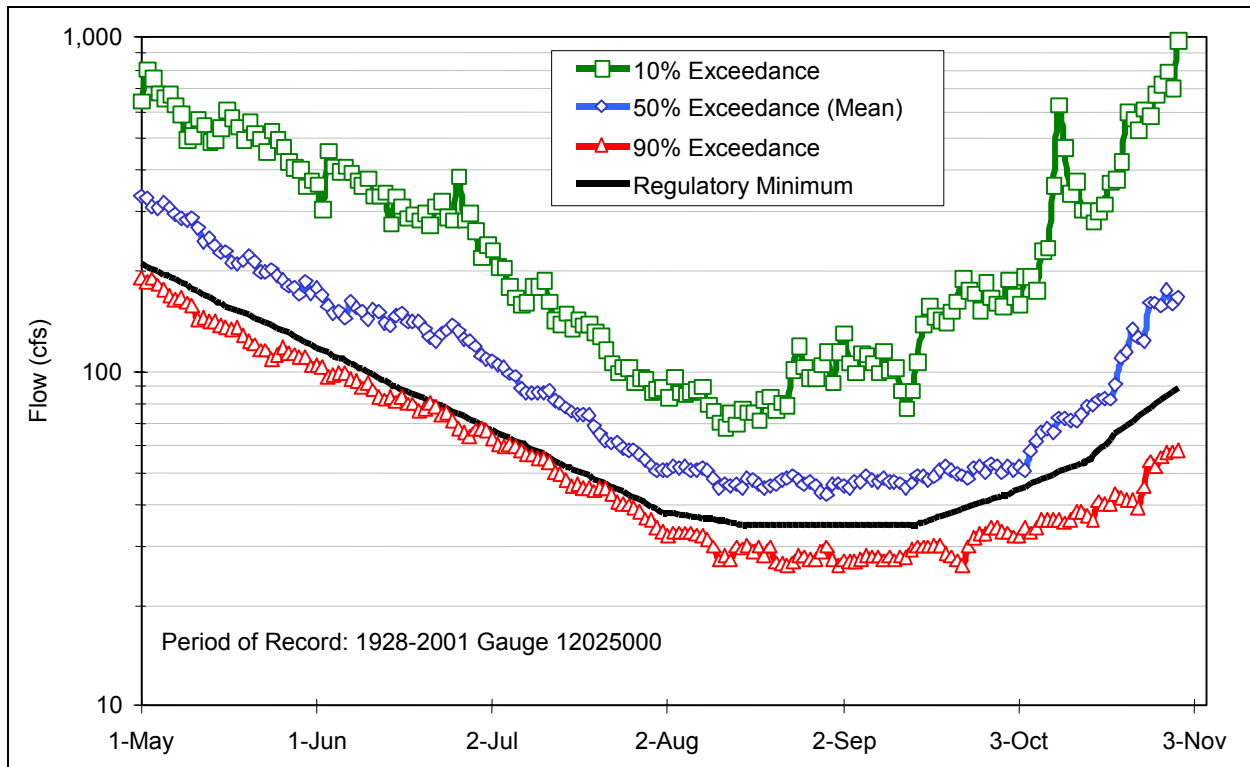


Figure 2-8. Dry-Weather Flow Exceedances and Regulatory Minimum, Newaukum River

- Location of Regulatory Control Point—Confluence with the Chehalis River
- Location of Existing Gauge—At Rogers Road bridge about 3 miles upstream of the Chehalis River confluence
- Period of Record—1929-2001

No major tributaries exist between the gauge and the regulatory control point. Gauge records are complete with the exception of the period from 1931 to 1942 and the 1982 water year. Given the proximity of the gauge to the regulatory control point, the lack of significant surface water inflow between the gauge and control point, and the 60-year gauge record, the exceedance curves in Figure 2-8 are a good indication of flows at the control point. The regulatory flows are just above the 90-percent curve and well below the median during the early summer through July. The 90-percent flows in late summer fall below the regulatory minimums by about 5 cfs. The regulatory minimums are about 10 cfs below the mean flows during this time. The regulatory minimums, mean, and 90-percent flows increase at about the same rate into the fall.

REVIEW OF HISTORICAL USGS GAUGE STATION DATA

The following sections summarize data obtained from the 12 historical USGS gauge stations near Chehalis Basin control points that are no longer in operation. These gauge stations are referred to by the associated control point name.

South Fork Chehalis River

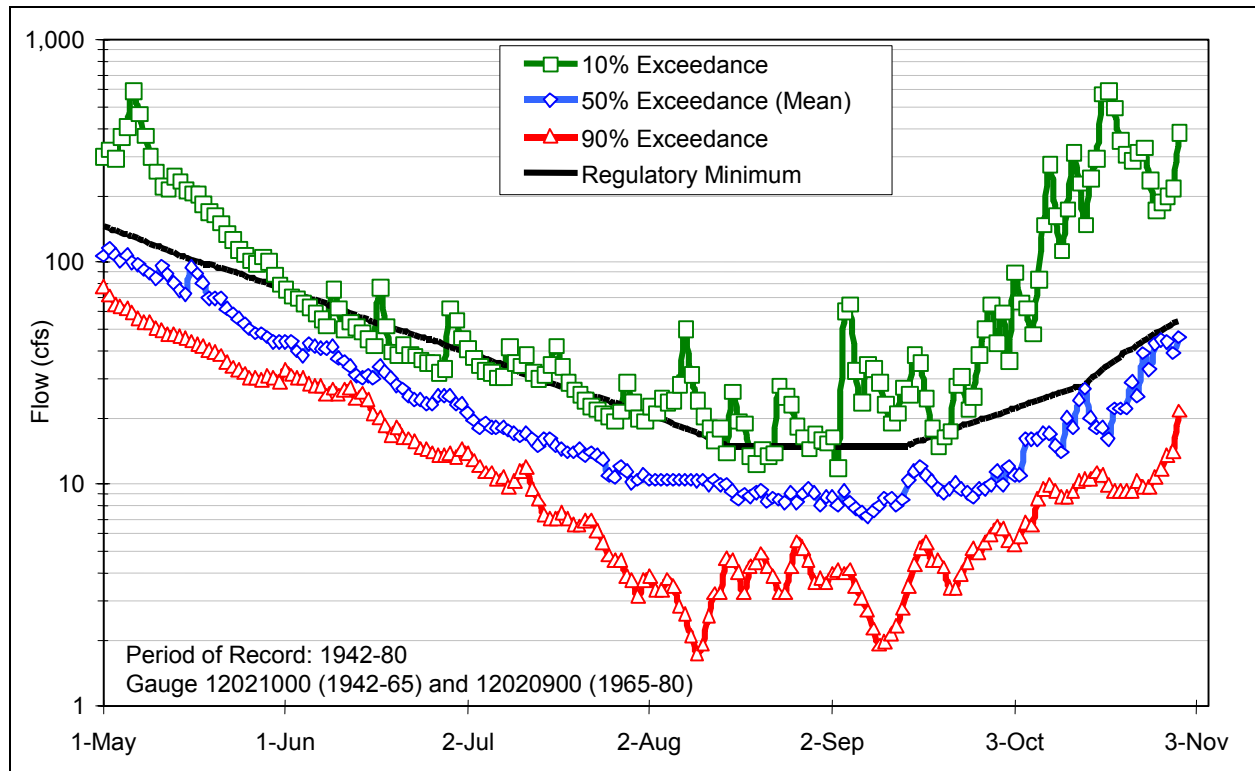


Figure 2-9. Historical Dry-Weather Flow Exceedances and Regulatory Minimum, South Fork Chehalis River

- Location of Regulatory Control Point—Chehalis River confluence
- Location of Historical Gauge—Several miles upstream of Chehalis River confluence
- Period of Record—1942-80.

The USGS operated a gauge on the South Fork Chehalis River at Boistfort from 1942 to 1965 (USGS Gauge No. 12021000). The gauge was near the intersection of Boistfort Road and Lost Valley road, about 5 miles upstream of the Chehalis River confluence. In 1965, the USGS began collecting data from a new site about 10 miles upstream of the confluence (USGS Gauge No. 12020900). The exceedance curves shown in Figure 2-9 are derived from both gauges. No data are available after 1980, as gauge operation was apparently discontinued. Additional data include several current meter measurements taken at the gauge locations (Walker, 1964).

The historical data were collected several miles upstream of the regulatory control point. Lake Creek is a tributary that could contribute a significant portion of flow to the South Fork near the town of Curtis, downstream of the USGS gauge locations. Thus, records from the USGS gauge probably underestimate the total instream flow at the control point.

The South Fork Chehalis River was monitored for flow at a point closer to the regulatory control point during the 2002 flow monitoring program. Results for this monitoring are presented in Chapter 4.

Chehalis River Below Confluence with Satsop River

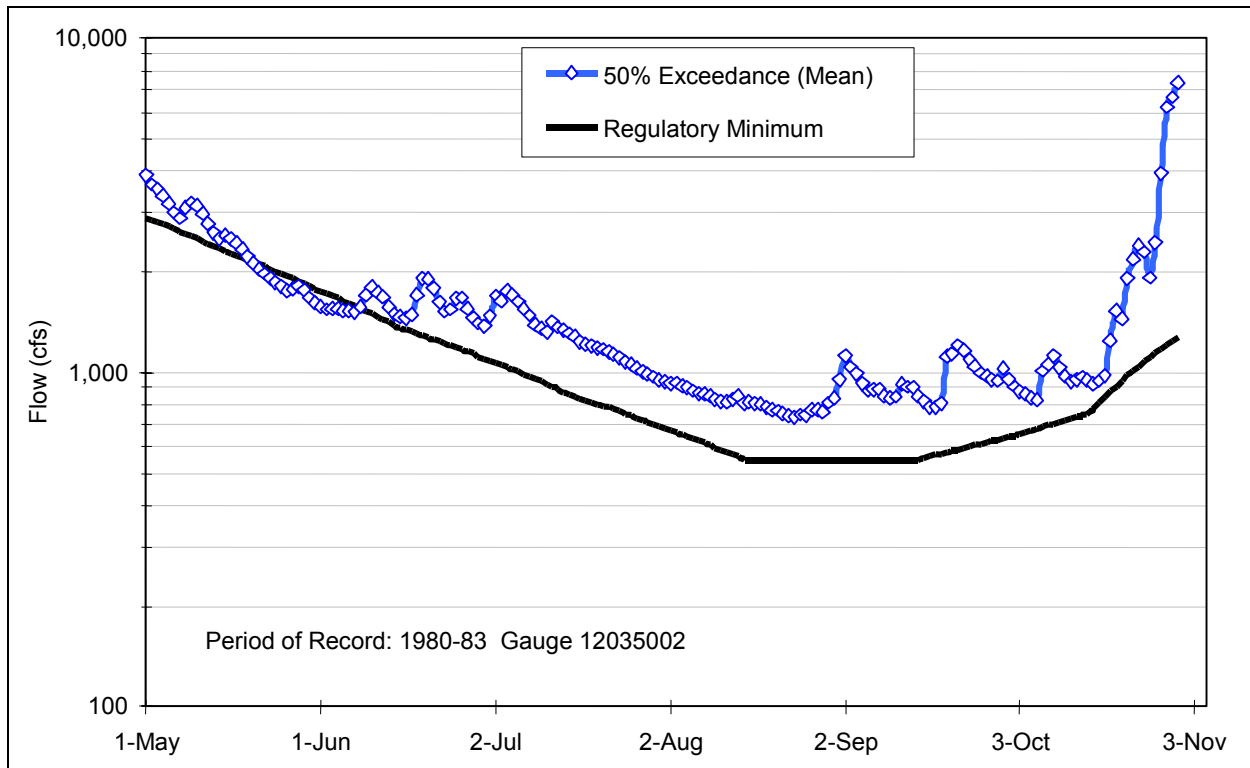


Figure 2-10. Historical Dry-Weather Flow Exceedances and Regulatory Minimum, Chehalis River below Confluence with Satsop River

- Location of Regulatory Control Point—Below Satsop River confluence
- Location of Historical Gauge—Below Satsop River confluence
- Period of Record—1980-83.

The USGS operated a gauge about 1.5 miles downstream of the Keys Road bridge for four years from 1980 through 1983. Ten- and 90-percent exceedance flows are not provided because the record is so brief. The mean daily flows for the low-flow season are plotted in Figure 2-10 with the regulatory minimum flows. It is not known why the gauge was discontinued or what methods were used to compute discharge in this tidally influenced reach.

Elk Creek

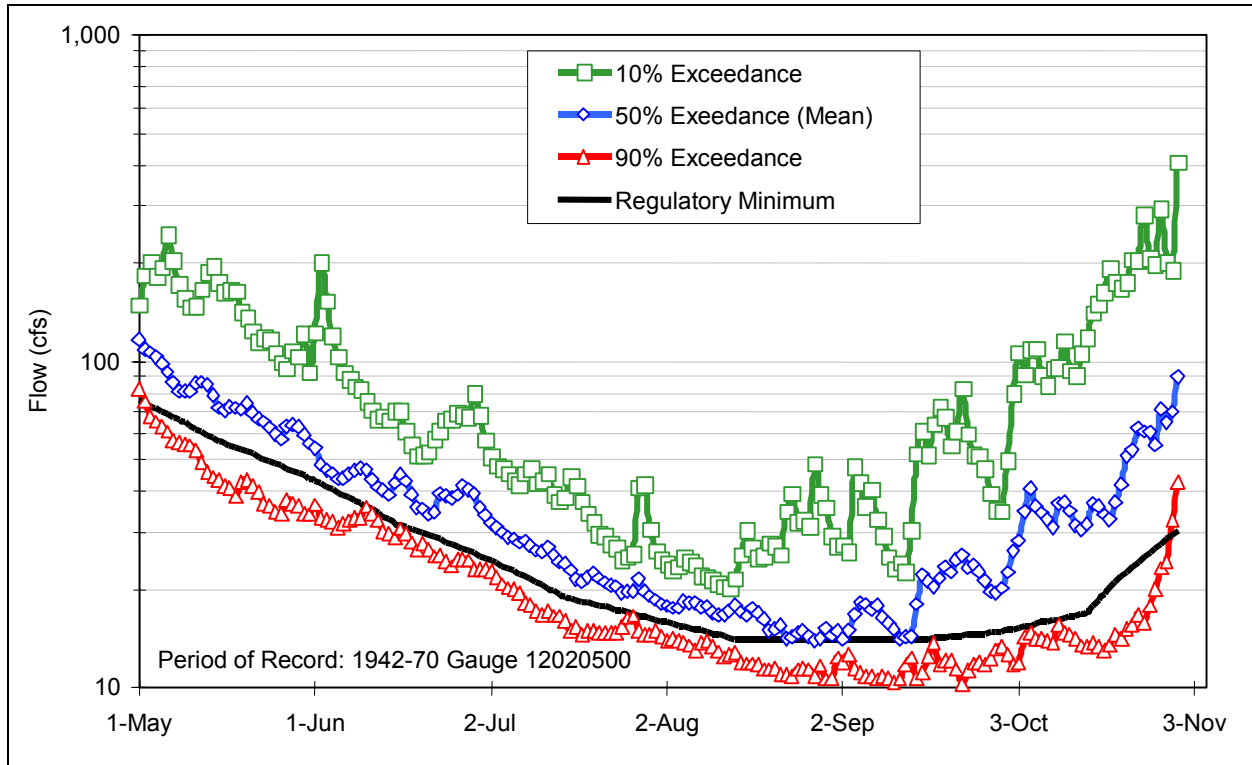


Figure 2-11. Historical Dry-Weather Flow Exceedances and Regulatory Minimum, Elk Creek

- Location of Regulatory Control Point—Chehalis River confluence
- Location of Historical Gauge—Approximately 3 miles upstream of Chehalis River confluence
- Period of Record—1942-70.

The Elk Creek historical gauge location is just downstream of the confluence with Seven Creek and Eight Creek. Two tributaries, Nine and Deer Creeks, contribute flow to Elk Creek between the gauge and the regulatory control point. Within the period of record, seven complete years of stream flow are available, for the periods 1945-49 and 1968-69.

Figure 2-11 shows that the mean flow is consistently above the regulatory minimum flow, except on a few days in late summer when the flows are about equal. The regulatory minimum flows are 2 to 4 cfs above the 90-percent exceedance flows for all but a couple of days during the low-flow season. Because the gauge record does not account for tributary inflow between the regulatory control point and the gauge location, the exceedance curves could underestimate the control-point flow to some degree. Available topographic maps indicate that the ungauged area is on the order of 10 percent of the total watershed. If it is assumed that discharge is a function of basin area, and no significant downstream diversions exist, then the exceedance curves could be shifted upward slightly.

Salzer Creek

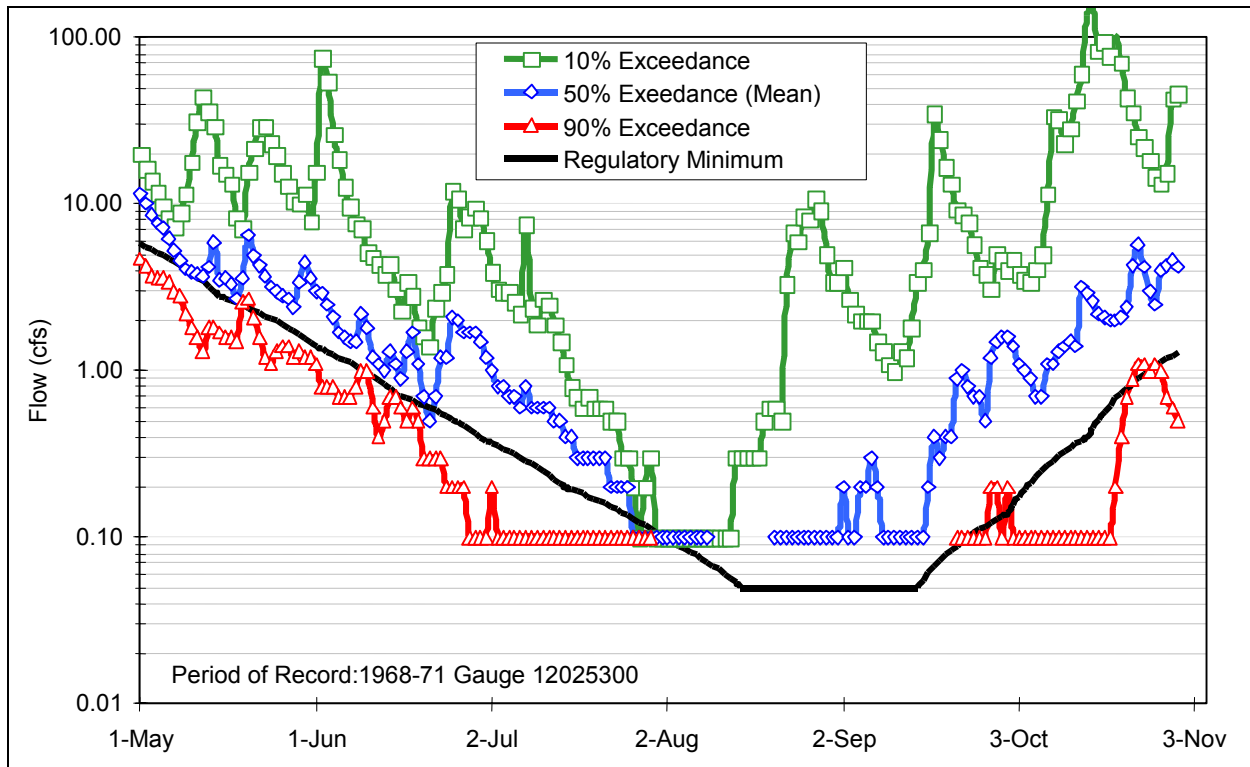


Figure 2-12. Historical Dry-Weather Flow Exceedances and Regulatory Minimum, Salzer Creek

- Location of Regulatory Control Point—Confluence with Chehalis River
- Location of Historical Gauge—At road bridge approximately 3 miles upstream of confluence
- Period of Record—1968-71

Figure 2-12 shows that the discharge in Salzer Creek is highly variable. The mean and 90-percent exceedances both have minimum values of zero; however, these values appear as gaps in the figure because zero values cannot be plotted on a logarithmic scale. The lowest 10-percent exceedance flow is 0.1 cfs, and the lowest regulatory minimum flow is 0.05 cfs. Variation in flows less than 0.1 cfs is probably not significant because such flows are generally below the resolution of gauge measurement.

The data suggest that Salzer Creek is essentially dry during the late summer. During the early summer, the regulatory minimum flows exceed the 90-percent flows for all but a few days. Mean flows exceed the regulatory minimums by 1 to 2 cfs. No major tributaries contribute flow to Salzer Creek downstream of the historical gauge location.

Porter Creek

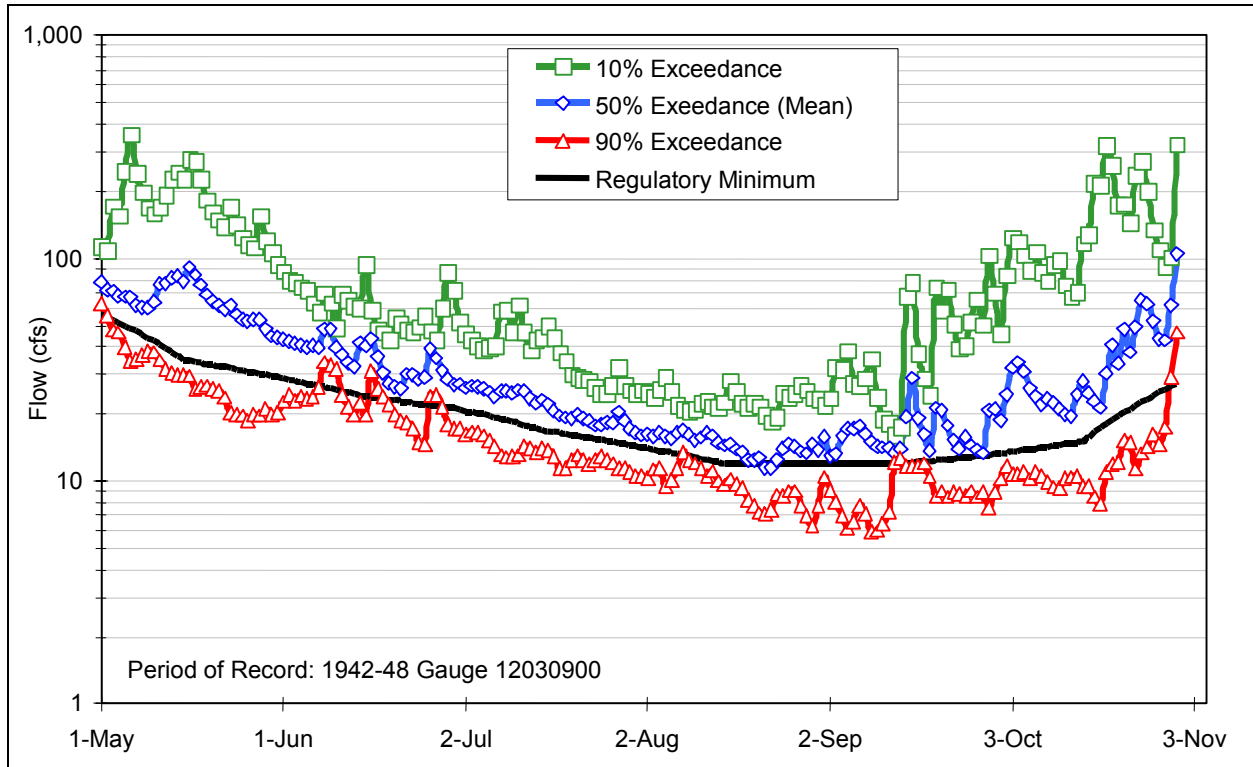


Figure 2-13. Historical Dry-Weather Flow Exceedances and Regulatory Minimum, Porter Creek

- Location of Regulatory Control Point—Confluence with Chehalis River
- Location of Historical Gauge—Approximately 2 miles upstream of Chehalis River Confluence
- Period of Record—1942-48

The record is complete from 1945-48; data are missing during several months for the years 1942 through 1944. Figure 2-13 shows that the regulatory minimum flow is generally midway between the mean and 90-percent exceedance curves. However, the four-year record is unlikely to be sufficient to develop the 10- and 90-percent exceedance curves shown in Figure 2-13.

Although two mapped tributaries contribute flow to Porter Creek downstream of the historical gauge location, available mapping shows the ungauged area of the basin to be small compared to the total basin area (less than 5 percent). It can therefore be assumed that most of the Porter Creek flow was accounted for at the historical gauge.

Black River

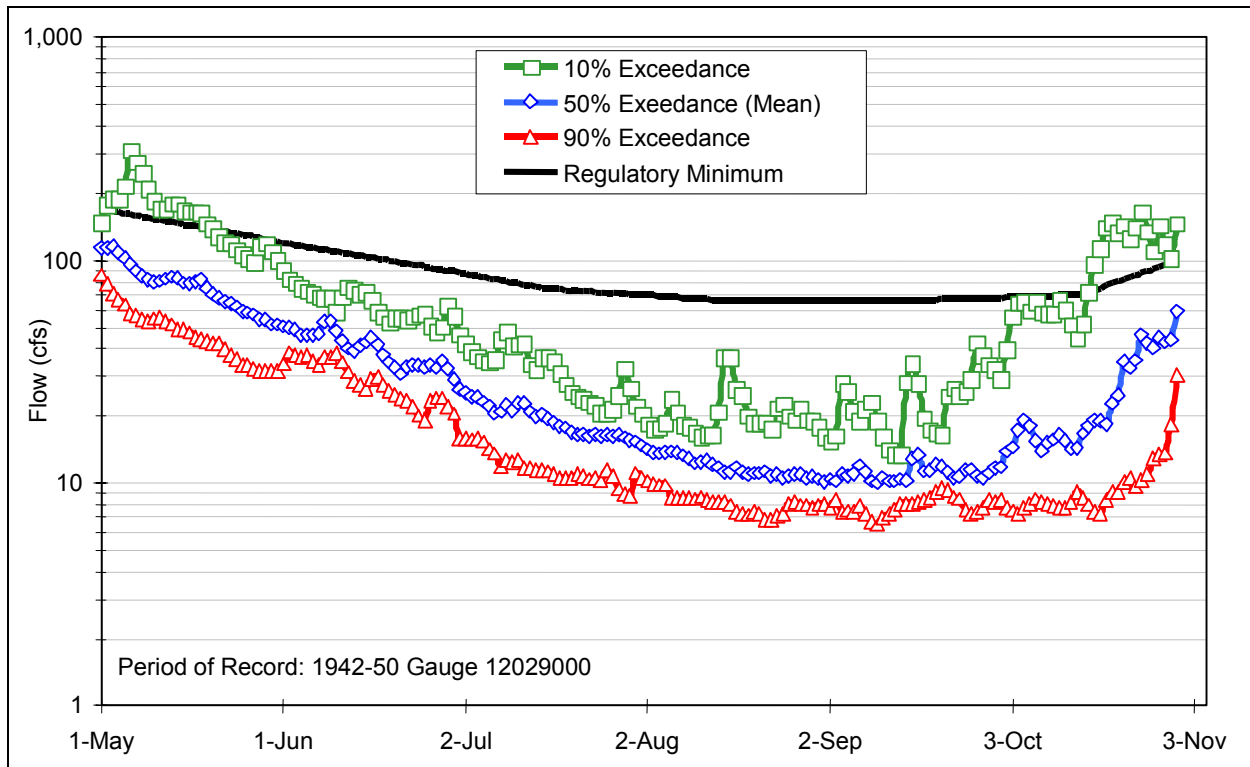


Figure 2-14. Historical Dry-Weather Flow Exceedances and Regulatory Minimum, Black River

- Location of Regulatory Control Point—Confluence with Chehalis River
- Location of Historical Gauge—About 15 miles upstream of the Chehalis River confluence, just downstream of the Waddell Creek confluence
- Period of Record—1942-50

Data are missing for all months except July, August, and September from 1942 through 1945. The exceedance curves in Figure 2-14 are computed from nine years of data for July through September, eight years of data in October, and six years of data for all other months.

All exceedance curves for the historical gauge are well below the regulatory minimums during the low-flow season, but the location of the historical gauge is far upstream of the regulatory control point, and it is believed that significant groundwater inflow contributes to the Black River. Flow data collected near the control point during the summer of 2002 support the idea that flows are typically higher than the exceedance curves indicate. For example, the mean August 2002 measured flow near the control point was 55.5 cfs, whereas the mean exceedance flow for August 15 at the historical gauge was 11.2 cfs. Flows measured elsewhere during the summer of 2002 indicating that it was a fairly low flow year, so the difference between the control point flows for that season and the historical gauge median can likely be attributed to inflow between the two locations.

Cloquallum Creek

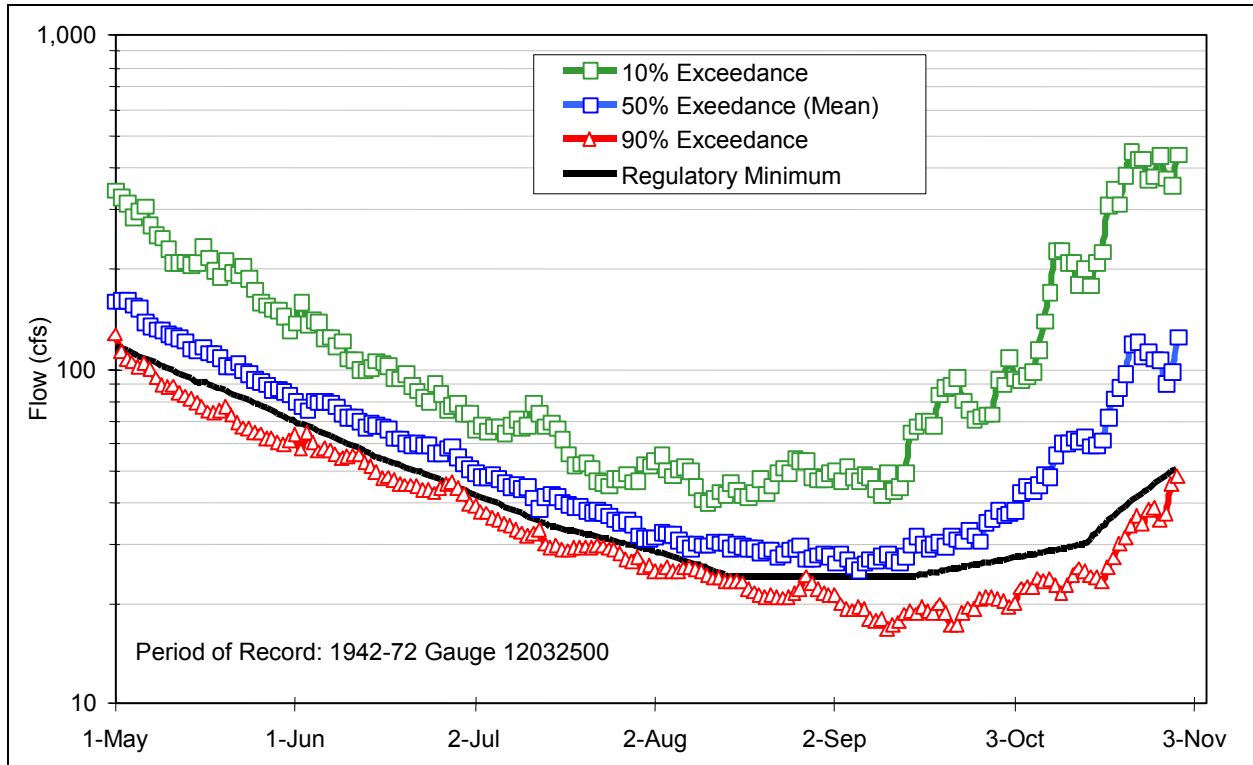


Figure 2-15. Historical Dry-Weather Flow Exceedances and Regulatory Minimum, Cloquallum Creek

- Location of Regulatory Control Point—At Chehalis River confluence
- Location of Historical Gauge—At road bridge approximately 1.5 miles upstream of confluence
- Period of Record: 1942-72

The gauge record is complete, except for the first three years (1942 through 1944). The 27-year period of record should be sufficient to represent typical flow conditions. The historical gauge location is just upstream of the Chehalis River floodplain. No major tributaries contribute flow below the gauge.

Figure 2-15 shows that mean flows exceed the regulatory minimums during all months of the low-flow season. Ninety-percent exceedance flows are slightly below the regulatory minimum for all but a few days of the low-flow season, when flow values are nearly equal.

East Fork Satsop River

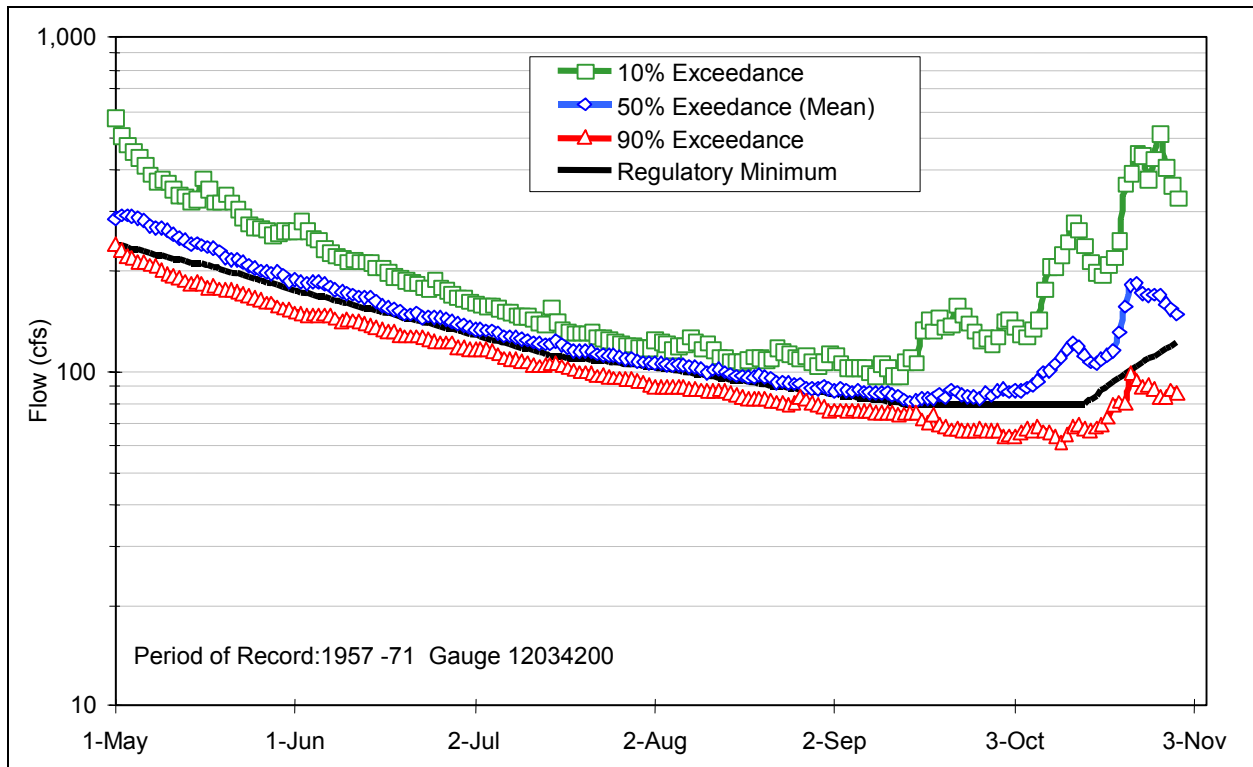


Figure 2-16. Historical Dry-Weather Flow Exceedances and Regulatory Minimum, East Fork Satsop River

- Location of Regulatory Control Point—At confluence with Dry Run Creek
- Location of Historical Gauge—Approximately 3 miles upstream of Dry Run Creek confluence
- Period of Record—1957-71

The record is complete with the exception of the first year of record, for which data are available from July through September. The 11-year record should be sufficient to develop the 10- and 90-percent exceedance curves shown. USGS topographic maps indicate that no major tributaries contribute flow to the East Fork Satsop River below the historical gauge site.

Figure 2-16 shows that the mean exceedance flow curve follows the regulatory minimum closely throughout the low-flow season. The curves are about equal during mid- to late summer. Ninety-percent flows continue to drop into autumn.

Humptulips River

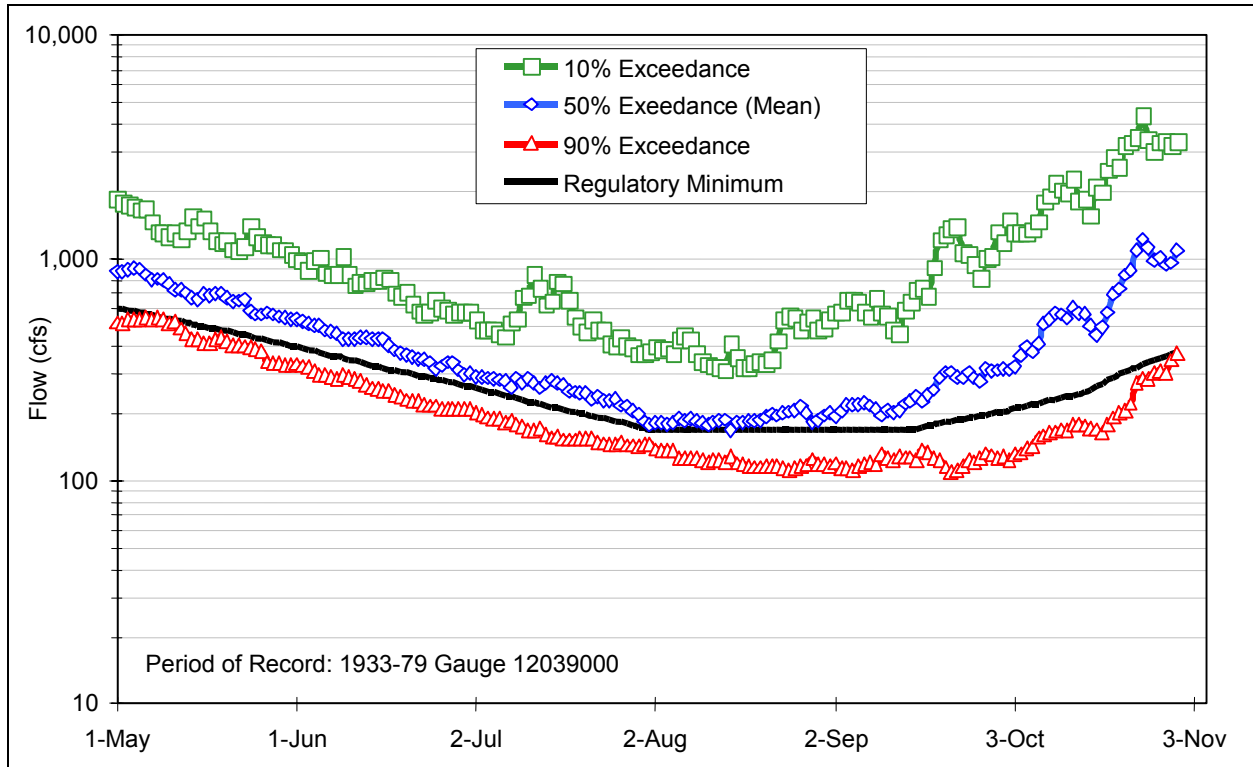


Figure 2-17. Historical Dry-Weather Flow Exceedances and Regulatory Minimum, Humptulips River

- Location of Regulatory Control Point—Point of tidal influence
- Location of Historical Gauge—Just upstream of Highway 101
- Period of Record—1933-79

Data are missing from the record from February 1936 through June 1942 (about seven years), however, the 40-year record should sufficiently describe typical flow conditions at the historical gauge location. It is thought that tidal influence extends upstream to a point near the bridge crossing between the towns of Tulips and Copalis Crossing. The gauging station location is several miles upstream of the regulatory control point. At least one significant tributary, Big Creek, contributes flow downstream of the historical gauge site.

Figure 2-17 shows that the regulatory minimum curve is between the 90-percent and mean exceedance curves. Regulatory minimum flows are closer to 90-percent flows in early summer, but move closer to the mean as the summer progresses.

Newskah Creek

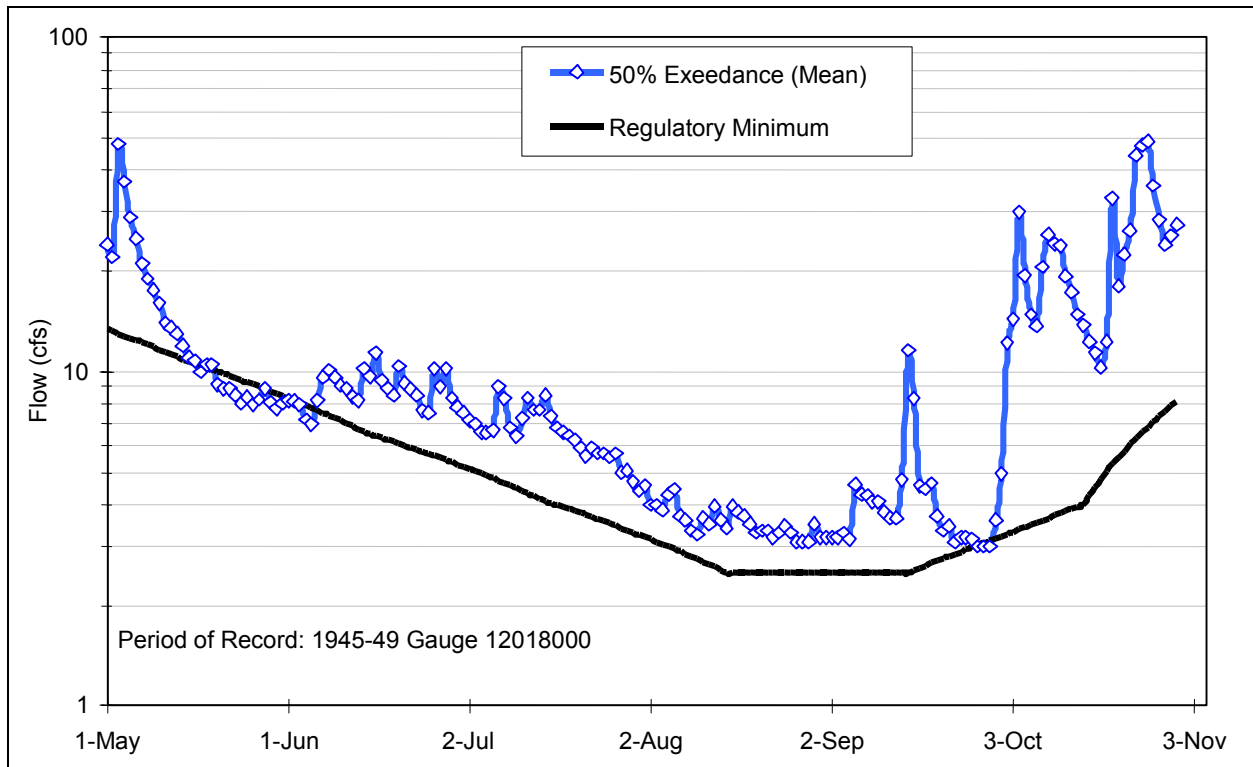


Figure 2-18. Historical Dry-Weather Flow Exceedances and Regulatory Minimum, Newkah Creek

- Location of Regulatory Control Point—Point of tidal influence
- Location of Historical Gauge—Approximately 2 miles upstream of Grays Harbor
- Period of Record—1945-49

The record contains four complete years of data. Ten- and 90-percent exceedance flows are not available because the period of record is too short. The reported elevation of the historical gauge is 40 feet above mean sea level, so it is probably upstream of tidal influence. Topographic maps indicate that no major tributaries contribute additional flow below the historical gauge site.

Charley Creek

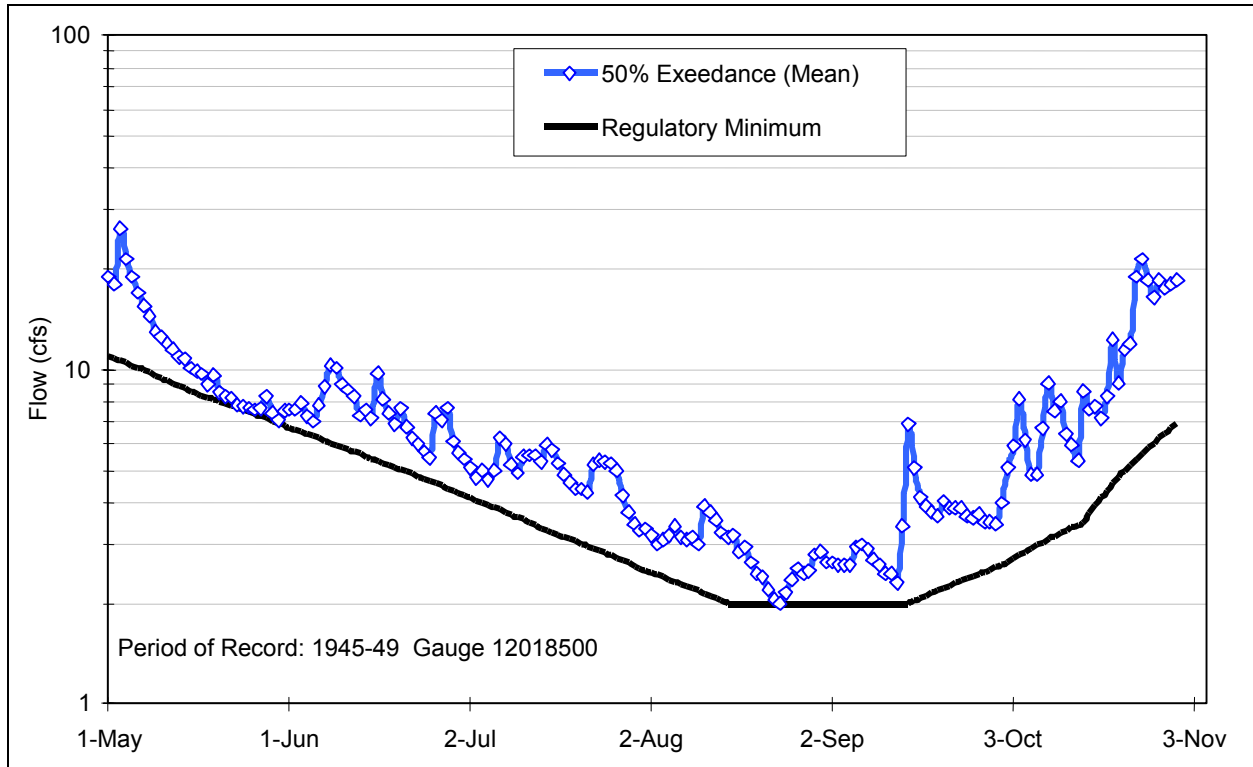


Figure 2-19. Historical Dry-Weather Flow Exceedances and Regulatory Minimum, Charley Creek

- Location of Regulatory Control Point—Point of tidal influence
- Location of Historical Gauge—Approximately 2 miles upstream of Grays Harbor
- Period of Record—1945-49

The record contains four complete years of data. Ten- and 90-percent exceedance flows are not available because the period of record is too short. The reported elevation of the historical gauge is 20 feet above mean sea level, and should therefore be upstream of tidal influence. Topographic maps indicate that no major tributaries contribute additional flow below the historical gauge site.

North Fork Newaukum River

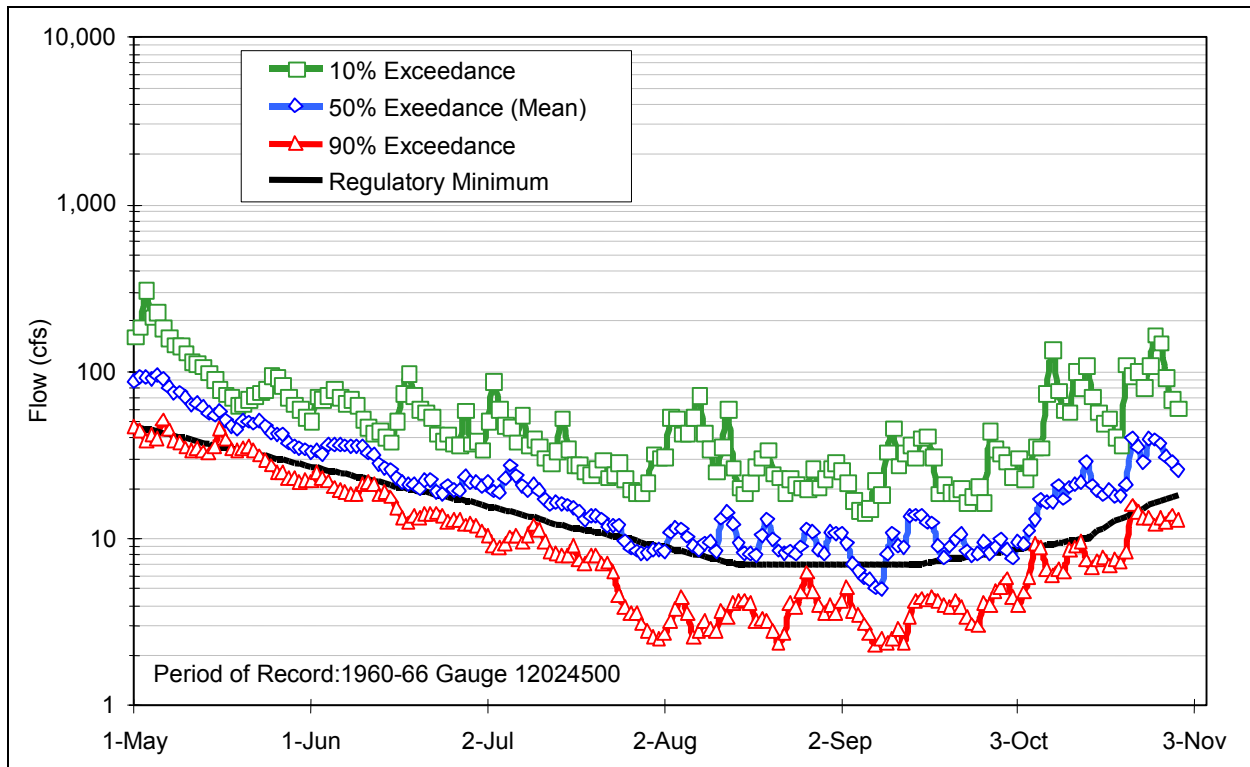


Figure 2-20. Historical Dry-Weather Flow Exceedances and Regulatory Minimum, North Fork Newaukum River

- Location of Regulatory Control Point—The WAC legal description locates the control point about 2 miles upstream of the Lucas Creek confluence. However, the written description indicates that the furthest downstream point of the “affected reach” is “the mouth,” which is assumed to mean the confluence with the South Fork Newaukum River.
- Location of Historical Gauge—About 2 miles upstream of the Lucas Creek confluence
- Period of Record—1960-66

The historical gauge site coincides with the WAC legal description of the regulatory control point; both are approximately 6 miles upstream of the confluence with the South Fork Newaukum River. The period of record is complete for water years 1960 through 1966. Figure 2-20 shows that regulatory minimum flows in early summer are closer to the 90-percent exceedance curve than the mean. By mid-June, the 90-percent curve falls below the regulatory minimum, which stays closer to the mean through late summer. In October, the mean and 90-percent flows increase faster than the regulatory minimum.

Given the relatively short period of record, the curves in Figure 2-20 may not accurately represent typical low-flow-season discharges. In addition, the data are fairly old, and may not represent current flow conditions. If the regulatory minimums are meant to be valid

over the river's entire length, as stated in WAC, the exceedance curves could be too low because the historical gauge did not account for the Lucas Creek contribution.