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SUSITNA-WATANA HYDRO

March 1, 2013

Ms. Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Re: Susitna-Watana Hydroelectric Project, FERC Project No. 14241-000; Filing of 2012 Baseline Environmental and Resources Study Reports

Dear Secretary Bose:

As explained in its Pre-Application Document and Revised Study Plan (RSP) for the proposed Susitna-Watana Hydroelectric Project, FERC Project No. 14241 (Project), the Alaska Energy Authority (AEA) carried out numerous baseline environmental and resources studies related to the proposed Project during the 2012 field season. Because the 2012 studies occurred prior to the commencement of the study phase of the licensing effort under the Federal Energy Regulatory Commission's (Commission) Integrated Licensing Process, AEA was not required to complete these baseline studies. However, AEA voluntarily undertook these studies for purposes of taking advantage of the 2012 field season to gather environmental data related to the proposed Project, and to help inform the scope and methods of the licensing studies during 2013-14, as set forth in AEA's RSP.

As AEA has completed the study reports associated with these 2012 baseline environmental and resources studies, it has made the study reports publicly available by uploading them to the "Documents" page of its licensing website, http://www.susitna-watanahydro.org/type/documents/. The purpose of this filing is to submit these study reports to the Commission's record for the above-referenced Project.

In particular, the following study reports are attached, all of which are relevant to the Commission's study plan determination scheduled for April 1, 2013:

- Attachment A: *Adult Salmon Distribution and Habitat Utilization Study* (January 2013)
- Attachment B: *Synthesis of Existing Fish Population Data* (February 2013)
- Attachment C: *Mercury Assessment and Potential for Bioaccumulation* (February 2013)

813 West Northern Lights Boulevard Anchorage, Alaska 99503 T 907.771.3000 Toll Free (Alaska Only) 888.300.8534 F 907.771.3044

- Attachment D: *Technical Memorandum, Susitna River Large Woody Debris Reconnaissance* (March 2013)

- Attachment E: *Riparian Vegetation Study Downstream of the Proposed Susitna-Watana Dam* (February 2013)

- Attachment F: *Technical Memorandum, Reconnaissance Level Assessment of Potential Channel Change in the Lower Susitna River Segment* (February 2013)

- Attachment G: *Stream Flow Assessment* (February 2013)

- Attachment H: *Development of Sediment-Transport Relationships and an Initial Sediment Balance for the Middle and Lower Susitna River Segments* (February 2013)

- Attachment I: *Technical Memorandum, Initial Geomorphic Reach Delineation and Characterization, Middle and Lower Susitna River Segments* (February 2013)

As the remaining 2012 study reports are finalized, AEA will continue to update its website and submit them to the record.

If you have questions concerning this submission, please contact me at wdyok@aidea.org or (907) 771-3955.

Sincerely,

Wayne Dyok
Project Manager
Alaska Energy Authority

Attachments

cc: Distribution List (w/o Attachments)

Attachment G

Stream Flow Assessment (February 2013)

Susitna-Watana Hydroelectric Project (FERC No. 14241)

Stream Flow Assessment

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

Tetra Tech, Inc.

February 2013

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LIST OF ACRONYMS AND SCIENTIFIC LABELS

Abbreviation	Definition
AEA	Alaska Energy Authority
cfs	cubic feet per second
FDC	flow-duration curve
FERC	Federal Energy Regulatory Commission
ILP	Integrated Licensing Process
NAVD	North American Vertical Datum
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum
OS	Operation Scenario
Project	Susitna-Watana Hydroelectric Project
PRM	Project River Mile
RM	River Mile
sq. mi.	square mile
USGS	U.S. Geological Survey
WY	Water Year

SUMMARY

The 2012 Stream Flow Assessment involved analysis of pre-Project and post-Project flows in the Susitna River below Watana Dam. The pre-Project condition was based on the extended flow record developed by the USGS. The post-Project condition was based on a hypothetical operational scenario (OS) referred to as Maximum Load Following OS-1.

The purpose of the Stream Flow Assessment was to identify the potential Project related changes in Susitna River flows and stage in the Lower River (the portion of the river downstream of the Susitna, Chulitna and Talkeetna river confluence). The analysis performed was an initial assessment to inform the study planning and early execution phases of the integrated licensing process (ILP). Of primary interest was whether the results of the analysis indicate the need to extend portions of Fluvial Geomorphology Modeling Study and other studies further downstream in the Lower River.

The 2012 work involved four main areas of analysis: Assessment of pre-Project and Maximum Load Following OS-1 stream flows, determination of stage exceedances at the Sunshine and Susitna Station USGS gages, and analysis of the long-term stability of the USGS gages (specific gage analysis) and evaluation of discharge effects on ice elevation an flow characteristics at the USGS gages.

The study results were provided the hydrologic information to perform three other 2012 study efforts, the Reconnaissance Level Assessment of Potential Channel Change in the Lower Susitna River Segment, Development of Sediment-Transport Relationships and an Initial Sediment Balance for the Middle and Lower Susitna River Segments, and Synthesis of the 1980s Lower Susitna River Segment Aquatic Habitat Information. Updated and more detailed analysis of the Susitna River hydrology under Project conditions will be investigated in the 2013 and 2014 studies, including other operating scenarios in addition to Maximum Load Following OS-1.

The most significant finding of the Stream Flow Assessment comes from the results of the annual peak flow frequency analysis. Comparison of results between the existing conditions and the Maximum Load Following Operations Scenario 1 indicates the potential for an appreciable post-Project reduction in flows in the 1.5- to 5-year range of recurrence intervals in the Lower River. Discharges in the range of the 1.5- to 5-year peaks are often representative of the channel forming or effective discharge to which the bankfull channel capacity adjusts in streams such as the Lower River Segment that have mobile bed material and a substantial sediment supply. For the 2-year event, the reduction at Sunshine and Susitna Station were estimated at 24 and 17 percent, respectively. Relationships between channel size and discharge suggest that the level of peak flow reduction could result narrowing of the channel width by in slightly greater than 10 percent in the portion of the Lower River below Sunshine, and less than 10 percent downstream from the Yentna River confluence. These preliminary results have served as part of the decision criteria to extend the Fluvial Geomorphology Modeling Study 50 miles further downstream in the Lower River to the Susitna Station USGS Gage, or approximately 30 miles above the mouth of the river in order to provide more detailed assessment of the potential Project effects in this portion of the river.

1. INTRODUCTION

The Alaska Energy Authority (AEA) is preparing a License Application that will be submitted to the Federal Energy Regulatory Commission (FERC) for the Susitna-Watana Hydroelectric Project (Project) using the Integrated Licensing Process (ILP). The Project is located on the Susitna River, an approximately 300-mile-long river in the Southcentral Alaska. The Project's dam site would be located at River Mile (RM) 184. The results of this study provided information to inform the 2013–2014 licensing study program, Exhibit E of the License Application, and FERC's National Environmental Policy Act (NEPA) analysis for the Project license.

This report provides the results of the Streamflow Assessment Task and the River Stage subtask of the Riverine Habitat-Flow Relationship Assessment Task, both conducted as part of the Geomorphology Study's 2012 Reconnaissance Level Geomorphic and Aquatic Habitat Assessment of the Project Effects on the Lower River Channel Study (AEA 2012). The report includes the results of the hydrologic analysis which summarizes pre-Project hydrology and post-Project hydrology under an operations scenario referred to as Maximum Load Following Operation Scenario 1 (OS-1) conditions hydrology.

The pre-Project analysis was performed using 61-year extended hydrologic records developed by the U.S. Geological Survey (USGS 2012) for the period from Water Year (WY) 1950 through WY2010 for 11 streamflow gages located in the Susitna Basin. The Maximum Load Following OS-1 analysis was performed using a simulated record developed with-Project conditions flow routing model (MWH 2012) for the same period. The Maximum Load Following OS-1 is based on the assumption that the entire load fluctuation of the entire Railbelt would be provided by the Susitna-Watana Project, and that all other sources of electrical power in the Railbelt would be running at base load. This assumed condition is not realistic for an entire year, and the results of this condition should be conservative with respect to assessing downstream impacts of load following.

The analysis included monthly flow summaries, flow-duration curves, flood frequencies curves, and associated statistics the gages for which flow records are available. A comparison between the pre-Project conditions and the Maximum Load Following OS-1 conditions was also conducted for the Gold Creek, Sunshine and Susitna Station gages.

The analysis presented in this report is an initial assessment intended to help in the study planning and early execution phases of the ILP. The routing model downstream of the Project utilized the 1980s cross-sections and simplified routing techniques. The open water hydraulic routing (R2 Resource Consultants et al. 2013) model being currently developed will replace 1980s-based routing model applied in this initial assessment. Analysis to be conducted in 2013 and 2014 will replace the initial assessment presented in this report.

2. STUDY OBJECTIVES

The overall objective of this memorandum is to evaluate the relative magnitude of changes to the flow regime of the Susitna River pre- and post-Project and associated change in river stage. More

specifically, the objectives are to characterize the existing streamflow regime in the Susitna River and key tributaries, and to perform preliminary quantification of the anticipated changes under Maximum Load Following OS-1 conditions, including assessments of the following, interrelated topics:

- Pre-Project and Maximum Load Following OS-1 streamflows
- Pre-Project and Maximum Load Following OS-1 river stage duration at the Sunshine and Susitna Station USGS gages
- Analysis of specific gages to assess historic changes in the stage-discharge relationships at the mainstem gages
- Using available USGS data identify discharge effects on ice elevation and cross-sectional flow characteristics, if feasible.

Throughout this report, the term "Available Record" refers to the data collected by the USGS at each gage and varies in availability based on the years each gage was in operation. The term "Extended Record" refers to the 61-year (WY1950 and WY2010) record of daily streamflows developed by the USGS through correlation analysis for each of the 11 streamflow gages that was considered in the pre-Project analysis.

3. STUDY AREA

3.1. General

The Susitna River, located in Southcentral Alaska, drains an area of approximately 20,010 square miles and flows about 320 miles from its headwaters at the Susitna, West Fork Susitna, and East Fork Susitna glaciers to the Cook Inlet (USGS 2012). The Susitna River basin is bounded on the west and north by the Alaska Range, on the east by the Talkeetna Mountains and Copper River Lowlands and on the south by Cook Inlet. The highest elevations in the basin are at Mt. McKinley at 20,320 feet while its lowest elevations are at sea level where the river discharges into Cook Inlet. Major tributaries to the Susitna River between the headwaters and Cook Inlet include the Chulitna, Talkeetna and Yentna rivers that are also glacially fed in their respective headwaters. The basin receives, on average, 35 inches of precipitation annually with average annual air temperatures of approximately 29^{o}F.

3.2. Specific Study Area

For the Susitna-Watana Hydro Project licensing effort the Susitna River from Cook Inlet to the Maclaren River confluence at Project River Mile (PRM)261.3, the river has been subdivided into three segments (Tetra Tech 2013) whose general characteristics are governed by the basin geology as described by Wilson et al. (2009). The segments are referred to as the Upper, Middle and Lower Susitna River segments (Figure 3.2-1):

- Upper Susitna River Segment: Maclaren River confluence (PRM 261.3) downstream to the proposed Watana Dam site (PRM 187.1)
- Middle Susitna River Segment: Proposed Watana Dam site (PRM 187.1) downstream to the Three Rivers Confluence (PRM 102.4)

- Lower Susitna River Segment: Three Rivers Confluence (PRM 102.4) downstream to Cook Inlet (PRM 3.3)

In addition to the segment boundaries, Figure 3.2-1 also shows the locations of gaging stations where flow, and in some cases, sediment measurements are available. The upstream-most segment, referred to as the Upper River (UR), extends from PRM 261.3 to PRM 187.1 at the Watana Dam site. The morphologic characteristics of this segment of the river are dominated by the products of Quaternary-age glaciation. The Middle River (MR) segment extends from the Watana Dam site to the Three Rivers Confluence at about PRM 102.4. The general characteristics of the river in this segment are heavily influenced by bedrock outcrop as well as Quaternary-age glaciations. The Lower River (LR) segment extends from the Three Rivers Confluence (PRM 102.4) to the tidal flats at Cook Inlet (PRM 3.3). The morphologic characteristics of the river in this segment are dominated by the sediment loading from the major tributaries and variable resistance to erosion of the Pleistocene-age, glacially-derived materials including tills (moraines), glacio-fluvial sediments in various elevation outwash-surfaces and glacio-lacustrine sediments that control the width of the valley.

The study effort presented in this Technical Memorandum is concentrated on the Lower Susitna River Segment. However, the study area also includes the Middle and Upper Susitna River Segment since USGS gaging stations that helped form the basis for the hydrologic analysis are located throughout the Susitna River Basin.

4. ASSESSMENT OF PRE-PROJECT AND MAXIMUM LOAD FOLLOWING OS-1 STREAM FLOWS

4.1. Objectives

The overall purpose of this task is to develop hydrologic information for both the pre-Project and Maximum Load Following OS-1 (post-Project scenario) conditions and use this information to compare pre-Project and potential post-Project flows. Specific hydrologic indicators to be developed include: monthly and annual flow duration curves, monthly flow statistics (mean, median, maximum and minimum), and annual flood frequency analysis.

4.2. Available Data

There are 14 USGS streamflow gages in the Susitna River Basin plus one on the Little Susitna River that was used as an index station (Table 4.2-1 and Figure 3.2-1). The period of record for these gages ranges from 58 years at the Gold Creek gage to less than 10 years at the Yentna River at Susitna Station and the Susitna River at Sunshine gages. The available data from many of these gages "…might not adequately represent long-term streamflow conditions" in the Susitna River Basin because of the short period of record and the distribution of years during which data were collected (USGS 2012). To provide a consistent long-term record, the USGS extended the record of 11 of these gages to 61 years (WY1950 – WY2010). WY1950 was selected for the start of the record because this was the first full water year of data collection for the primary index station at Gold Creek. The Montana Creek (Mont), Deception Creek (Decep), and the Deshka River (Desh) gages were not included in the extended record analysis because

they could not be adequately correlated to any long-term index station for the entire study period (USGS 2012).

4.3. Methods

This section describes the methods used to develop the monthly flows and summary statistics, the flow duration analysis, and the flood frequency analysis for both the pre-Project and Maximum Load Following OS-1 conditions.

4.3.1. Pre-Project

Monthly flow summaries were developed from the USGS (2012) extended records (downloaded from the USGS website at http://pubs.usgs.gov/sir/2012/5210) by calculating the average, maximum, minimum and median flow by month across all 61 years of the extended record, with all results rounded three significant figures. Flow-duration curves (FDCs) that represent the percentage of time each discharge is equaled or exceeded during the period of analysis were then developed using the mean daily data from the extended records. The FDCs were developed for each month and on an annual basis for each gage.

Flood frequency curve were also developed for each of the gages using the U.S. Army Corps of Engineers Hydraulic Engineering Center Statistical Software Package (HEC-SSP) that applies standard methods outlined in Bulletin 17B (IACWD 1982). These methods involve fitting a log-Pearson Type III (LPIII) frequency distribution to the annual peak flow. Recorded annual peak flow data for the available record were downloaded from the USGS water data website (http://waterdata.usgs.gov) for each gage. As noted above, the period of available record at these gages ranges between 10 and 58 years. The records were, therefore, extended to 61 years by developing a correlation relationship between instantaneous peak flow and the corresponding mean daily flow, and applying that relationship to the annual maximum mean daily flow in the extended portion of the record. The LPIII distribution was fit to the extended data using the weighted-skew method with a regional skew coefficient of 0.70 from the map of Generalized Skew Coefficients in IACWD (1982), the station skew that is a function of the measured data, and the recommended value of 0.302 for the mean square error of the generalized skew coefficient. HEC-SSP conducts high and low outlier tests to remove data that departs significantly from the trend of the annual series before fitting the distribution to the data.

To provide a basis for directly comparing modeled flows under Maximum Load Following Operation Scenario 1 (OS-1), MWH (2012) performed HEC-ResSim modeling for the pre-Project condition using the USGS gage records as model input. The HEC-ResSim model used the 1980s cross sections and the Muskingum-Cunge hydrologic routing procedure to route the flows downstream of the Watana Dam site to Sunshine Station. Flood frequency analyses were conducted using the annual hourly maximum flows as a surrogate for the 15-minute "instantaneous" measurements that are typically used for this purpose.

4.3.2. Maximum Load Following Operation Scenario 1

Flow-duration and flood frequency analyses were performed for a post-Project scenario, referred to as Maximum Load Following Operation Scenario 1 (OS-1), were performed for the three mainstem Susitna River gages (Gold Creek PRM 140, Sunshine PRM 88 and Susitna Station

PRM 30) below the Watana Dam site (PRM 187) using the same methods that were described in the previous section for the pre-Project analysis. Data used in the analysis were developed by MWH (2012) using the HEC-ResSim operations model of the Project that uses the USGS 61-year extended record of mean daily flows as a long-term reservoir inflow time series. The model run on which these data are based represents a preliminary operation scenario that was developed by placing the entire variability of the Railbelt electricity load on Susitna-Watana; thus, it represents a maximum (or worst-case) load-following scenario (John Haapala, personal communication, January 24, 2013). The model was used to route the reservoir outflows downstream through the Susitna River to the Sunshine Gage at PRM 88, providing a 61-year period of simulated flows for Maximum Load Following OS-1 at Gold Creek and Sunshine. A 61-year flow record for the Susitna Station gage was estimated by adding the difference between the flows at the Sunshine and Susitna Station gages from the USGS (2012) extended record to the routed flows at Sunshine. Annual hourly maximum hourly flows from the HEC-ResSim routings were used for the peak flood frequency analysis at Gold Creek and Sunshine as a surrogate for the instantaneous (15-minute) gage data that is typically used for this type of analysis, since the maximum temporal resolution of the model output is 1 hour. This approach is not considered to be a significant limitation in the analysis, since Susitna River is relatively large, and the difference between the peak 15-minute and maximum hourly flows is typically quite small. The frequency analysis for Susitna Station was performed based on the annual maximum mean daily flows because sufficient information is not available at this time to reliably estimate maximum flows at a higher temporal resolution. As will be shown in the analysis, this is also not a significant limitation at this location on the river.

4.4. Results

This section details the monthly flows and summary statistics, the flow duration analysis, and the flood frequency analysis for both the pre-Project and Maximum Load Following OS-1 conditions.

4.4.1. Pre-Project

The pre-Project condition is based on the 61-year extended flow record developed by the USGS (2012). It represents flow conditions without the Project in place.

4.4.1.1. Average Annual and Monthly Flow Summary

The average annual discharge from the USGS (2012) extended record at Gold Creek is about 9,700 cfs (average annual volume of ~7M ac-ft), and it is between 8,100 and 11,200 cfs in 80 percent of the years (Tables 4.4-1 and 4.4-2). Due, primarily, to inflows from the Chulitna and Talkeetna rivers that contribute 36 and 17 percent of the total, respectively, the average annual flow increases to about 24,000 cfs (~17.4M ac-ft) at the Sunshine gage, and is between 20,400 and 26,900 cfs in 80 percent of the years. At the Susitna Station gage, the average annual discharge is about 48,600 cfs (~35.2M ac-ft) and is between 42,500 and 55,600 cfs in 80 percent of the years. The Yentna and Skwentna River contribute 40 percent and 14 percent of the total flow at Susitna Station, respectively.

The Susitna River and its tributaries are located at varying elevations and the seasonal variability in flow is, in large part, driven by seasonal snow melt in June and July, and also by the relative

timing and magnitude of glacial melt and rainstorm outside this period. Under pre-Project conditions, the highest flows occur in June, the low-flow period occurs between November and April, and flows are typically elevated above baseflow from May through October (Figure 4.4-1 and Table 4.4-2). Monthly flow summaries for each year in the extended record on which these averages are based are provided in Appendix A.

4.4.1.2. Flow-duration Analysis

The annual flow-duration curves indicate the expected increase in discharge from upstream to downstream, consistent with the average annual flows discussed in the previous section (Figures 4.4-2 and 4.4-3, Table 4.4-3). For example, the median annual flow (flow that is equaled or exceeded 50 percent of the time) increases from about 2,050 cfs at Cantwell to about 3,400 cfs at Gold Creek, 8,220 cfs at Sunshine and 19,000 cfs at Susitna Station. Similarly, the 90-percent exceedence flow increases from about 690 cfs at Cantwell, to about 1,200 cfs at Gold Creek, 2,830 cfs at Sunshine and 6,400 cfs at Susitna Station, and the 10-percent exceedence flow increases from 16,500 cfs at Cantwell to about 25,300 cfs at Gold Creek, 64,000 cfs at Sunshine, and 124,000 cfs at Susitna Station. Similar flow-duration curves were developed for each month at each of the stations, including the tributaries (Appendix B), and the values for specific exceedence durations are tabulated in Appendix C. An example of a monthly flow duration curve is provided in Figure 4.4-4.

4.4.1.3. Flood-Frequency Analysis

The pre-Project flood-frequency analysis was performed for each of the gages using a combination of the recorded instantaneous peak flow data and the USGS extended record. This was accomplished by first correlating the recorded peak discharges for the period of record with the mean daily discharges on the day of the peak discharge (Figure 4.4-5). The instantaneous peak discharges for the years in the extended record for which measured data are not available were then estimated by applying the resulting regression relationship to the maximum mean daily discharge. As seen in Figure 4.4-5, the relationship for the Gold Creek gage that is being used here as an example fits the recorded data very well (R2=0.98). This relationship indicates that the instantaneous peak flows at Gold Creek are typically about 4 percent greater than the corresponding mean daily flow at discharges in the 20,000-cfs range, increasing to about 7 percent at flows in the 90,000-cfs range. Similar relationships for the other gages are provided in Appendix D. A potential source of error in this method results from the fact that the instantaneous peak discharge does not always occur on the same day as the maximum mean daily discharge. This is not believed to be a significant limitation, however, because this occurs in less than 20 percent of the years, and the difference between the maximum mean daily flow and the mean daily flow on the day of the peak was not significant during those years.

Flood frequency curves developed using the HEC-SSP program with the resulting extended record of peak discharges indicates that the 2-year recurrence interval peak discharge is about 27,300 cfs at the Cantwell gage and about 43,500 cfs at Gold Creek (Table 4.4-4). The 2-year peak discharges at Sunshine and Susitna Station are substantially higher (106,000 and 170,000 cfs, respectively). The 2-year peak discharges in the Chulitna and Yentna River are 35,200 and 23,200 cfs, respectively (Table 4.4-5). The peak discharges for other events from the 1.25-year through the 100-year recurrence interval flows are also provided in Tables 4.4-4 and 4.4-5, and the plotted flood-frequency curves with the data points from the extended record and upper and

lower 90-percent confidence bands and the computed frequency curve at each of the gages being considered in this analysis are provided Appendix E.

4.4.2. Maximum Load Following OS-1

The presence of the Watana Dam at PRM 187 will affect flows in the mainstem of the Susitna River downstream of the project site, but flows in the tributaries and the mainstem upstream from the reservoir will not be affected by the dam. The Maximum Load Following OS-1 analysis, therefore, only considered the three gages along the mainstem downstream from PRM 187 (i.e., Gold Creek, Sunshine, and Susitna Station). As discussed above, the flow records used for the Maximum Load Following Scenarios OS-1 analysis were developed by MWH (2012) using a HEC-ResSIM model that represents a preliminary operation scenario that was developed by placing the entire variability of the Railbelt electricity load on Susitna-Watana; thus, it represents a maximum (or worst-case) load-following scenario (John Haapala, personal communication, January 24, 2013). The HEC-ResSim model only considered flows in the reach between Watana Dam and the Sunshine gage. To estimate the Susitna Station Maximum Load Following OS-1 flows, the pre-Project difference between the mean daily flow at the Sunshine and Susitna Station gages was added to the Maximum Load Following OS-1 Sunshine mean daily flows, under the assumption that flow changes in that part of the reach would be the same under both pre-Project and Maximum Load Following OS-1 conditions. The HEC-ResSim model was also run for pre-Project (i.e., unregulated) conditions. Results from this run were used as the basis for comparing pre- and Maximum Load Following OS-1 conditions since the purpose of the comparison is to assess the differences between the two conditions, and there are minor differences between the measured and simulated flow record that could potentially confound the analysis. This comparison described in Section 6.

4.4.2.1. Monthly and Annual Flow Summary

The Project does not permanently add to or divert flows from the river. As a result, the simulated average annual discharge at the three gages under the Maximum Load Following Scenario OS-1 is essentially the same as under pre-Project conditions, ranging from about 9,700 cfs at Gold Creek to about 24,000 cfs at Sunshine and 48,500 cfs at Susitna Station, and the variability from year to year is also approximately the same (Tables 4.4-6 and 4.4-7). Average monthly flow releases under Maximum Load Following Scenario OS-1 are; however, more uniformly distributed throughout the year than under pre-Project conditions (Figure 4.4-6). Tributary inflows between the dam and the Three Rivers Confluence are relatively small compared to the mainstem flows; thus, the distribution of average monthly flows at the Gold Creek gage is also relatively uniform. Unlike the upstream, smaller tributaries, inflows from the Chulitna and Talkeetna Rivers are significant compared to the upstream mainstem flows, and there is, therefore, significant seasonal variability in the downstream river, even under the Maximum Load Following Scenario OS-1. Monthly flow summaries for the individual gages for each year in the extended record are provided in Appendix F.

4.4.2.2. Flow-duration Analysis

The annual and monthly flow-duration curves also reflect the more uniform distribution of flows throughout the year under Maximum Load Following Scenario OS-1 (Figure 4.4-7 and Tables 4.4-8

through 4.4-10). The median flow at the Gold Creek gage, for example, increases from about 3,400 cfs under pre-Project conditions to about 8,800 cfs under Maximum Load Following Scenario OS-1, and the 10-percent (low) exceedence flow increases from about 1,200 to 7,200 cfs, while the 90-percent (high) exceedence flow decreases from about 25,300 to 12,300 cfs. Similar changes occur at the two downstream gages, but the relative magnitude of the change is smaller because of the influence of the tributary inflows. For example, the median flow at Sunshine for Maximum Load Following Scenario OS-1 (13,200 cfs) is about 60 percent larger than the pre-Project median flow (8,200 cfs) and the Maximum Load Following Scenario OS-1 median flow at Susitna Station (23,100 cfs) is about 20-percent larger than the pre-Project median flow (19,000 cfs). A duration analysis of monthly flows was also conducted, and the resulting duration curves for each of the gages are provided in Appendix G.

4.4.2.3. Flood-frequency Analysis

As noted above, the flood frequency analysis for Maximum Load Following Scenario OS-1 was conducted using the simulated annual maximum hourly flows from the HEC-ResSim model. Based on the analysis, the 2-year peak discharge at Gold Creek will decrease to about 23,900 cfs under Maximum Load Following Scenario OS-1, and the 100-year peak discharge will decrease to about 66,400 cfs, reductions of 45 and 28 percent, respectively (Table 4.4-11, Figure 4.4-8). Consistent with the mean daily flows, the reduction at the two downstream gages is less significant. At Sunshine, for example, the 2-year peak will decrease by about 24 percent to 72,000 cfs and the 100-year peak will decrease by about 23 percent to 137,000 cfs (Figure 4.4-9). The estimated 2- and 100-year peaks at Susitna Station will decrease by only about 18 percent to 142,000 cfs and 5 percent to 261,000 cfs, respectively (Figure 4.4-10).

4.5. Discussion

The pre-Project hydrology analysis was conducted based on the USGS extended record data at the five mainstem gages and six tributary gages for which the data were available. Unregulated flows at the Watana Dam-site were also developed using the HEC-ResSim model to provide a basis for directly comparing pre-Project and Maximum Load Following Scenario OS-1 flows at that location.

The specific effects of the proposed Watana Dam on the downstream flow regime will, of course, depend on the manner in which the reservoir is operated. The HEC-ResSim model on which the Maximum Load Following Scenario OS-1 analysis is based represents a preliminary operation scenario that was developed by placing the entire variability of the Railbelt electricity load on the Susitna-Watana Project; thus, it represents a maximum (or worst-case) load-following scenario (John Haapala, personal communication, January 24, 2013).

Because the Project will not affect mainstem flows upstream from the reservoir or inflows from the downstream tributaries, the Maximum Load Following OS-1 analyses only considered the Gold Creek, Sunshine, and Susitna Station gages. Output from the HEC-ResSim model was used directly for the analysis at Gold Creek and Sunshine. Since the model domain only extends downstream to PRM 88, it was necessary to estimate Maximum Load Following Scenario OS-1 flows at Susitna Station using the simulated Sunshine flows, adjusted for the difference between the Sunshine and Susitna Station flows from the USGS extended record.

4.5.1. Seasonal and Flow-duration Comparison

The Project will change the seasonal flow patterns by increasing flow during the typical low-flow season that occurs in late-fall, winter and early-spring under pre-Project conditions, and decreasing the flows during the pre-Project high-flow period between May and September (Table 4.5-1 and Figure 4.5-1). These changes also affect the annual mean daily flow duration curves by reducing the magnitude of flows in the high-flow range that occur 30 to 40 percent of the time, and increasing flows in the low flow (60 to 70 percent) range (Table 4.5-2 and Figure 4.5-2). In all cases, the relative magnitude of the changes is much greater in the Middle River above the Three Rivers Confluence, and they decrease in the downstream direction because of the influence of the major tributary inflows.

4.5.2. Flood-frequency Comparison

Comparison of the flood frequency curves developed from the 61-year record of flows from the HEC-ResSim model results indicates that the annual peak flows for equivalent recurrence intervals at the Watana Dam site will decrease by about 50 percent for frequent events in the 1.25- to 1.5-year range under Maximum Load Following Operation Scenario OS-1, with the relative change decreasing to approximately 27 percent at the 100-year peak discharge (Table 4.5-4 and Figure 4.5-3). The relative change at Gold Creek is similar, decreasing from 50 percent to 59 percent for frequent events to about 28 percent at the 100-year peak (Figure 4.5-4). At Sunshine, the relative magnitude of the change is somewhat smaller, ranging from about 25 percent for frequent events to about 23 percent at the 100-year peak, due primarily to inflows from the Chulitna and Yentna Rivers (Figure 4.5-5). Tributaries downstream from Sunshine, including the Yentna and Skwentna, cause a further decrease in the relative change at Susitna Station (17 to 18 percent for the frequent event to only about 5 percent at the 100-year peak) (Figure 4.5-6).

These results can also be assessed by comparing the recurrence intervals of equivalent discharges under pre-Project and Maximum Load Following Operation Scenario OS-1 (Table 4.5-5). For example, the 2-year peak discharge of 34,200 cfs at the Watana Dam site under pre-Project conditions would occur only about once in 10 years, on average, and the 20-year flow of 57,600 cfs would occur only about once in 140 years, on average, with Maximum Load Following Operation Scenario OS-1. At Gold Creek, the 2-year peak discharge of 43,700 cfs would occur about once in 12 years on average and the 20-year flow of 72,300 cfs could occur very rarely (once in about 166 years, on average) under Maximum Load Following Operation Scenario OS-1. The 2-year peak discharge at Sunshine of 94,700 cfs would occur about once every 7 to 8 years, and the 20 year flow of 143,600 cfs would occur about once in 150 years, on average. The changes are less significant at Susitna Station, with the pre-Project 2-year flow of 170,300 cfs occurring about once in 5.2 years and the 20-year flow of 233,500 cfs occurring about one in 43 years, on average, with Maximum Load Following Operation Scenario OS-1.

5. STAGE-EXCEEDENCE ANALYSIS

This section documents the analysis that was conducted to evaluate the relative difference in stage associated with the two hydrologic conditions: pre-Project and Maximum Load Following OS-1. This analysis built on the results of the flow duration analysis. The stage exceedence analysis was conducted at two locations along the Lower Susitna River Segment: the Sunshine Gage (USGS 15292780) and the Susitna Station Gage (USGS 15294350).

This stage exceedence analysis was conducted as part of the overall 2012 Lower River Geomorphology Study, specifically as part of the "Riverine Habitat-Flow Relationship Assessment" task.

5.1. Objectives

The objective of this analysis is to quantify the relative change in river stage at two locations in the Lower Susitna River Segment between the pre-Project hydrologic condition and the Maximum Load Following OS-1 hydrologic condition. The results of the analysis provide a preliminary assessment of the change in hydraulic conditions in the Lower Susitna River Segment. The results will also provide a basis for interpreting how hydraulic responses to changes in hydrologic conditions can affect habitats and access to tributaries in the Lower River (described in a separate technical memorandum).

5.2. Methods

The primary sources of information used to conduct the stage exceedence analysis at each gage location were (1) the most recent USGS stage-discharge ratings at each site, and (2) the results of the flow-duration analyses for the pre-Project and the Maximum Load Following OS-1 hydrologic conditions. The mean daily flow record (WY1950 through WY2010) for each hydrologic condition was converted to values of stage, in feet, using the most recent USGS stage-discharge ratings. It is noted that the ratings developed for both gages do not account for the effects of ice on river stage. Each computed stage for the WY1950 through WY2010 period of record therefore represents the stage corresponding to the mean daily flow; it does not necessarily represent the mean daily stage.

5.2.1. Conversion of Mean Daily Flow Records to Stage Records

At the Sunshine Gage, the most recent rating published by the USGS is Rating ID 6.0 (the red line in Figure 5.2-1). Rating ID 6.0 is based on measurements conducted by the USGS through September 2012. According to USGS staff, at this gage there have not been any open water measurements for discharges less than 35,000 cfs, so the rating is not defined for flows less than this threshold (Josh Morse, personal communication, January 31, 2013).

The USGS is not currently maintaining the Susitna Station Gage. Rating ID 4.0 is the most current, with an apparent inflection in the rating at a stage of 10 feet (Figure 5.2-2). This rating and is based on flow measurements conducted through October 2003.

The lowest measured flow used to develop the Sunshine stage-discharge rating is 2,940 cfs and the lowest measured flow used to develop the Susitna Station stage-discharge rating is 28,000 cfs. Since the mean daily flow record at both sites includes flows less than these minima, the published ratings at both gages were extrapolated by fitting trend lines to the published relationships (Figures 5.2-1 and 5.2-2). For the Susitna Station Gage, the extrapolation was based only the stage-discharge relationship for stages less than 10 feet.

In converting the mean daily flow series to corresponding series of stage, the lookup function in Microsoft Excel was used. For flows greater than the minimum value on the published ratings, the published ratings were used to calculated stage; for flows less than these minimum values, stages were estimated using the trend lines extrapolated from the published datasets. This method produced a complete record of stages corresponding to the each value of mean daily flow at each of the two USGS locations for the pre-Project and Maximum Load Following OS-1 conditions.

5.2.2. Stage-Duration Analyses and Stage-Exceedence Analyses

A stage-duration analysis was conducted at each gage location, using the two complete stage records (WY1950 through WY2010) for both the pre-Project and Maximum Load Following OS-1 hydrologic conditions. An annual stage-duration analysis was based on the stage values for the entire period of record, and monthly stage-duration analyses were based on the stage values for each of the twelve months throughout the entire period of record. The results of these analyses were used to identify stage-exceedence relationships on annual and monthly bases. The stage-exceedence relationships corresponding to the pre-Project hydrologic conditions and the Maximum Load Following OS-1 hydrologic conditions were plotted together to compare the relative changes in stage across the range of exceedence values. A statistical analysis was also conducted to quantify the maximum, minimum, average and median stages by month.
To better illustrate how the changes in stage relate to the channel/floodplain morphology at each site, selected stage-exceedence ordinates were converted to water surface elevations and overlaid on plots of cross section geometry. The 10-, 50- and 90-percent exceedence values were selected for this graphical representation. Representative cross section geometry was first developed at each gaging station location using USGS discharge measurement notes for a recent high flow measurement. Table 5.2-1 summarizes the specific USGS flow measurements that were used to develop the representative cross section geometry at each location.

Cross-section geometry was developed by converting each incremental depth measurement (feet) corresponding to the information in Table 5.2-1 to a bed elevation (feet, NAVD88) using Equation 5.2-1.

$$Elev_{bed} = [Gage + Datum + Conversion] - Depth \qquad \textbf{(5.2-1)}$$

where

$Elev_{bed}$	=	elevation of bed at each horizontal increment (feet, NAVD88)
Gage	=	gage reading at time of USGS flow measurement (feet), see Table 5.2-1
Datum	=	assumed gage datum relative to NGVD29 (40 feet for Susitna Station; 242 feet for Sunshine)
Conversion	=	conversion from NGVD29 to NAVD88 (6 feet used at both locations)
Depth	=	USGS measured depth at each horizontal increment (feet)

There is no published conversion factor available in the vicinity of the two gaging stations to transform elevations between the NGVD29 geodetic datum and the NAVD88 geodetic datum. However, several National Geodetic Survey control points were found in the vicinity of the Susitna River. A number of these control points reported elevations relative to both NGVD29 and NAVD88. A review of a number of these control points found that the average difference in elevations expressed in NGVD29 and elevations expressed in NAVD88 was approximately 6 feet. This vertical transformation was therefore assumed at both gage locations.

The stages associated with the 10-, 50 and 90-percent exceedences were converted to water surface elevations using Equation 5.2-2.

$$WSEL = Stage + Datum + Conversion \quad \textbf{(5.2-2)}$$

where

WSEL	=	water surface elevation corresponding to specified stage (feet, NAVD88)
Stage	=	stage selected from stage-exceedence relationship (feet)
Datum	=	assumed gage datum relative to NGVD29 (40 feet for Susitna Station; 242 feet for Sunshine)
Conversion	=	conversion from NGVD29 to NAVD88 (6 feet used at both locations)

5.3. Results

This section presents the results of the comparative stage-exceedence analysis for the pre-Project and the Maximum Load Following OS-1 hydrologic conditions at both the Sunshine Gage and the Susitna Station Gage. Specific conclusions drawn from this analysis are presented in Section 5.4. Note that the stage values presented in the graphs and tables in this section are unique to each gage location. In other words, a five-foot stage at the Sunshine Gage is not equivalent to a five-foot stage at the Susitna Station Gage.

Tables 5.3-1 through 5.3-5 present the results of the stage-exceedence analyses of the pre-Project hydrologic condition as compared to those for the Maximum Load Following OS-1 hydrologic condition. Table 5.3-1 includes specific annual stage-exceedence ordinates for both gage locations. Tables 5.3-2 and 5.3-3 include monthly stage-exceedence ordinates for the Sunshine Gage; Tables 5.3-4 and 5.3-5 include monthly stage-exceedence ordinates for the Susitna Station Gage. In each of these tables, the relative change in stage (either positive or negative) for each exceedence percentile is indicated.

Table 5.3-6 (Sunshine Gage) and Table 5.3-7 (Susitna Station Gage) provide results of statistical analyses of monthly stages calculated for both the pre-Project hydrologic conditions and the Maximum Load Following OS-1 hydrologic conditions. In each table, the relative change in stage (either positive or negative) for each statistic is indicated.

At the two gage locations, annual stage-exceedence relationships and monthly stage-exceedence relationships were developed for both the pre-Project and the Maximum Load Following OS-1 conditions. To allow a direct comparison between the results for the two hydrologic conditions, the stage-exceedence relationships were plotted together. Annual stage-exceedence relationships for the Sunshine Gage are provided in Figure 5.3-1; the annual relationships for the Susitna Station Gage are shown in Figure 5.3-2. As seen in these two figures, the line representing the pre-Project conditions is solid whereas the line representing the Maximum Load Following OS-1

conditions is dashed. Figure 5.3-3 (Sunshine Gage) and Figure 5.3-4 (Susitna Station Gage) illustrate the monthly stage-exceedence relationships for the month of May. Appendix J includes plots of the pre-Project and the Maximum Load Following OS-1 annual and monthly stage-exceedence relationships for the two locations.

The results of the stage-exceedence analysis are alternatively presented on representative cross section plots at each gage location, after converting the stages (feet) to water surface elevations (feet, NAVD88). For this presentation, the 90-, 50- and 10-percent pre-Project and Maximum Load Following OS-1 stage-exceedence values were converted to water surface elevations (see Equation 5.2-2) and overlaid on the representative cross section geometry (Figures 5.3-5 and 5.3-6). Appendix K includes identical figures showing the results of the monthly stage-exceedence analyses at both gages. This method of presentation provides a visual assessment of the relative changes in water surface elevation between the pre-Project and the Maximum Load Following OS-1 hydrologic conditions. It also provides a visual assessment of the relationship between the water-surface elevations associated with the range of flows between the 10- and 90-percent stage-exceedences.

5.4. Discussion

The stage-discharge ratings published by the USGS do not include the effect that ice has on river stage. For this reason, the results of the stage-exceedence analyses through the winter months should consider this limitation.

The tables and figures presented in the Section 5.3, Appendices A and B indicate that the magnitude of change in stage (or water-surface elevation) from the pre-Project condition to the Maximum Load Following OS-1 condition varies somewhat between the two gage locations. The results also indicate that the changes in stage vary considerably by season (i.e., month).

Regarding the sensitivity to location, it was found that for a given exceedence percentile and a given month, the magnitude of change in stage from the pre-Project hydrologic condition to the Maximum Load Following OS-1 hydrologic condition was often quite different between the two gage locations (Table 5.4-1). As seen in Table 5.4-1, the relative change in flow from the pre-Project hydrologic condition to the Maximum Load Following OS-1 hydrologic condition for a given exceedence percentile is roughly equivalent between the Sunshine Gage and the Susitna Station Gage. However, the change in stage from the pre-Project hydrologic condition to the Maximum Load Following OS-1 hydrologic condition for this same exceedence percentile varies. For stages less than the 50-percent exceedence, the change is slightly greater at the Susitna Station Gage than at the Sunshine Gage; when the stage is greater than the 50-percent exceedence value; the change at the Sunshine Gage is greater than at the Susitna Station Gage. Since the change in flows is approximately the same for each exceedence probability, the explanation is due to the differences in the slope of the published stage-discharge ratings at the two sites. For higher flow conditions, an equivalent change in flow rate at the two locations is associated with a larger change in stage at the Sunshine Gage than at the Susitna Station Gage (Figure 5.4-1).

Regarding the sensitivity to seasonality, it was found that for a given exceedence percentile and a given month, the magnitude of change in stage from the pre-Project hydrologic condition to the Maximum Load Following OS-1 hydrologic condition was often quite different between the two gage locations. For high-flow conditions (i.e. during the months of May through August,

inclusive), the changes in stage at the Sunshine Gage were higher than at the Susitna Station Gage for all exceedence probabilities.

The magnitude of the change in flow in the Susitna River from the pre-Project to the Maximum Load Following OS-1 condition varies by month, as illustrated in the monthly flow-duration curves provided in Appendix G. This monthly variability is a product of the assumptions that were made for Watana Dam operating under the Maximum Load Following OS-1 hydrologic condition. Correspondingly, the magnitude of the change in stage also varies by month. This monthly variability was shown in the tables in the previous section and is further illustrated in monthly bar charts (Figures 5.4-2 through 5.4-7). These bar charts illustrate the change in stage, by month, at a specific location (either the Sunshine Gage or the Susitna Station Gage) for a specific stage-exceedence value. For instance, Figure 5.4-2 is for the Sunshine Gage location, illustrating the change in magnitude for the 90-percent stage exceedence value for each of the twelve months. Similar figures were developed for the 50- and 10-percent exceedence values at both gage locations.

The months that exhibited the least pronounced absolute change in hydrologic conditions were the months of August and September. This same observation was identified for the absolute change in stage at both gage locations. At the Sunshine Gage, the change in stage for the exceedence percentiles summarized in Table 5.3-3 ranged from -1.00 to +0.27 feet. At the Susitna Station Gage, the change in stage for the exceedence percentiles summarized in Table 5.3-5 ranged from -0.45 to +0.22 feet.

During the months of June and July, the entire flow-exceedence relationship for the Maximum Load Following OS-1 hydrologic condition was lower than for the pre-Project condition at both gage locations. Therefore, stage values for the entire range of flows for these months were also reduced. For instance, the median value of stage (50-percent exceedence) at the Sunshine Gage was reduced by 1.43 feet (June) and 1.21 feet (July). At the Susitna Station Gage, the reduction in the median value of stage was 0.87 feet (June) and 0.77 feet (July). The months of June and July exhibited the largest reduction in stage values, using the median value as the measure.

Overall, the largest changes in stage occurred during the winter/spring months of November through April. For each of these months, the median value of stage was increased by more than one foot at both of the gage locations (see Tables 5.3-6 and 5.3-7). This observation is attributed to the lowest magnitude flows during these months of the year, and incremental changes in lower flows producing relatively larger changes in stage due to the steepness of the lower part of the stage-discharge ratings. However, as previously stated, it is noted that the stage-discharge ratings published by the USGS do not include the effect that ice has on river stage. Thus, interpretation of the calculated stages should consider this limitation.

In summary, the months of October through April exhibit increased stages at both gage locations for the entire range of exceedence probabilities that were included in Tables 5.3-2 through 5.3-5. The month of May exhibits increased stages for the lower flow conditions and reduced stages for the higher flow conditions. The months of June and July show reduced stages at both gage locations for all flow conditions. The months of August and September showed increased stages for the lower flow conditions and reduced stages for the higher flow conditions.

6. SPECIFIC GAGE ANALYSIS

This section documents the specific gage analysis that was conducted to characterize the relative vertical stability of the Susitna River channel. The analysis requires comparisons of stage-discharge ratings over time, so analyses were planned for the two USGS gaging stations that are located in the Lower River Segment. The analysis was to be conducted at the Susitna River at Sunshine Gage (USGS Gage 15292780) and the Susitna River at Susitna Station Gage (USGS Gage 15294350); however, as further described in Section 6.2, the analyses were completed only for the Susitna Station Gage.

This specific gage analysis was conducted as part of the overall 2012 Lower River Geomorphology Study, specifically as part of the "Riverine Habitat-Flow Relationship Assessment" task (AEA 2012).

6.1. Objectives

The objective of this analysis is to assess the relative vertical stability of the Susitna River channel in the immediate vicinity of the two USGS gaging stations in the Lower River Segment.

6.2. Methods

A specific gage analysis involves the development of a graph of stage for a specific discharge at a particular location plotted over time. When such an analysis is made for a family of specific discharges, a family of graphs can be plotted. The resulting family of curves illustrates the changes in stage for each specific discharge, so the curves can be used to interpret if the channel in the vicinity of the gaging station is considered to be in equilibrium. If the family of curves neither progressively rise nor fall over time, the channel may be considered to be in a state of dynamic equilibrium. If the family of curves exhibits a progressive pattern of rising (falling), this may be interpreted to indicate bed aggradation (degradation).

Specific gage analyses are ideally conducted using direct measurements of stage and discharge. However, an adequate number of measurements are required for each specific discharge of interest over the period of analysis for meaningful interpretation of the results. In this study, insufficient measurement data were available, so the analyses were conducted using an adaptation of the "specific gage" technique described by Blench (1969) and Klingeman (1973). The adaptation relied on published stage-discharge ratings developed by the USGS for the gaging stations instead of directly measured stages and discharges. There are six such ratings available for the Sunshine Gage and four ratings available for the Susitna Station Gage. Information regarding each of the ratings is summarized in Tables 6.2-1 and 6.2-2, along with relevant station notes from the USGS station description.

The current location of the Susitna River at Sunshine Gage is on the left bank, approximately fifty feet downstream of the George Parks Highway Bridge near PRM 88 (Figure 6.2-1). The flow in the 2012 aerial photo (Figure 6.2-1) is 38,000 cfs, as measured at the Sunshine Gage. The channel is straight for about 2,500 feet downstream of the gage and for about 1,500 feet upstream. Further upstream, the channel is braided. According to the USGS station notes, at low and medium stages, a side channel can form along the right bank upstream of and under the bridge, and at medium to high stages, this channel can flow back into the main channel

downstream of the gage. Since its original installation, the gage has been moved twice. Each time the gage was moved, the USGS revised the reference datum. According to the USGS station notes, the datum was "lowered by 5.0 feet on May 28, 1982". However, the stage values in the rating table for Rating No. 1 were subsequently adjusted so that this rating, as currently published, is relative to the lowered datum (Josh Morse, personal communication, January 31, 2013). When the gage was re-established on October 6, 2011 at its new location downstream of the bridge, the USGS station notes indicate that 10 feet was added to the datum to prevent negative gage height values. It is not certain whether this adjustment of 10 feet reflects the actual difference in elevation between the datums at the two locations.

The location of the Susitna River at Susitna Station Gage is on the left bank, approximately 1.5 miles downstream of the confluence with the Yenta River, near Project River Mile (PRM) 30 (Figure 6.2-2). The gage is located at the mid-point of a one-mile long straight section of the river. According to the USGS station notes for this gage, the hydraulic control at the site is the downstream channel for all but extreme stages, when the island 2,000 feet downstream may become the control. The station notes go on to state that while at higher flows there is one channel, at mid- to low-flows, a sand bar is exposed approximately 1,000 feet from the left bank which divides the river into two channels. This sand bar can be seen in Figure 6.2-2. The aerial photo used in this figure was flown on September 30, 2012 when the recorded discharge at the USGS gage at Sunshine was 48,000 cfs. This flow corresponds approximately to a 25 percent pre-Project annual exceedence flow.

The Susitna River at Sunshine Gage was in continuous operation from May 1981 through June 1986 and was subsequently re-established in October 2011. To date, a total of fifty-six flow measurements have been made at the site, with only two measurements made during the 25 year period between June 1986 and October 2011. Figure 6.2-3 graphically illustrates the time of survey and the magnitude of the USGS discharge measurements. Measurements that were rated as "Poor" by the USGS are distinguished since these were generally made during periods of ice cover. Rating No. 6 is the current rating for this station.

The Susitna River at Susitna Station Gage was in continuous operation from May 1975 through September 1993 and is now considered inactive. For the entire period of record, the gage remained in the same location and was never moved. To date, a total of 130 flow measurements have been made at the site, with six of them having been made subsequent to when the gage became inactive. Figure 6.2-4 graphically illustrates the time of survey and the magnitude of the USGS discharge measurements. Measurements that were rated as "Poor" by the USGS are distinguished since these were generally made during periods of ice cover. Rating No. 4 was the last published rating for this station.

The specific gage analysis was not completed for the Sunshine Gage location for several reasons. The gage has been moved on two occasions, with changes made to the recording datum after each move. More importantly, however, the gage was discontinued in 1986 so there is only a short five year period of gage operation and discharge measurement data. There was nearly a twenty-five year gap in time between when the gage was discontinued in 1986 and re-established in 2011 (at the new location downstream of the George Parks Highway Bridge), and although there have been eight flow measurements conducted since the gage was re-established, there is some uncertainty that the gage datum at the new location is correctly tied to the previous datum. Therefore, the specific gage analysis was only conducted for the Susitna Station Gage.

The first step for conducting a specific gage analysis is to confirm that measured stages reference the same datum over the entire period of the analysis. If different datums are referenced, conversions to a consistent reference are required. No adjustments were needed for the Susitna Station Gage because the gage was never moved and the USGS never changed the reporting datum. Figure 6.2-5 shows the four ratings published by the USGS for this gaging station.

The next step was to select specific discharges for analysis. The flow magnitudes that were selected for the Susitna Station Gage analysis were obtained from the pre-Project flow-duration analysis and the pre-Project flood-frequency analysis. The magnitudes that were selected were intended to cover a wide range of flow rates, and to include flows that had geomorphological significance. For instance, the 1.01- and 2-year return period flows were selected because they bracket the return period of bankfull discharge (Leopold et al. 1964). Table 6.2-3 summarizes the flow rates that were selected to develop the family of curves for the Susitna Station specific gage analysis. As indicated in this table, the minimum flow rate common to all of the published ratings is 30,000 cfs, so this selected as the minimum flow of interest. It is noted that 30,000 cfs is approximately equal to the pre-Project 45 percent annual exceedence flow. The maximum flow common to all of the published rating curves was 201,000 cfs. The pre-Project 5-year return period flow of 197,000 cfs was selected as the maximum flow for analysis because it was reasonably close to the maximum value on the published ratings.

The final step was to calculate the stage for each selected flow in Table 6.2-3 from each of the four USGS rating curves representing different periods in time. The results were plotted to develop the specific gage graphs.

6.3. Results

The tabular results of the specific gage analysis conducted at the Susitna Station Gage are summarized in Table 6.3-1. The stages in this table were calculated using the four ratings published by the USGS. The results shown in Table 6.3-1 were plotted to develop a family of nine specific gage curves (Figure 6.3-1). In developing the figure, the stage values for each flow rate were assumed constant throughout the range of effective dates for each rating, thus giving the curves a stair-step appearance. Each curve illustrates the changing conditions in river stage for the indicated flow rate over the period of record for the gaging station.

6.4. Discussion

A specific gage analysis was conducted for the Susitna River at Susitna Station Gage. A similar analysis was not conducted for the Susitna River at Sunshine Gage, in part because the period of time when the gage was in operation and when discharge data was collected was only five years (May 1981 through June 1986). Although the Sunshine Gage was re-established in 2011, and flow measurements have been conducted since this time, there is some uncertainty as to whether the gage datum at the new location is tied to the previous datum.

The analysis of the Susitna River at Susitna Station encompassed four periods (each defined by a published USGS rating) over the course of approximately 18 years, from 1975 through 1993. During this period, the USGS conducted 69 discharge measurements, ranging from 5,380 to 221,000 cfs, rated as either “Good” or “Fair”. The fact that the USGS only developed four ratings for this 18-year period is indicative of a fairly stable channel section over this time.

This observation is substantiated by the graphical results of the specific gage analysis. The family of specific gage curves shows evidence that for the range of flows selected, there has been only minor changes in stage, with no more than 0.5 feet of change for a given flow rate between any two rating periods. If net stage change for a given flow rate is defined as the change in stage between Rating 1 and Rating 4, then the flows associated with the largest net increase in stage are 80,000 and 94,000 cfs, each showing a net increase of 0.3 feet. The flow rate with the largest net decrease in stage (i.e., 0.5 feet) was 197,000 cfs.

Overall, the trend in stage change was for a net decrease of no more than 0.5 feet for flows greater than or equal to 152,000 cfs (1.25-year return period), and a net increase of no more than 0.3 feet for flows between 60,000 and 132,000 cfs. For flows less than 60,000 cfs, the results indicated a net decrease in stage of no more than 0.3 feet.

The flow rates with the least amount of net change in stage were 132,000 cfs (1.01-yr return period) and 152,000 cfs (1.25-year return period), each with a net change of only 0.1 feet.

The small observed net decrease of specific gage for flows greater than 152,000 cfs may indicate a minor change in the downstream channel control during high flows. This might be due to changes in the planform of the downstream island that the USGS indicated may function as a high flow control, or it might be due to widening of the channel downstream of the gage. The variation in specific gage for flows less than 152,000 cfs might simply be a result of the changing influence of the adjacent sandbar over time. However, given the small magnitudes of change in stage as summarized above and as seen in Figure 6.3-1, and the apparent absence of any substantial progressive changes in stage for specific discharges over and 18-year period, the Susitna River channel section in the vicinity of the Susitna Station Gage can be considered to be in equilibrium.

7. DISCHARGE EFFECTS ON ICE ELEVATION AND CROSS-SECTIONAL FLOW CHARACTERISTICS

The available data from the USGS Susitna River at Sunshine and Susitna River at Susitna Station mainstem gages were evaluated to assess potential discharge effects on ice elevation and cross sectional flow characteristics (depth and velocity) at the gage locations, as part of the Riverine Habitat-Flow Relationship Assessment.

Ice cover over a river channel increases resistance to flow in several ways, including the following (Beltaos 1995):

- Increases in the wetted perimeter on which shear stress operates, causing a significant reduction in the hydraulic radius for the same flow depth, compared to open-water conditions,
- Increases in the total channel resistance due to the roughness of the undersurface of the ice cover, and
- Potentially significant reductions in cross-sectional area due to large, undersurface ice protrusions.

Resistance to flow and the conveyance capacity in an ice-covered channel are often difficult to estimate precisely due to the following complicating factors (Beltaos 1995):

- The increase in roughness of the undersurface of the ice cover is difficult to measure directly or estimate indirectly from velocity profiles,
- The unobstructed waterway under the ice cover varies with large deposits of loose slush in a manner that is difficult to estimate,
- With an ice cover, the slope of the energy grade line is assumed to be parallel to that for uniform, steady, open channel flow conditions, an assumption that may be invalid, particularly with heavy frazil loads or rapid flow variation,
- The bed roughness can be significantly different under ice cover than for open channel conditions

7.1. Objectives

The objective of this analysis was to determine whether discharge effects on ice elevation and flow characteristics could be detected from the available data at the USGS gages, and if so, to approximate the magnitude of these effects.

7.2. Methods

Winter gage data are available from 13 measurements taken between 1981 and 1986 at the Sunshine gage and 23 measurements taken between 1982 and 1993 at the Susitna Station gage. These measurements were recorded by hand, and the hand-written notes were entered into an Excel spreadsheet to analyze the relationships between discharge, ice thickness, and cross sectional flow characteristics (Tables 7.2-1 and 7.2-2).

The data were reviewed to determine discharge effects on ice elevation and flow characteristics. Unfortunately, neither the stage nor the water-surface elevation were surveyed during the field discharge measurements, thus comparisons to ice elevation were not possible. In addition, the hydraulic condition of the flow and the interface of the ice cover were not noted. It is, therefore, not possible to evaluate whether the flow was under pressure, and if so, by how much. As a result, the effects of the pressure head on the hydraulic properties cannot be assessed with the available data.

Further analysis could not be performed for the Susitna Station gage site, because the hydraulic (i.e., area, width and velocity) data from the open-water field measurements were not reported.

The USGS NWIS site contains field measurement data for the Sunshine gage for 48 measurements from 1981 through 2012, including 15 ice measurements. The 13 measurements for which hand written notes were obtained, and additional measurements taken on January 31, 2012, and March 19, 2012, are included (Table 7.2-1). There are 35 measurements reported for open water conditions.

Reported data for the field measurements include channel discharge, channel width, channel area and channel velocity (hydraulic depth was calculated by dividing the channel area by the channel width). The data for the 48 measurements were used to compare trends of velocity, hydraulic depth and flow area with discharge between ice covered and open channel flow conditions.

The available data at the Susitna Station gage site does not include the hydraulic (i.e., area, width and velocity) data from the field measurements.

7.3. Results

Independent regression lines through the velocity versus discharge data at the Sunshine gage indicates that there may be difference in the relationship for ice-covered conditions compared to open-water conditions (Figure 7.3-1). The ice cover line is steeper and appears to be shifted to somewhat higher velocities than the open-water line, which is reasonable based on the expected relationships for pressure flow and open-water flow at equivalent discharges. However, since the range of discharges for the ice-cover data is relatively small and all of the points were collected at discharges less than the range of discharges from the open-water data, drawing this conclusion from the data, alone, is tenuous. In fact, a regression line through the combined data set appears to fit reasonably well, with the exception of a few points at the lower end of each data set that had unusually low velocities compared to the remainder of the data sets. The hydraulic (i.e., average) depth and cross sectional relationships (Figures 7.3-2 and 7.3-3) lead to the same conclusions.

7.4. Discussions

The available data at the Sunshine and Susitna Station gages, that represent pre-Project conditions, do not provide sufficient information with which to draw defensible conclusions about the differences in hydraulic conditions between ice-covered and open-water conditions, particularly those that will occur under Project conditions. Future discharge measurements under ice-cover conditions should include the elevation of the top of the ice and the static water-level to provide a basis for assessing the degree of pressure flow.

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9. TABLES

Table 4.2-1. List of streamflow gages.

Gage Number	Gage Name	Drainage Area (sq. mi.)	Gage Datum (NGVD 29,ft)	Latitude	Longitude	Available Record	Extended Record	Main Stem River Mile
15290000	Little Susitna River near Palmer	63	917	61° 42' 37"	149° 13' 47"	1948 - 2011		-
15291000	Susitna River near Denali	950	2,440	63° 06' 14"	147° 30' 57"	1957 - 1966; 1968 - 1986	Yes	291
15291200	Maclaren River near Paxson	280	2,866	63° 07' 10"	146° 31' 45"	1958 - 1986	Yes	-
15291500	Susitna River near Cantwell	4,140	1,900	62° 41' 55"	147° 32' 42"	1961 - 1972; 1980 - 1986	Yes	223
15292000	Susitna River at Gold Creek	6,160	677	62° 46' 04"	149° 41' 28"	1949 - 1996; 2001 - 2011	Yes	136
15292400	Chulitna River near Talkeetna	2,570	520	62° 33' 31"	150° 14' 02"	1958 - 1972; 1980 - 1986	Yes	-
15292700	Talkeetna River near Talkeetna	1,996	400	62° 20' 49"	150° 01' 01"	1964 - 2011	Yes	-
15292780	Susitna River at Sunshine	11,100	270	62° 10' 31.3"	150° 10' 13.5"	1981 - 1986	Yes	84
15292800	Montana Creek near Montana	164	250	62° 06' 19"	150° 03' 27"	2005 - 2006; 2008 - 2011		-
15294005	Willow Creek near Willow	166	350	61° 46' 51"	149° 53' 04"	1978 - 1993; 2001 - 2011	Yes	-
15294010	Deception Creek near Willow	48	250	61° 44' 52"	149° 56' 14"	1978 - 1985		-
15294100	Deshka River near Willow	591	80	61° 46' 05"	150 20' 13"	1978 - 1986; 1998 - 2001		-
15294300	Skwentna River near Skwentna	2,250	200	61° 52' 23"	151 22' 01"	1959 - 1982	Yes	-
15294345	Yentna River near Susitna Station	6,180	80	61° 41' 55"	150 39' 02	1980 - 1986	Yes	-
15294350	Susitna River at Susitna Station	19,400	40	61° 32' 41"	150 30' 45	1974 - 1993	Yes	28

Table 4.4-1. Average annual flows (cfs) for pre-Project conditions based on the USGS extended record.

Water Year	Average Annual Flow, Q (cfs), for Pre-Project Conditions										
	Susitna River near Denali	Maclaren River near Paxson	Susitna River near Cantwell	Susitna River at Gold Creek	Chulitna River near Talkeetna	Talkeetna River near Talkeetna	Susitna River at Sunshine	Willow Creek near Willow	Skwentna River near Skwentna	Yentna River near Susitna Station	Susitna River at Susitna Station
1950	2,200	816	5,080	8,030	7,410	3,390	19,600	277	5,520	16,300	42,400
1951	2,620	978	5,790	9,110	8,470	3,860	22,300	394	6,190	18,500	47,300
1952	2,570	962	6,060	9,530	8,190	4,030	22,900	423	6,280	18,300	46,800
1953	2,830	1,070	6,410	10,100	9,240	4,260	24,700	351	6,830	20,400	52,200
1954	2,810	1,040	6,150	9,680	8,890	4,090	23,700	308	6,560	19,600	49,700
1955	2,730	1,030	6,520	10,300	8,730	4,320	24,600	391	6,730	19,700	50,300
1956	3,180	1,190	7,310	11,400	9,790	4,880	27,600	343	7,420	21,800	55,200
1957	3,650	1,100	6,610	10,400	9,240	4,360	25,300	361	6,950	20,600	52,300
1958	2,510	1,110	5,990	9,480	8,770	3,970	23,000	271	6,420	18,900	48,700
1959	2,610	843	6,710	10,600	8,380	4,070	25,500	404	6,910	20,400	51,700
1960	2,900	1,180	6,140	9,690	8,360	3,920	23,600	340	6,390	17,900	47,700
1961	2,660	1,110	6,460	10,800	9,450	4,350	26,300	381	7,250	20,300	52,200
1962	3,190	1,010	7,990	11,600	8,820	4,370	27,500	431	5,700	16,000	47,900
1963	3,150	1,290	7,370	11,100	8,270	4,150	26,700	500	5,850	16,400	47,100
1964	2,600	960	6,610	9,770	9,310	3,950	22,600	351	6,270	17,500	42,700
1965	2,510	985	6,630	10,200	9,360	4,750	25,800	385	6,630	18,600	49,300
1966	2,410	816	5,190	9,430	8,650	4,220	23,600	327	6,430	18,000	46,300
1967	2,970	1,150	6,840	11,200	11,100	4,470	26,900	423	5,610	15,700	45,200
1968	3,430	896	6,130	9,790	9,170	4,470	24,600	379	6,440	18,000	46,800
1969	2,290	697	4,190	5,600	6,110	2,250	14,000	204	5,200	14,600	33,400

Water Year	Average Annual Flow, Q (cfs), for Pre-Project Conditions										
	Susitna River near Denali	Maclaren River near Paxson	Susitna River near Cantwell	Susitna River at Gold Creek	Chulitna River near Talkeetna	Talkeetna River near Talkeetna	Susitna River at Sunshine	Willow Creek near Willow	Skwentna River near Skwentna	Yentna River near Susitna Station	Susitna River at Susitna Station
1970	2,240	735	4,550	7,590	8,740	3,500	19,700	308	7,240	20,300	46,600
1971	2,900	1,090	6,820	10,300	8,410	5,300	25,400	399	6,940	19,400	47,800
1972	2,940	1,060	6,910	10,900	8,340	4,480	26,500	402	6,000	16,800	46,700
1973	2,240	890	5,110	8,090	7,590	3,850	20,800	350	5,240	14,700	41,400
1974	2,960	846	4,820	7,630	7,910	3,320	19,500	337	5,160	14,500	40,000
1975	3,000	1,030	6,550	10,300	8,970	4,340	25,400	410	6,490	18,900	46,100
1976	2,580	920	5,170	8,170	7,590	3,400	20,500	311	5,820	17,200	43,000
1977	3,050	1,160	6,410	10,100	8,740	4,360	24,700	434	10,100	26,300	56,000
1978	2,680	925	5,150	8,190	7,660	3,300	20,400	256	6,370	17,800	42,000
1979	3,040	886	6,030	9,490	8,940	4,450	24,000	433	6,630	20,700	53,700
1980	2,910	1,020	6,770	10,700	9,650	4,350	26,100	511	9,050	26,000	61,900
1981	3,400	1,170	7,890	12,000	10,400	4,420	28,400	367	9,050	24,900	55,700
1982	2,620	806	6,020	9,670	8,450	4,200	24,100	427	6,130	18,600	47,100
1983	2,830	994	6,510	9,920	8,220	3,640	23,600	349	6,390	18,300	43,800
1984	2,930	938	6,650	9,580	8,460	3,640	23,500	331	6,950	20,000	45,400
1985	3,000	1,070	5,930	9,880	8,460	4,260	24,300	468	6,840	19,700	47,300
1986	2,970	1,060	5,770	8,530	7,470	3,350	20,600	320	6,480	19,700	46,300
1987	3,060	1,070	6,710	10,600	9,860	4,810	26,700	416	7,750	23,600	54,900
1988	3,050	983	6,500	10,200	8,080	3,740	24,800	349	7,520	22,900	53,600
1989	3,210	1,030	6,500	10,300	8,960	4,240	25,500	413	7,980	24,400	56,500
1990	3,700	1,290	8,310	13,000	10,900	5,390	31,800	536	8,610	26,400	61,200

Water Year	Average Annual Flow, Q (cfs), for Pre-Project Conditions										
	Susitna River near Denali	Maclaren River near Paxson	Susitna River near Cantwell	Susitna River at Gold Creek	Chulitna River near Talkeetna	Talkeetna River near Talkeetna	Susitna River at Sunshine	Willow Creek near Willow	Skwentna River near Skwentna	Yentna River near Susitna Station	Susitna River at Susitna Station
1991	2,600	855	5,390	8,530	7,940	3,780	21,600	383	6,740	20,600	48,200
1992	2,430	863	5,510	8,720	7,510	3,530	21,600	335	6,080	18,400	43,900
1993	3,040	1,090	6,410	10,100	10,000	4,840	26,000	383	6,830	20,400	53,100
1994	2,770	990	6,300	9,960	9,170	4,340	25,100	413	6,710	19,800	51,800
1995	2,850	1,020	6,540	10,300	8,680	4,040	25,400	360	6,970	20,600	51,300
1996	1,860	648	4,260	6,800	6,790	3,120	17,700	245	4,750	13,800	38,300
1997	2,440	827	5,510	8,800	7,670	3,580	23,100	317	6,050	18,400	44,600
1998	2,670	907	5,890	9,380	8,230	3,850	24,600	336	6,380	19,500	47,100
1999	2,520	864	5,810	9,290	8,080	3,850	24,400	326	6,360	19,500	46,600
2000	2,750	963	6,400	10,200	8,900	4,450	26,600	429	6,910	21,100	50,300
2001	2,510	901	6,030	9,540	7,850	3,700	23,800	355	6,380	19,200	46,900
2002	2,420	865	5,360	8,480	8,090	3,800	21,700	315	5,800	17,100	45,100
2003	2,820	1,000	6,510	10,300	9,080	4,250	25,600	338	6,930	20,300	52,400
2004	2,570	912	5,960	9,400	7,900	3,610	23,300	268	6,400	18,900	47,700
2005	3,660	1,330	7,820	12,200	11,700	5,860	30,900	607	7,970	23,600	61,400
2006	2,710	983	6,550	10,300	8,290	4,010	24,900	434	6,800	20,000	49,500
2007	2,550	917	6,100	9,650	7,840	3,590	23,700	313	6,640	19,800	48,500
2008	2,360	844	5,630	8,900	7,460	3,420	22,000	314	6,120	18,000	45,300
2009	2,530	903	6,020	9,500	7,730	3,560	23,400	289	6,470	19,200	47,700
2010	2,720	983	6,440	10,100	8,180	3,760	24,800	293	6,870	20,500	50,300

Water Year	Average Annual Flow, Q (cfs), for Pre-Project Conditions										
	Susitna River near Denali	Maclaren River near Paxson	Susitna River near Cantwell	Susitna River at Gold Creek	Chulitna River near Talkeetna	Talkeetna River near Talkeetna	Susitna River at Sunshine	Willow Creek near Willow	Skwentna River near Skwentna	Yentna River near Susitna Station	Susitna River at Susitna Station
Average	2,790	980	6,190	9,730	8,600	4,060	24,050	370	6,660	19,460	48,560
Median	2,750	980	6,300	9,790	8,460	4,040	24,400	360	6,490	19,500	47,700
90% Exceed-ence	2,370	820	5,120	8,110	7,530	3,390	20,420	280	5,630	16,060	42,460
10% Exceed-ence	3,210	1,170	7,230	11,180	9,850	4,800	26,860	430	7,930	23,600	55,600
Annual Volume (af)	2,018,000	711,000	4,486,000	7,047,000	6,230,000	2,938,000	17,426,000	266,000	4,828,000	14,101,000	35,180,000

Table 4.4-2. Average monthly flows (cfs) at USGS gages in the Susitna River watershed for pre-Project conditions based on the USGS extended record.

Period	Susitna River near Denali	Maclaren River near Paxson	Susitna River near Cantwell	Susitna River at Gold Creek	Chulitna River near Talkeetna	Talkeetna River near Talkeetna	Susitna River at Sunshine	Willow Creek Near Willow	Skwentna River near Skwentna	Yentna River near Susitna Station	Susitna River at Susitna Station
Drainage Area (sq. mi.)	950	280	4,140	6,160	2,570	1,996	11,100	166	2,250	6,180	19,400
OCT	1,330	465	3,800	6,320	5,750	2,840	15,900	332	4,780	13,400	36,000
NOV	503	182	1,600	2,670	2,260	1,160	6,490	153	2,020	5,350	14,400
DEC	326	125	1,130	1,890	1,550	801	4,490	105	1,400	3,640	9,510
JAN	263	102	938	1,590	1,300	655	3,720	84	1,160	3,020	7,910
FEB	229	88	820	1,420	1,140	553	3,260	71	1,020	2,650	7,080
MAR	212	81	755	1,300	1,060	502	2,960	60	916	2,400	6,510
APR	293	106	1,030	1,740	1,370	670	4,030	79	1,330	3,480	8,990
MAY	3,120	1,140	8,630	13,800	10,400	5,120	33,200	487	9,280	26,900	66,100
JUN	7,400	2,800	16,900	26,300	21,500	10,700	63,700	1,040	17,400	50,600	120,000
JUL	8,580	2,920	15,800	24,000	23,200	10,300	60,500	745	16,700	49,900	122,000
AUG	7,300	2,420	13,900	21,400	20,600	9,210	54,200	666	14,200	43,100	109,000
SEP	3,640	1,290	8,620	13,700	12,600	5,940	34,900	573	9,320	27,900	72,800
Annual	2,780	982	6,190	9,720	8,600	4,060	24,100	368	6,660	19,500	48,600

Table 4.4-3. Annual flow exceedence ordinates (cfs) for pre-Project conditions based on the USGS Extended Record.

Annual Flow Exceedence Ordinates											
Percentile	Susitna River near Denali	Maclaren River near Paxson	Susitna River near Cantwell	Susitna River at Gold Creek	Chulitna River near Talkeetna	Talkeetna River near Talkeetna	Susitna River at Sunshine	Willow Creek near Willow	Skwentna River near Skwentna	Yentna River near Susitna Station	Susitna River at Susitna Station
99%	110	47	440	750	820	380	1,740	38	600	1,460	5,210
95%	181	60	560	960	965	450	2,310	51	750	1,910	5,840
90%	200	76	694	1,200	1,040	500	2,830	60	850	2,280	6,400
75%	263	100	940	1,600	1,230	621	3,750	80	1,140	2,970	7,710
50%	650	220	2,050	3,400	2,840	1,430	8,220	171	2,660	6,950	19,000
25%	5,070	1,820	11,400	17,800	16,100	7,240	45,000	526	12,000	36,500	94,000
10%	8,500	2,950	16,500	25,300	23,400	10,500	64,000	930	17,200	51,300	124,000
5%	9,570	3,400	19,400	29,800	26,200	12,800	72,800	1,240	19,900	58,700	138,000
1%	12,700	4,400	25,700	39,300	33,700	18,100	91,200	1,870	26,400	73,700	164,000

Table 4.4-4. Mainstem Susitna River estimated return period peak flows (cfs) for pre-Project conditions based on the USGS extended record.

Return Period (years)	Flow (cfs)				
	Denali	Cantwell	Gold Creek	Sunshine	Susitna Station
1.25	11,300	23,100	35,100	90,200	152,000
2	13,500	27,300	43,500	106,000	170,000
5	17,200	33,400	56,200	129,000	197,000
20	23,100	41,900	74,600	160,000	233,000
50	27,500	47,600	87,500	181,000	258,000
100	31,200	52,100	98,000	197,000	276,000

Table 4.4-5. Susitna River Tributary estimated return period peak flows (cfs) for pre-Project conditions based on the USGS extended record.

Return Period (years)	Flow (cfs)					
	Maclaren	Chulitna	Talkeetna	Willow	Skwentna	Yentna
1.25	4,220	30,200	17,700	1,970	25,000	74,100
2	4,900	35,200	23,200	2,700	29,100	83,600
5	5,950	43,000	32,700	3,990	35,300	97,400
20	7,510	54,800	49,100	6,240	44,400	116,000
50	8,620	63,200	62,300	8,080	50,800	129,000
100	9,510	70,100	73,900	9,700	55,900	139,000

Table 4.4-6. Average monthly flows (cfs) at three USGS gages in the Susitna River watershed for Maximum Load Following Scenario OS-1, based on the HEC-ResSim model.

Period	Susitna River at Gold Creek	Susitna River at Sunshine	Susitna River at Susitna Station
Drainage Area (sq. mi.)	6,160	11,100	19,400
OCT	8,240	18,000	38,100
NOV	7,990	11,900	19,800
DEC	8,750	11,300	16,300
JAN	9,140	11,300	15,500
FEB	9,750	11,600	15,400
MAR	7,460	9,190	12,700
APR	6,950	9,160	14,100
MAY	8,490	27,400	60,200
JUN	10,200	47,500	104,000
JUL	10,800	47,200	108,000
AUG	15,400	48,400	103,000
SEP	12,700	34,100	72,000
Annual	9,660	24,000	48,500

Table 4.4-7. Average annual flows (cfs) for Maximum Load Following OS-1 conditions based on the HEC-ResSim model.

Water Year	Average Annual Flow, Q (cfs), for Maximum Load Following OS-1 Conditions		
	Susitna River at Gold Creek	Susitna River at Sunshine	Susitna River at Susitna Station
1950	8,470	20,100	42,900
1951	9,110	22,300	47,300
1952	9,000	22,400	46,300
1953	9,890	24,500	52,000
1954	9,640	23,700	49,700
1955	10,100	24,400	50,100
1956	11,400	27,500	55,100
1957	10,300	25,200	52,200
1958	9,440	23,000	48,700
1959	10,300	25,200	51,400
1960	9,630	23,500	47,600
1961	10,800	26,300	52,200
1962	11,500	27,500	47,900
1963	11,000	26,600	47,100
1964	9,740	22,600	42,600
1965	10,100	25,700	49,100
1966	9,410	23,700	46,300
1967	10,900	26,600	44,900
1968	9,770	24,600	46,800
1969	8,180	16,500	36,000
1970	6,880	19,000	45,900
1971	8,230	23,400	45,800
1972	10,800	26,400	46,700
1973	8,480	21,300	41,800
1974	8,860	20,700	41,200
1975	8,490	23,600	44,300
1976	8,550	20,900	43,400
1977	9,640	24,200	55,500
1978	8,420	20,700	42,300
1979	9,180	23,700	53,400
1980	10,600	25,900	61,800
1981	11,600	28,000	55,400

Water Year	Average Annual Flow, Q (cfs), for Maximum Load Following OS-1 Conditions, cont.		
	Susitna River at Gold Creek	Susitna River at Sunshine	Susitna River at Susitna Station
1982	9,610	24,000	47,000
1983	9,880	23,500	43,800
1984	9,550	23,500	45,400
1985	9,820	24,200	47,200
1986	8,550	20,600	46,400
1987	10,400	26,600	54,700
1988	10,200	24,800	53,500
1989	10,200	25,500	56,400
1990	12,900	31,600	61,100
1991	8,570	21,700	48,300
1992	8,620	21,500	43,800
1993	10,000	25,900	53,000
1994	9,960	25,100	51,800
1995	10,200	25,300	51,200
1996	8,450	19,400	40,000
1997	8,270	22,600	44,000
1998	8,680	23,800	46,400
1999	8,800	23,900	46,100
2000	10,100	26,400	50,100
2001	9,530	23,800	47,000
2002	8,530	21,700	45,100
2003	10,100	25,500	52,300
2004	9,440	23,400	47,800
2005	12,000	30,700	61,200
2006	10,100	24,800	49,300
2007	9,570	23,700	48,500
2008	8,860	22,000	45,200
2009	9,460	23,400	47,600
2010	10,100	24,800	50,300

Table 4.4-8. Annual and monthly flow exceedence ordinates (cfs) for Maximum Load Following OS-1 conditions at Susitna River at Gold Creek based on the HEC-ResSim model.

Susitna River at Gold Creek													
Percentile	**Annual**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
99%	1,400	6,440	7,140	6,880	7,070	795	800	952	2,240	7,980	7,880	7,900	6,200
95%	6,870	6,710	7,250	7,210	7,880	8,160	1,400	1,420	6,200	8,480	8,380	8,420	6,730
90%	7,210	6,920	7,330	7,660	8,220	8,500	6,900	6,250	6,620	8,700	8,600	8,730	7,170
75%	7,840	7,300	7,690	8,240	8,720	8,850	7,250	6,970	7,460	9,200	9,000	9,260	8,150
50%	8,750	7,730	8,010	8,740	9,190	9,800	7,850	7,390	8,300	9,890	9,480	12,600	11,000
25%	9,920	8,390	8,230	9,230	9,560	10,700	8,210	7,750	9,560	10,800	10,300	20,300	15,500
10%	12,300	10,100	8,450	9,760	10,300	11,400	8,620	7,990	10,800	11,900	12,000	25,600	21,100
5%	17,800	12,000	8,760	10,200	10,600	11,700	9,040	8,210	11,600	12,800	22,400	29,500	24,200
1%	26,900	15,900	9,610	11,300	11,700	13,200	9,650	8,730	13,300	16,500	29,700	39,600	32,200

Table 4.4-9. Annual and monthly flow exceedence ordinates (cfs) for Maximum Load Following OS-1 conditions at Susitna River at Sunshine based on the HEC-ResSim model.

Susitna River at Sunshine													
Percentile	**Annual**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
99%	3,240	11,000	9,300	8,880	8,840	2,110	2,080	2,360	5,400	26,400	32,000	21,900	13,800
95%	8,840	11,800	9,920	9,590	9,810	9,760	3,270	3,360	9,710	31,100	35,000	31,400	15,900
90%	9,470	12,400	10,300	10,000	10,200	10,100	8,290	7,850	10,700	33,400	37,400	34,900	18,300
75%	10,800	13,500	10,900	10,600	10,700	10,700	8,920	8,700	14,600	39,800	41,100	39,500	23,300
50%	13,200	15,800	11,600	11,300	11,400	11,700	9,510	9,320	25,900	48,000	45,800	46,000	31,300
25%	38,400	20,200	12,500	11,900	11,900	12,700	10,000	9,890	36,900	54,100	51,800	55,100	41,400
10%	51,000	26,800	13,800	12,500	12,600	13,500	10,600	10,700	48,500	60,400	58,200	64,800	54,300
5%	57,100	31,700	14,700	13,000	13,100	14,000	11,100	11,600	54,900	65,000	63,900	73,300	62,000
1%	71,300	42,900	16,500	14,000	13,900	15,100	11,700	17,000	60,400	77,200	77,000	97,800	80,300

Table 4.4-10. Annual and monthly flow exceedence ordinates (cfs) for Maximum Load Following OS-1 conditions at Susitna River at Susitna Station based on the HEC-ResSim model.

Susitna River at Susitna Station													
Percentile	**Annual**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
99%	6,810	16,500	13,200	12,500	11,900	6,020	5,450	5,760	10,100	58,200	73,700	45,200	22,900
95%	12,300	19,600	14,000	13,300	13,400	13,200	7,000	6,880	14,000	69,500	81,700	68,900	34,200
90%	13,000	21,900	14,800	13,800	13,900	13,600	11,500	11,300	17,400	77,400	88,100	76,600	39,400
75%	15,100	26,700	16,500	14,800	14,500	14,400	12,300	12,100	32,700	90,400	97,600	88,400	50,900
50%	23,100	33,600	18,500	16,000	15,400	15,500	12,900	12,900	57,700	106,000	107,000	102,000	68,000
25%	87,400	43,800	21,800	17,600	16,400	16,600	13,700	14,700	85,800	117,000	118,000	116,000	88,800
10%	112,000	60,200	25,800	18,800	17,500	17,600	14,600	18,100	106,000	128,000	129,000	129,000	112,000
5%	122,000	70,600	29,200	19,700	18,100	18,400	15,300	23,000	116,000	134,000	139,000	144,000	123,000
1%	145,000	97,000	40,900	25,400	19,000	19,700	16,300	39,000	128,000	149,000	162,000	188,000	152,000

Table 4.4-11. Susitna River estimated return period peak flows (cfs) for Maximum Load Following OS-1 conditions based on the HEC-ResSim model.

Return Period (years)	Flow (cfs)		
	Gold Creek	Sunshine	Susitna Station
1.25	16,900	60,500	125,000
2	23,900	72,000	142,000
5	34,300	88,200	169,000
20	48,800	110,000	209,000
50	58,600	125,000	238,000
100	66,400	137,000	261,000

Table 4.5-1. Average monthly flow (cfs) comparison for pre-Project and Maximum Load Following OS-1 conditions.

Period	Watana Dam			Susitna River at Gold Creek			Susitna River at Sunshine			Susitna River at Susitna Station		
	Pre-Project	Max LF OS-1	Δ	Pre-Project	Max LF OS-1	Δ	Pre-Project	Max LF OS-1	Δ	Pre-Project	Max LF OS-1	Δ
OCT	5,100	7,020	1,920	6,320	8,240	1,920	15,900	18,000	2,100	36,000	38,100	2,100
NOV	2,150	7,520	5,370	2,670	7,990	5,320	6,490	11,900	5,410	14,400	19,800	5,400
DEC	1,520	8,540	7,020	1,890	8,750	6,860	4,490	11,300	6,810	9,510	16,300	6,790
JAN	1,280	8,840	7,560	1,590	9,140	7,550	3,720	11,300	7,580	7,910	15,500	7,590
FEB	1,130	9,450	8,320	1,420	9,750	8,330	3,260	11,600	8,340	7,080	15,400	8,320
MAR	1,040	7,170	6,130	1,300	7,460	6,160	2,960	9,190	6,230	6,510	12,700	6,190
APR	1,400	6,650	5,250	1,740	6,950	5,210	4,030	9,160	5,130	8,990	14,100	5,110
MAY	11,300	6,090	-5,210	13,800	8,490	-5,310	33,200	27,400	-5,800	66,100	60,200	-5,900
JUN	21,700	5,680	-16,020	26,300	10,200	-16,100	63,700	47,500	-16,200	120,000	104,000	-16,000
JUL	20,000	6,980	-13,020	24,000	10,800	-13,200	60,500	47,200	-13,300	122,000	108,000	-14,000
AUG	17,800	11,900	-5,900	21,400	15,400	-6,000	54,200	48,400	-5,800	109,000	103,000	-6,000
SEP	11,300	10,100	-1,200	13,700	12,700	-1,000	34,900	34,100	-800	72,800	72,000	-800
Annual	8,010	7,990	-20	9,720	9,660	-60	24,100	24,000	-100	48,600	48,500	-100

Table 4.5-2. Average annual flow (cfs) comparison for pre-Project versus Maximum Load Following OS-1 conditions.

Water Year	Average Annual Flow, Q (cfs), Comparison							
	Watana Dam		Susitna River at Gold Creek		Susitna River at Sunshine		Susitna River at Susitna Station	
	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1
1950	6600	7100	8,030	8,470	19,600	20,100	42,400	42,900
1951	7500	7500	9,110	9,110	22,300	22,300	47,300	47,300
1952	7800	7400	9,530	9,000	22,900	22,400	46,800	46,300
1953	8300	8100	10,100	9,890	24,700	24,500	52,200	52,000
1954	8000	8000	9,680	9,640	23,700	23,700	49,700	49,700
1955	8400	8300	10,300	10,100	24,600	24,400	50,300	50,100
1956	9400	9400	11,400	11,400	27,600	27,500	55,200	55,100
1957	8600	8500	10,400	10,300	25,300	25,200	52,300	52,200
1958	7800	7800	9,480	9,440	23,000	23,000	48,700	48,700
1959	8700	8500	10,600	10,300	25,500	25,200	51,700	51,400
1960	8000	8000	9,690	9,630	23,600	23,500	47,700	47,600
1961	8700	8700	10,800	10,800	26,300	26,300	52,200	52,200
1962	9800	9800	11,600	11,500	27,500	27,500	47,900	47,900
1963	9300	9300	11,100	11,000	26,700	26,600	47,100	47,100
1964	8200	8200	9,770	9,740	22,600	22,600	42,700	42,600
1965	8500	8400	10,200	10,100	25,800	25,700	49,300	49,100
1966	7400	7400	9,430	9,410	23,600	23,700	46,300	46,300
1967	9100	8900	11,200	10,900	26,900	26,600	45,200	44,900
1968	8000	8000	9,790	9,770	24,600	24,600	46,800	46,800
1969	4900	7500	5,600	8,180	14,000	16,500	33,400	36,000

Water Year	Average Annual Flow, Q (cfs), Comparison							
	Watana Dam		Susitna River at Gold Creek		Susitna River at Sunshine		Susitna River at Susitna Station	
	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1
1970	6100	5400	7,590	6,880	19,700	19,000	46,600	45,900
1971	8600	6600	10,300	8,230	25,400	23,400	47,800	45,800
1972	8900	9000	10,900	10,800	26,500	26,400	46,700	46,700
1973	6600	7100	8,090	8,480	20,800	21,300	41,400	41,800
1974	6300	7500	7,630	8,860	19,500	20,700	40,000	41,200
1975	8500	6700	10,300	8,490	25,400	23,600	46,100	44,300
1976	6700	7100	8,170	8,550	20,500	20,900	43,000	43,400
1977	8300	7900	10,100	9,640	24,700	24,200	56,000	55,500
1978	6700	7000	8,190	8,420	20,400	20,700	42,000	42,300
1979	7800	7600	9,490	9,180	24,000	23,700	53,700	53,400
1980	8800	8700	10,700	10,600	26,100	25,900	61,900	61,800
1981	10000	9700	12,000	11,600	28,400	28,000	55,700	55,400
1982	7900	7900	9,670	9,610	24,100	24,000	47,100	47,000
1983	8300	8300	9,920	9,880	23,600	23,500	43,800	43,800
1984	8200	8200	9,580	9,550	23,500	23,500	45,400	45,400
1985	8000	8000	9,880	9,820	24,300	24,200	47,300	47,200
1986	7200	7200	8,530	8,550	20,600	20,600	46,300	46,400
1987	8700	8500	10,600	10,400	26,700	26,600	54,900	54,700
1988	8400	8400	10,200	10,200	24,800	24,800	53,600	53,500
1989	8400	8400	10,300	10,200	25,500	25,500	56,500	56,400
1990	10700	10600	13,000	12,900	31,800	31,600	61,200	61,100

Water Year	Average Annual Flow, Q (cfs), Comparison							
	Watana Dam		Susitna River at Gold Creek		Susitna River at Sunshine		Susitna River at Susitna Station	
	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1
1991	7000	7100	8,530	8,570	21,600	21,700	48,200	48,300
1992	7200	7100	8,720	8,620	21,600	21,500	43,900	43,800
1993	8300	8300	10,100	10,000	26,000	25,900	53,100	53,000
1994	8200	8200	9,960	9,960	25,100	25,100	51,800	51,800
1995	8500	8500	10,300	10,200	25,400	25,300	51,300	51,200
1996	5600	7300	6,800	8,450	17,700	19,400	38,300	40,000
1997	7200	6700	8,800	8,270	23,100	22,600	44,600	44,000
1998	7700	7000	9,380	8,680	24,600	23,800	47,100	46,400
1999	7600	7200	9,290	8,800	24,400	23,900	46,600	46,100
2000	8400	8300	10,200	10,100	26,600	26,400	50,300	50,100
2001	7800	7800	9,540	9,530	23,800	23,800	46,900	47,000
2002	7000	7100	8,480	8,530	21,700	21,700	45,100	45,100
2003	8500	8300	10,300	10,100	25,600	25,500	52,400	52,300
2004	7700	7800	9,400	9,440	23,300	23,400	47,700	47,800
2005	10100	10000	12,200	12,000	30,900	30,700	61,400	61,200
2006	8500	8300	10,300	10,100	24,900	24,800	49,500	49,300
2007	7900	7900	9,650	9,570	23,700	23,700	48,500	48,500
2008	7300	7300	8,900	8,860	22,000	22,000	45,300	45,200
2009	7800	7800	9,500	9,460	23,400	23,400	47,700	47,600
2010	8300	8300	10,100	10,100	24,800	24,800	50,300	50,300

Table 4.5-3. Annual flow exceedence ordinate (cfs) comparison for Pre-Project and Maximum Load Following Scenario OS-1.

Annual Flow Duration Comparison (cfs)								
Percentile	Watana Dam		Susitna River at Gold Creek		Susitna River at Sunshine		Susitna River at Susitna Station	
	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1
99%	603	1,120	750	1,400	1,740	3,240	5,210	6,810
95%	777	4,960	960	6,870	2,310	8,840	5,840	12,300
90%	956	5,400	1,200	7,210	2,830	9,470	6,400	13,000
75%	1,280	6,140	1,600	7,840	3,750	10,800	7,710	15,100
50%	2,730	7,370	3,400	8,750	8,220	13,200	19,000	23,100
25%	14,700	8,670	17,800	9,920	45,000	38,400	94,000	87,400
10%	20,900	10,800	25,300	12,300	64,000	51,000	124,000	112,000
5%	24,600	14,700	29,800	17,800	72,800	57,100	138,000	122,000
1%	32,500	22,900	39,300	26,900	91,200	71,300	164,000	145,000

Table 4.5-4. Susitna River estimated return period peak flow (cfs) comparison for pre-Project and Maximum Load Following Scenario OS-1.

Return Period (Years)	Watana Dam Site				Gold Creek				Sunshine				Susitna Station			
	Pre-Project Flow (cfs)	Max LF OS-1 (cfs)	Difference (cfs)	Difference (%)	Pre-Project Flow (cfs)	Max LF OS-1 (cfs)	Difference (cfs)	Difference (%)	Pre-Project Flow (cfs)	Max LF OS-1 (cfs)	Difference (cfs)	Difference (%)	Pre-Project Flow (cfs)	Max LF OS-1 (cfs)	Difference (cfs)	Difference (%)
1.01	21,100	12,800	-8,300	-39%	25,400	12,600	-12,800	-50%	64,000	47,600	-16,400	-26%	131,700	109,500	-22,200	-17%
1.25	27,800	14,100	-13,700	-49%	35,100	14,400	-20,700	-59%	80,200	60,500	-19,700	-25%	151,600	124,900	-26,700	-18%
1.5	30,700	15,800	-14,900	-49%	39,000	19,100	-19,900	-51%	87,000	65,800	-21,200	-24%	160,400	132,900	-27,500	-17%
2	34,200	20,700	-13,500	-39%	43,700	23,900	-19,800	-45%	94,700	72,000	-22,700	-24%	170,300	141,900	-28,400	-17%
5	43,700	28,700	-15,000	-34%	55,800	34,300	-21,500	-39%	115,400	88,200	-27,200	-24%	197,000	168,900	-28,100	-14%
20	57,600	40,200	-17,400	-30%	72,300	48,800	-23,500	-33%	143,600	110,400	-33,200	-23%	233,500	209,400	-24,100	-10%
50	67,300	48,200	-19,100	-28%	83,400	58,600	-24,800	-30%	162,500	125,100	-37,400	-23%	257,600	238,200	-19,400	-8%
100	75,100	54,600	-20,500	-27%	92,100	66,400	-25,700	-28%	177,300	136,700	-40,600	-23%	276,300	261,400	-14,900	-5%

Table 4.5-5. Recurrence interval of annual peak flows for pre-Project and Maximum Load Following Scenario OS-1.

Watana Dam Site			Gold Creek			Sunshine			Susitna Station		
Discharge (cfs)	Pre-Project Return Period (yrs)	Max Load Following OS-1 Return Period (yrs)	Discharge (cfs)	Pre-Project Return Period (yrs)	Max Load Following OS-1 Return Period (yrs)	Discharge (cfs)	Pre-Project Return Period (yrs)	Max Load Following OS-1 Return Period (yrs)	Discharge (cfs)	Pre-Project Return Period (yrs)	Max Load Following OS-1 Return Period (yrs)
21,100	1.01	2.1	25,400	1.01	2.2	64,000	1.01	1.4	131,700	1.01	1.5
27,800	1.25	4.5	35,100	1.25	5.4	80,200	1.25	3.1	151,600	1.25	2.7
30,700	1.5	6.4	39,000	1.5	7.8	87,000	1.5	4.6	160,426	1.5	3.6
34,200	2	9.8	43,700	2	12	94,700	2	7.4	170,300	2	5.2
43,700	5	30	55,800	5	39	115,400	5	27	197,000	5	13
57,600	20	136	72,300	20	166	143,600	20	149	233,500	20	43

Table 5.2-1. USGS Measurements Used to Develop Representative Cross Section Geometry.

Gage	USGS Measurement No.	Date of Measurement	Flow Rate Measured (cfs)	Stage (ft)
Sunshine	55 [a]	9/22/2012	155,000	25.17
Susitna Station	127	7/18/2003	234,000	19.54

Notes:

a. Specifically, Transect 2 from Measurement 55 was used

Table 5.3-1. Annual Stage-exceedence Ordinate (feet) Comparison for pre-Project and Maximum Load Following OS-1 Hydrologic Conditions at Sunshine Gage and Susitna Station Gage.

Percentile	Sunshine Gage (USGS 15292780)			Susitna Station Gage (USGS 15292780)		
	Annual Stage-exceedence Value			Annual Stage-exceedence Value		
	Pre-Project	Max LF OS-1	Delta [a]	Pre-Project	Max LF OS-1	Delta [a]
99%	10.93	11.08	0.15	2.59	3.03	0.44
95%	10.97	12.28	1.31	2.77	4.28	1.51
90%	10.99	12.40	1.41	2.93	4.43	1.50
75%	11.21	12.62	1.41	3.26	4.83	1.57
50%	12.17	13.02	0.85	5.53	6.21	0.68
25%	16.85	16.17	-0.68	13.00	12.57	-0.43
10%	18.60	17.42	-1.18	14.77	14.04	-0.73
5%	19.35	17.98	-1.37	15.51	14.66	-0.85
1%	20.81	19.22	-1.59	16.77	15.85	-0.92

Notes:

a. Delta calculated as Max LF OS-1 value minus pre-Project value, with negative values indicated in red text.

Table 5.3-2. Monthly (October through March) Stage-exceedence Ordinate (feet) Comparison for pre-Project and Maximum Load Following OS-1 Hydrologic Conditions at Sunshine Gage.

Sunshine Gage (USGS 15292780)									
Percentile	October			November			December		
	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta
99%	11.57	12.65	1.08	10.99	12.36	1.37	10.97	12.29	1.32
95%	11.91	12.78	0.87	11.17	12.47	1.30	10.98	12.42	1.44
90%	12.15	12.88	0.73	11.30	12.53	1.23	10.99	12.50	1.51
75%	12.57	13.07	0.50	11.54	12.65	1.11	11.21	12.59	1.38
50%	13.09	13.42	0.33	11.75	12.75	1.00	11.40	12.70	1.30
25%	13.94	14.02	0.08	12.02	12.91	0.89	11.55	12.82	1.27
10%	14.81	14.86	0.05	12.34	13.10	0.76	11.69	12.91	1.22
5%	15.40	15.44	0.04	12.57	13.26	0.69	11.81	12.98	1.18
1%	16.85	16.64	-0.21	13.00	13.52	0.52	12.22	13.13	0.91
Percentile	January			February			March		
	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta
99%	10.95	12.28	1.33	10.91	10.95	0.04	10.90	10.95	0.05
95%	10.95	12.46	1.50	10.94	12.45	1.51	10.92	11.09	0.16
90%	10.97	12.51	1.54	10.95	12.51	1.56	10.94	12.18	1.24
75%	11.08	12.62	1.54	10.99	12.62	1.63	10.97	12.29	1.32
50%	11.20	12.72	1.52	11.09	12.77	1.68	11.00	12.40	1.40
25%	11.36	12.80	1.44	11.21	12.93	1.72	11.14	12.50	1.36
10%	11.46	12.91	1.45	11.35	13.06	1.71	11.25	12.60	1.35
5%	11.49	12.99	1.50	11.39	13.13	1.74	11.37	12.67	1.30
1%	11.64	13.12	1.48	11.51	13.32	1.81	11.46	12.78	1.32

Notes:

a. Delta calculated as Max LF OS-1 value minus pre-Project value, with negative values indicated in red text.

Table 5.3-3. Monthly (April through September) Stage-exceedence Ordinate (feet) Comparison for pre-Project and Maximum Load Following OS-1 Hydrologic Conditions at Sunshine Gage.

Sunshine Gage (USGS 15292780)									
Percentile	April			May			June		
	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta
99%	10.91	10.97	0.05	11.03	11.60	0.57	15.22	14.81	-0.41
95%	10.94	11.10	0.17	11.58	12.44	0.86	16.03	15.36	-0.67
90%	10.95	12.09	1.14	11.93	12.62	0.69	16.42	15.62	-0.80
75%	10.98	12.26	1.28	13.01	13.24	0.23	17.39	16.32	-1.07
50%	11.15	12.37	1.22	15.37	14.76	-0.61	18.56	17.13	-1.43
25%	11.35	12.47	1.12	17.12	16.00	-1.12	19.44	17.71	-1.73
10%	11.70	12.62	0.92	18.76	17.18	-1.58	20.34	18.29	-2.05
5%	12.08	12.77	0.69	19.54	17.78	-1.76	20.98	18.69	-2.29
1%	13.41	13.58	0.17	20.34	18.28	-2.06	22.88	19.71	-3.17
Percentile	July			August			September		
	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta
99%	16.13	15.48	-0.65	14.14	14.26	0.12	12.83	13.10	0.27
95%	16.65	15.81	-0.84	15.69	15.41	-0.28	13.35	13.43	0.08
90%	16.98	16.07	-0.91	16.13	15.79	-0.34	13.73	13.78	0.05
75%	17.52	16.44	-1.08	16.80	16.29	-0.51	14.50	14.44	-0.06
50%	18.13	16.92	-1.21	17.61	16.94	-0.67	15.48	15.39	-0.09
25%	18.91	17.49	-1.42	18.36	17.80	-0.56	16.61	16.48	-0.13
10%	19.68	18.08	-1.60	19.23	18.67	-0.56	17.91	17.73	-0.18
5%	20.14	18.60	-1.54	19.94	19.39	-0.55	18.62	18.43	-0.20
1%	21.29	19.69	-1.60	22.30	21.30	-1.00	19.96	19.95	-0.01

Notes:

a. Delta calculated as Max LF OS-1 value minus pre-Project value, with negative values indicated in red text.

Table 5.3-4. Monthly (October through March) Stage-exceedence Ordinate (feet) Comparison for pre-Project and Maximum Load Following OS-1 Hydrologic Conditions at Susitna Station Gage.

Susitna Station Gage (USGS 15294350)									
Percentile	October			November			December		
	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta
99%	4.02	5.09	1.07	3.00	4.47	1.47	2.82	4.32	1.5
95%	4.82	5.63	0.81	3.27	4.62	1.35	2.89	4.50	1.61
90%	5.36	6.02	0.66	3.51	4.78	1.27	3.04	4.59	1.55
75%	6.26	6.75	0.49	3.95	5.08	1.13	3.29	4.77	1.48
50%	7.45	7.74	0.29	4.43	5.44	1.01	3.57	5.01	1.44
25%	8.90	9.01	0.11	5.13	5.99	0.86	3.95	5.29	1.34
10%	10.57	10.58	0.01	5.91	6.62	0.71	4.23	5.49	1.26
5%	11.31	11.36	0.05	6.50	7.07	0.57	4.49	5.65	1.16
1%	13.21	13.18	-0.03	8.13	8.66	0.53	5.68	6.55	0.87

Percentile	January			February			March		
	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta
99%	2.73	4.21	1.48	2.51	2.82	0.31	2.44	2.66	0.22
95%	2.76	4.52	1.76	2.63	4.47	1.84	2.55	3.08	0.53
90%	2.87	4.60	1.73	2.76	4.55	1.79	2.61	4.12	1.51
75%	3.08	4.73	1.65	2.92	4.70	1.78	2.76	4.28	1.52
50%	3.30	4.90	1.60	3.08	4.90	1.82	2.94	4.42	1.48
25%	3.47	5.08	1.61	3.22	5.10	1.88	3.08	4.56	1.48
10%	3.74	5.27	1.53	3.45	5.29	1.84	3.22	4.75	1.53
5%	3.87	5.37	1.50	3.62	5.42	1.80	3.57	4.87	1.30
1%	4.02	5.53	1.51	3.80	5.64	1.84	3.69	5.05	1.36

Notes:

a. Delta calculated as Max LF OS-1 value minus pre-Project value, with negative values indicated in red text.

Table 5.3-5. Monthly (April through September) Stage-exceedence Ordinate (feet) Comparison for pre-Project and Maximum Load Following OS-1 Hydrologic Conditions at Susitna Station Gage.

Susitna Station Gage (USGS 15294350)									
Percentile	April			May			June		
	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta
99%	2.53	2.75	0.22	3.12	3.82	0.70	10.96	10.43	-0.53
95%	2.65	3.05	0.40	3.89	4.63	0.74	11.85	11.27	-0.58
90%	2.69	4.07	1.38	4.76	5.26	0.50	12.49	11.88	-0.61
75%	2.85	4.26	1.41	7.62	7.60	-0.02	13.48	12.76	-0.72
50%	3.08	4.41	1.33	10.86	10.39	-0.47	14.56	13.69	-0.87
25%	3.62	4.75	1.13	13.07	12.46	-0.61	15.41	14.33	-1.08
10%	4.53	5.37	0.84	14.65	13.71	-0.94	16.21	14.99	-1.22
5%	5.53	6.19	0.66	15.36	14.29	-1.07	16.63	15.32	-1.31
1%	8.20	8.44	0.24	16.11	14.99	-1.12	17.59	16.07	-1.52

Percentile	July			August			September		
	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta
99%	12.08	11.60	-0.48	9.03	9.17	0.14	5.96	6.18	0.22
95%	12.79	12.18	-0.61	11.38	11.23	-0.15	7.66	7.81	0.15
90%	13.26	12.62	-0.64	12.04	11.82	-0.22	8.41	8.49	0.08
75%	13.83	13.21	-0.62	12.89	12.63	-0.26	9.77	9.78	0.01
50%	14.53	13.76	-0.77	13.77	13.45	-0.32	11.20	11.16	-0.04
25%	15.26	14.40	-0.86	14.71	14.30	-0.41	12.76	12.66	-0.10
10%	15.96	15.06	-0.90	15.51	15.06	-0.45	14.18	14.04	-0.14
5%	16.44	15.57	-0.87	16.23	15.79	-0.44	14.82	14.72	-0.10
1%	17.78	16.66	-1.12	18.18	17.85	-0.33	16.29	16.18	-0.11

Notes:

a. Delta calculated as Max LF OS-1 value minus pre-Project value, with negative values indicated in red text.

Table 5.3-6. Monthly Stage Statistics for pre-Project and Max Load Following OS-1 Hydrologic Conditions at Sunshine Gage.

Sunshine Gage (USGS 15292780)									
Statistic	Oct			Nov			Dec		
	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta
Maximum	22.15	20.39	-1.76	14.25	14.23	-0.02	12.53	13.32	0.79
Median	13.09	13.42	0.33	11.75	12.75	1.00	11.40	12.70	1.30
Average	13.33	13.68	0.34	11.80	12.80	0.99	11.39	12.70	1.32
Minimum	11.09	12.33	1.24	10.98	12.29	1.31	10.96	12.13	1.17
Statistic	Jan			Feb			Mar		
	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta
Maximum	11.89	13.29	1.40	12.01	13.43	1.42	11.52	13.16	1.64
Median	11.20	12.72	1.52	11.09	12.77	1.68	11.00	12.40	1.40
Average	11.22	12.70	1.48	11.12	12.75	1.63	11.06	12.33	1.27
Minimum	10.94	10.96	0.01	10.89	10.95	0.06	10.90	10.95	0.05
Statistic	Apr			May			June		
	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta
Maximum	17.25	15.85	-1.40	22.01	19.13	-2.88	25.51	21.19	-4.32
Median	11.15	12.37	1.22	15.37	14.76	-0.61	18.56	17.13	-1.43
Average	11.28	12.32	1.04	15.28	14.77	-0.51	18.49	17.05	-1.45
Minimum	10.91	10.95	0.04	10.94	11.08	0.14	14.64	14.31	-0.33
Statistic	July			Aug			Sept		
	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta
Maximum	24.89	21.86	-3.03	25.57	23.26	-2.31	21.65	21.02	-0.63
Median	18.13	16.92	-1.21	17.61	16.94	-0.67	15.48	15.39	-0.09
Average	18.25	17.02	-1.23	17.65	17.11	-0.54	15.67	15.59	-0.08
Minimum	15.40	15.01	-0.39	12.98	13.42	0.44	12.36	12.83	0.47

Notes:

a. Delta calculated as Max LF OS-1 value minus pre-Project value, with negative values indicated in red text.

Table 5.3-7. Monthly Stage Statistics for pre-Project and Max Load Following OS-1 Hydrologic Conditions at Susitna Station Gage.

Susitna Station Gage (USGS 15294350)									
Statistic	Oct			Nov			Dec		
	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta
Maximum	21.93	21.98	0.05	9.49	9.64	0.15	6.65	7.31	0.66
Median	7.45	7.74	0.29	4.43	5.44	1.01	3.57	5.01	1.44
Average	7.72	8.04	0.32	4.62	5.62	1.00	3.66	5.05	1.39
Minimum	3.14	4.45	1.31	2.93	4.31	1.38	2.82	4.14	1.32
Statistic	Jan			Feb			Mar		
	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta
Maximum	4.43	5.78	1.35	4.98	6.17	1.19	3.80	5.39	1.59
Median	3.30	4.90	1.60	3.08	4.90	1.82	2.94	4.42	1.48
Average	3.30	4.90	1.60	3.09	4.89	1.80	2.95	4.36	1.41
Minimum	2.72	2.89	0.17	2.35	2.70	0.35	2.42	2.66	0.24
Statistic	Apr			May			June		
	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta
Maximum	13.71	12.89	-0.82	17.28	16.46	-0.82	18.18	16.89	-1.29
Median	3.08	4.41	1.33	10.86	10.39	-0.47	14.56	13.69	-0.87
Average	3.45	4.58	1.13	10.27	9.95	-0.32	14.45	13.53	-0.92
Minimum	2.23	2.69	0.46	2.85	3.03	0.18	9.97	9.06	-0.91
Statistic	July			Aug			Sept		
	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta	Pre-Project	Max LF OS-1	Delta
Maximum	19.47	19.05	-0.42	19.55	19.14	-0.41	18.74	18.74	0.00
Median	14.53	13.76	-0.77	13.77	13.45	-0.32	11.20	11.16	-0.04
Average	14.57	13.81	-0.76	13.79	13.45	-0.34	11.26	11.22	-0.04
Minimum	10.65	10.40	-0.25	6.87	7.18	0.31	4.85	5.43	0.58

Notes:

a. Delta calculated as Max LF OS-1 value minus pre-Project value, with negative values indicated in red text.

Table 5.4-1. Annual Flow-exceedence and Stage-exceedence Comparison for the pre-Project and Maximum Load Following OS-1 Hydrologic Conditions at Sunshine Gage and Susitna Station Gage.

Percentile	Sunshine Gage (USGS 15292780)			Susitna Station Gage (USGS 15292780)			Sunshine Gage (USGS 15292780)			Susitna Station Gage (USGS 15292780)		
	Annual Flow Exceedence Value			Annual Flow Exceedence Value			Annual Stage Exceedence Value			Annual Stage Exceedence Value		
	Pre-Project (cfs)	Max LF OS-1 (cfs)	Delta [a] (cfs)	Pre-Project (cfs)	Max LF OS-1 (cfs)	Delta [a] (cfs)	Pre-Project (ft)	Max LF OS-1 (cfs)	Delta [a] (ft)	Pre-Project (ft)	Max LF OS-1 (cfs)	Delta [a] (ft)
99%	1,740	3,240	1,500	5,210	6,810	1,600	10.93	11.08	0.15	2.59	3.03	0.44
95%	2,310	8,840	6,530	5,840	12,300	6,460	10.97	12.28	1.31	2.77	4.28	1.51
90%	2,830	9,470	6,640	6,400	13,000	6,600	10.99	12.40	1.41	2.93	4.43	1.50
75%	3,750	10,800	7,050	7,710	15,100	7,390	11.21	12.62	1.41	3.26	4.83	1.57
50%	8,220	13,200	4,980	19,000	23,100	4,100	12.17	13.02	0.85	5.53	6.21	0.68
25%	45,000	38,400	-6,600	94,000	87,400	-6,600	16.85	16.17	-0.68	13.00	12.57	-0.43
10%	64,000	51,000	-13,000	124,000	112,000	-12,000	18.60	17.42	-1.18	14.77	14.04	-0.73
5%	72,800	57,100	-15,700	138,000	122,000	-16,000	19.35	17.98	-1.37	15.51	14.66	-0.85
1%	91,200	71,300	-19,000	164,000	145,000	-19,000	20.81	19.22	-1.59	16.77	15.85	-0.92

Notes:

a. Delta calculated as Max LF OS-1 value minus pre-Project value, with negative values indicated in red text

Table 6.2-1. USGS Ratings and Effective Dates at Sunshine Gage.

Rating ID	Effective Dates of Rating	USGS Notes within Effective Period of Rating [a]
1	5/8/81 – 5/1/82	• Gage established on 5/8/81 • Gage datum established on 5/7/81 • Gage located on right bank, 300 feet upstream of road • Stage values in this rating were adjusted by the USGS subsequent to the 5/28/82 lowering of the datum so that Rating 1 is relative to the same datum as Rating 2
2	5/1/82 – 10/1/83	• Datum was lowered by 5.0 feet on 5/28/82 • Gage moved on 7/13/82 to left bank, 100 feet upstream of bridge
3	10/1/83 – 5/1/84	
4	5/1/84 – 10/1/86	• Gage discontinued on 6/30/86
5	10/1/86 – 10/6/11	
6	10/6/11 - present	• Gage re-established on 10/6/11, using the lowered datum • Gage located on left bank, 50 feet downstream of bridge • Datum was lowered by an additional 10.0 feet to prevent negative gage height values

Note:
a. USGS notes were obtained from the USGS station description and from personal communication with USGS staff (Josh Morse, personal communication, January 31, 2013)

Table 6.2-2. USGS Ratings and Effective Dates at Susitna Station Gage.

Rating ID	Effective Dates of Rating	USGS Notes within Effective Period of Rating [a]
1	5/1/75 – 9/30/78	• Gage installed on 5/23/75 • Located on left bank approximately 1.5 miles downstream from Yentna River
2	10/1/78 – 5/23/85	
3	5/24/85 – 9/30/85	
4	10/1/85 – 9/30/93	• Gage discontinued on 9/30/93

Note:
a. USGS notes were obtained from the USGS station description

Table 6.2-3. Flows Selected for Specific Gage Analysis, Susitna Station Gage.

Flow Magnitude [a] (cfs)	Flow Statistic [a]
30,000	Minimum flow common to all rating curves
43,000	40% annual exceedence flow
60,000	35% annual exceedence flow
80,000	30% annual exceedence flow
94,000	25% annual exceedence flow
132,000	1.01-year return period flow
152,000	1.25-year return period flow
170,000	2-year return period flow
197,000	5-year return period flow

Note:
a. Based on pre-Project flow duration and flood frequency analysis

Table 6.3-1. Stages at Selected Specific Discharges Calculated from USGS Published Ratings for the Susitna Station Gage.

Rating ID	Effective Dates of Rating	Stage (feet) at Specified Discharge [a]								
		30,000	43,000	60,000	80,000	94,000	132,000	152,000	170,000	197,000
1	5/1/75 – 9/30/78	7.4	9.2	10.4	11.8	12.7	15.1	16.3	17.3	18.8
2	10/1/78 – 5/23/85	7.3	8.7	10.3	11.9	12.9	15.3	16.5	17.5	18.8
3	5/24/85 – 9/30/85	7.3	8.7	10.3	11.9	12.9	15.1	16.1	17.1	18.3
4	10/1/85 – 12/31/02	7.2	8.9	10.6	12.1	13.0	15.2	16.2	17.0	18.3

Note:
a. All stages are relative to the gage datum established at the time the gage was installed

Table 7.2.1. Ice Covered Discharge Measurement at USGS Susitna at Sunshine Gage.

Date of Measurement	Total Discharge (cfs)	Flow Depth to Ice Thickness Ratio	Total Depth (ft)	Average Ice Thickness (ft)	Average Flow Depth (ft)	Total Ice Area (ft^2)	Total Flow Area (ft^2)	Average Velocity (ft/s)
March 25, 1981	3,796	1.65	8.15	3.07	5.08	2,031	1,937	1.81
January 20, 1982	3,504	3.54	11.98	2.64	9.35	403	1,348	2.61
March 2, 1982	2,656	1.36	11.53	4.88	6.65	1,124	1,141	2.36
April 9, 1982	3,347	1.54	10.89	4.29	6.59	879	1,185	2.63
December 22, 1982	5,495	0.94	12.78	6.57	6.21	2,194	1,739	2.82
December 30, 1982	6,800	0.95	13.85	7.12	6.74	2,898	2,337	3.01
January 20, 1983	4,719	20.4	10.99	3.61	7.38	796	1,619	2.28
March 17, 1983	3,321	1.98	8.87	2.98	5.90	744	1,419	2.02
January 10, 1985	4,644	0.69	7.36	4.37	3.00	2,831	1,353	1.91
January 14, 1985	3,657	0.83	6.55	3.58	2.97	2,049	1,235	1.71
March 19, 1985	3,976	0.87	8.01	4.27	3.73	2,317	1,381	2.07
November 22, 1985	5,395	0.61	10.28	6.37	3.91	2,868	1,730	1.90
March 18, 1986	2,862	1.29	7.92	3.47	4.46	1,218	1,598	1.49

Table 7.2.2. Ice Covered Discharge Measurement at USGS Susitna at Susitna Gage.

Date of Measurement	Total Discharge (cfs)	Flow Depth to Ice Thickness Ratio	Total Depth (ft)	Average Ice Thickness (ft)	Average Flow Depth (ft)	Total Ice Area (ft^2)	Total Flow Area (ft^2)	Average Velocity (ft/s)
March 22, 1993	6,952	2.13	9.97	3.19	6.78	1,627	3,172	2.10
January 8, 1993	10,305	1.79	9.42	3.38	6.04	3,416	4,209	2.22
April 2, 1992	9,726	1.11	10.49	4.98	5.51	3,735	4,130	1.96
February 7, 1992	9,410	1.57	9.88	3.84	6.04	3,674	4,926	1.75
April 5, 1991	6,135	1.02	11.48	5.68	5.80	5,145	3,953	1.58
February 27, 1991	7,280	1.24	12.75	5.70	7.06	4,304	5,371	1.74
April 5, 1990	9,993	1.29	11.34	4.95	6.39	5,292	4,247	2.10
March 22, 1989	6,884	1.06	8.82	4.29	4.53	6,965	3,909	1.72
February 6, 1989	6,052	0.96	10.07	5.14	4.94	9,857	3,547	1.54
March 8, 1988	9,370	1.06	10.68	5.19	5.49	4,888	4,941	1.60
January 7, 1988	11,285	1.40	10.80	4.49	6.31	6,596	6,973	1.46
March 31, 1987	7,211	1.59	10.47	4.04	6.43	2,635	3,969	1.59
February 4, 1987	7,442	1.28	10.35	4.55	5.81	3,397	3,985	1.69
April 1, 1986	5,399	1.80	7.88	2.82	5.06	2,468	3,606	1.51
December 4, 1985	12,319	2.32	9.80	2.95	6.85	3,312	6,079	1.97
March 27, 1985	6,015	2.36	12.69	3.78	8.91	1,655	3,406	1.66
February 23, 1985	6,606	1.10	12.31	5.88	6.44	4,614	4,619	1.50
February 11, 1985	6,333	2.53	11.83	3.35	8.48	1,702	3,816	1.89
April 6, 1984	9,276	1.17	12.77	5.90	6.87	7,378	4,932	1.63
April 4, 1983	6,520	1.39	10.93	4.57	6.36	3,921	4,356	1.43
January 20, 1983	7,947	1.35	11.48	4.88	6.60	4,334	5,464	1.36
April 4, 1982	4,004	0.82	11.82	6.49	5.33	5,630	4,861	0.83
January 12, 1982	8,960	1.33	10.03	4.30	5.73	3,597	5,074	1.58

10. FIGURES

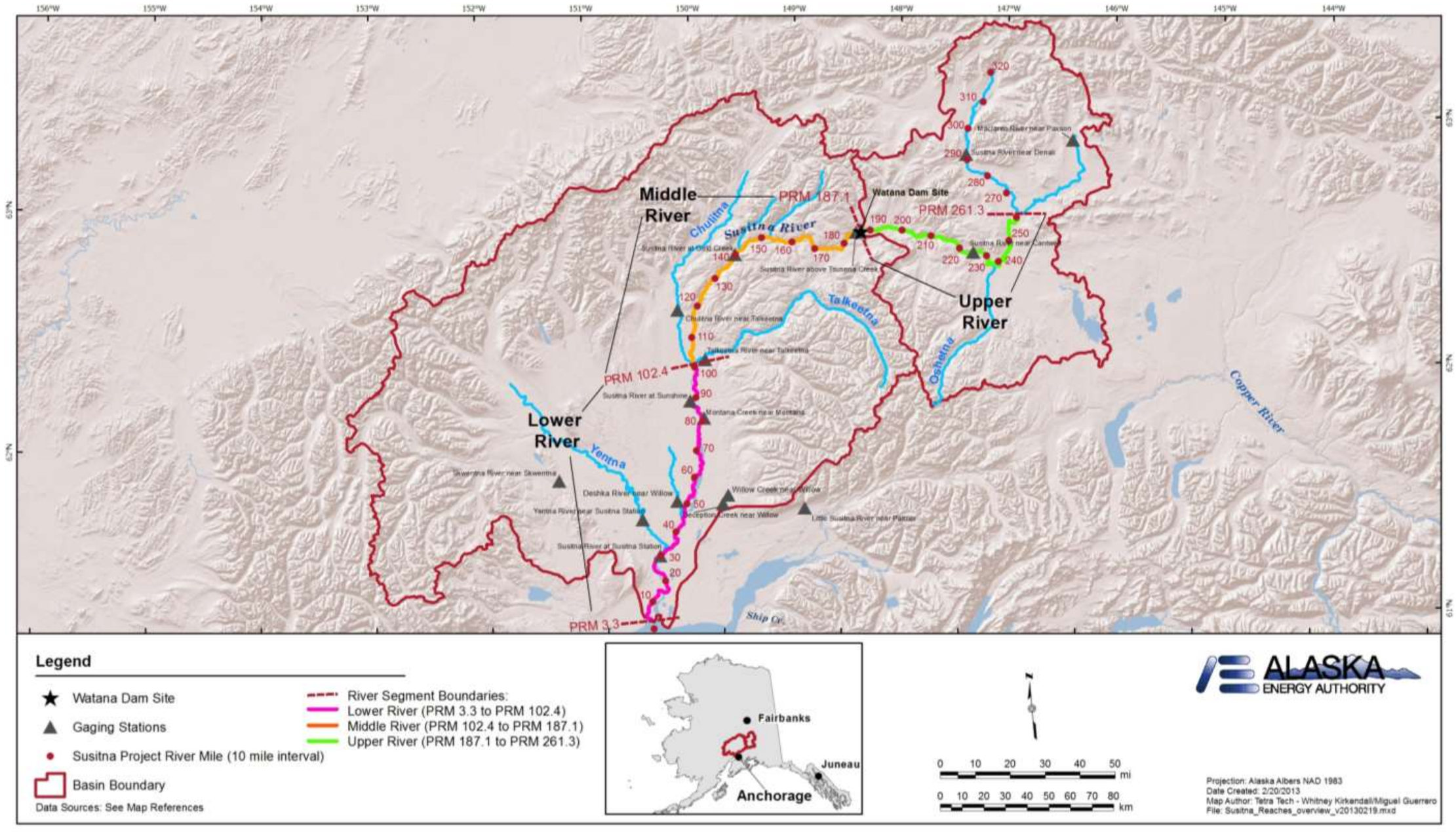

Figure 3.2-1. Susitna River study area and large-scale river segments.

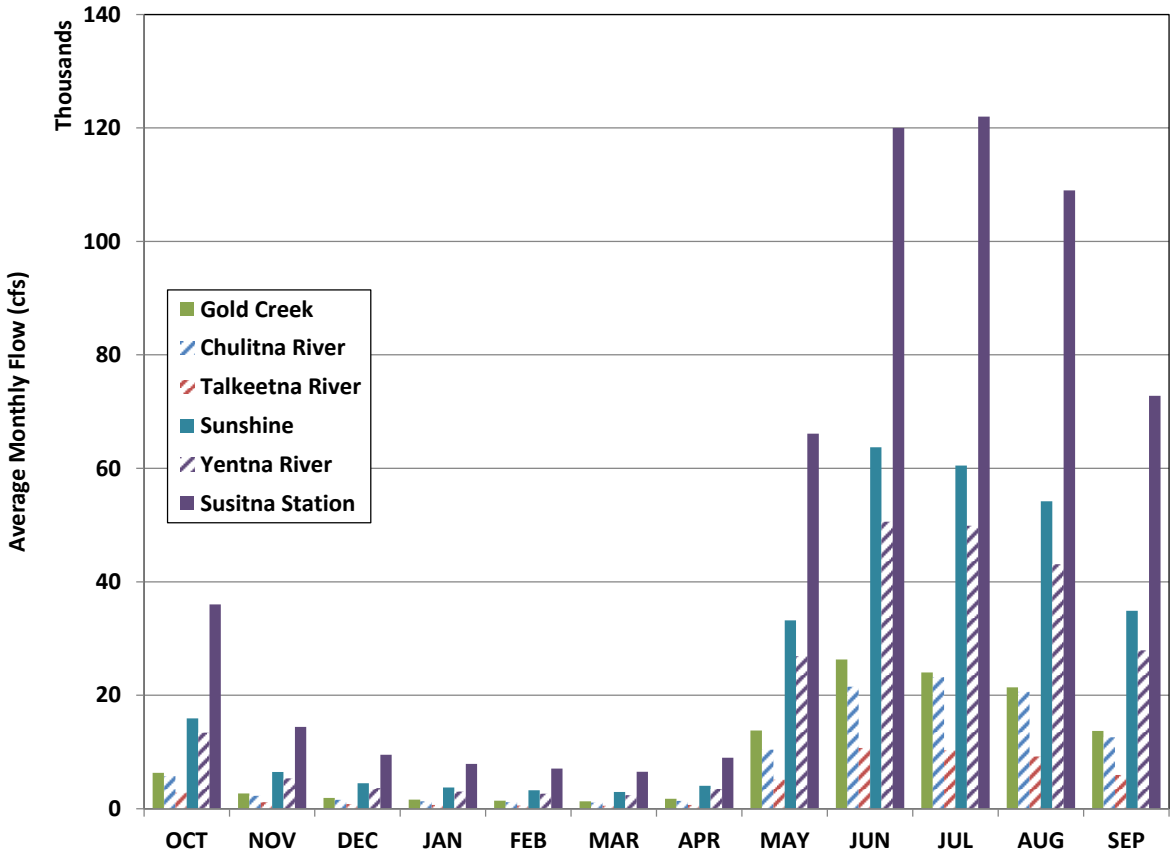

Figure 4.4-1. Average monthly flows (cfs) in the Susitna River and major tributaries downstream from the Watana Dam site under pre-Project conditions based on the USGS (2012) 61-year extended record. Solid bars are mainstem gages; cross-hatched bars are tributaries.

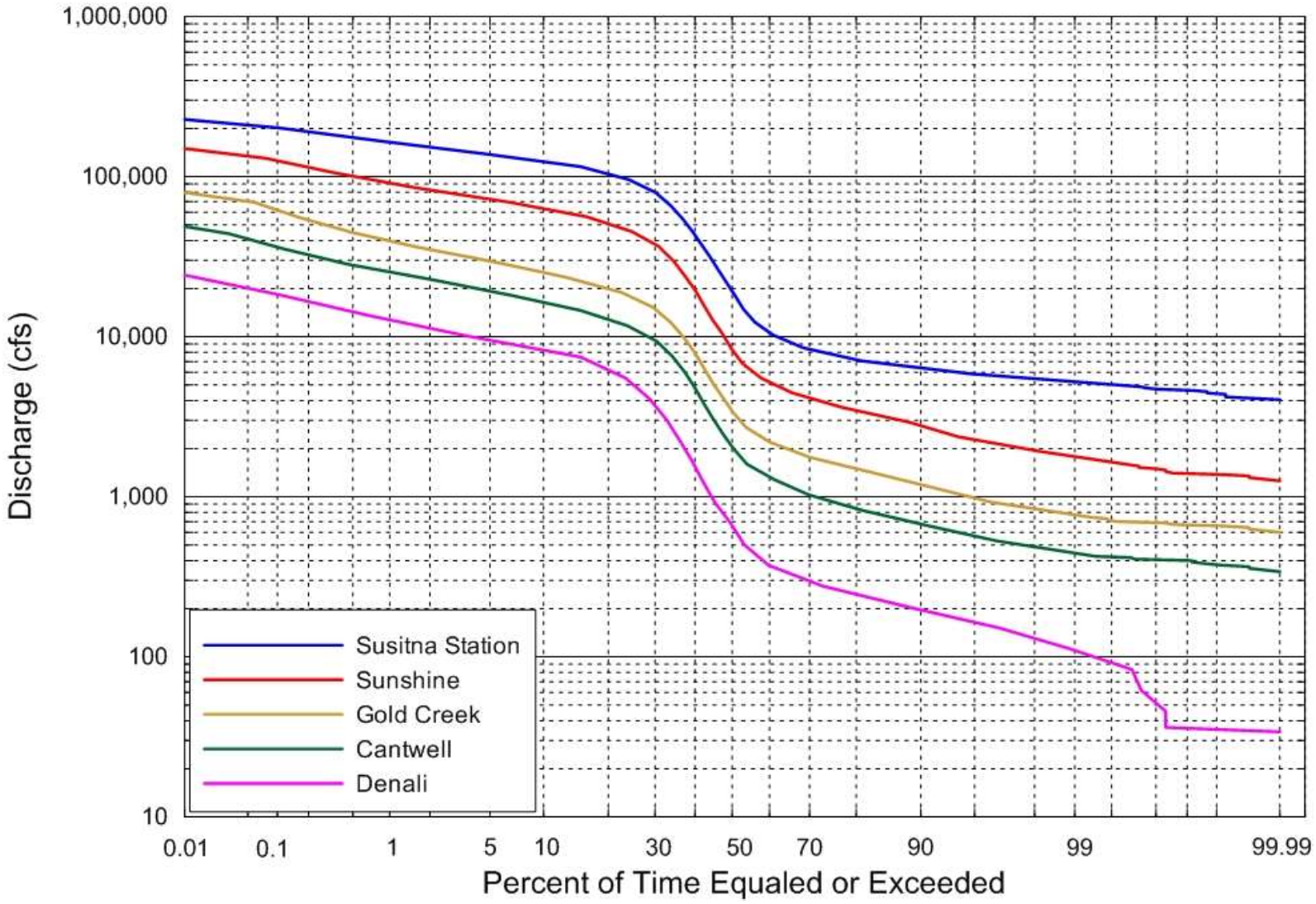

Figure 4.4-2. Annual flow-duration curves mainstem gages for pre-Project conditions based on the USGS extended record.

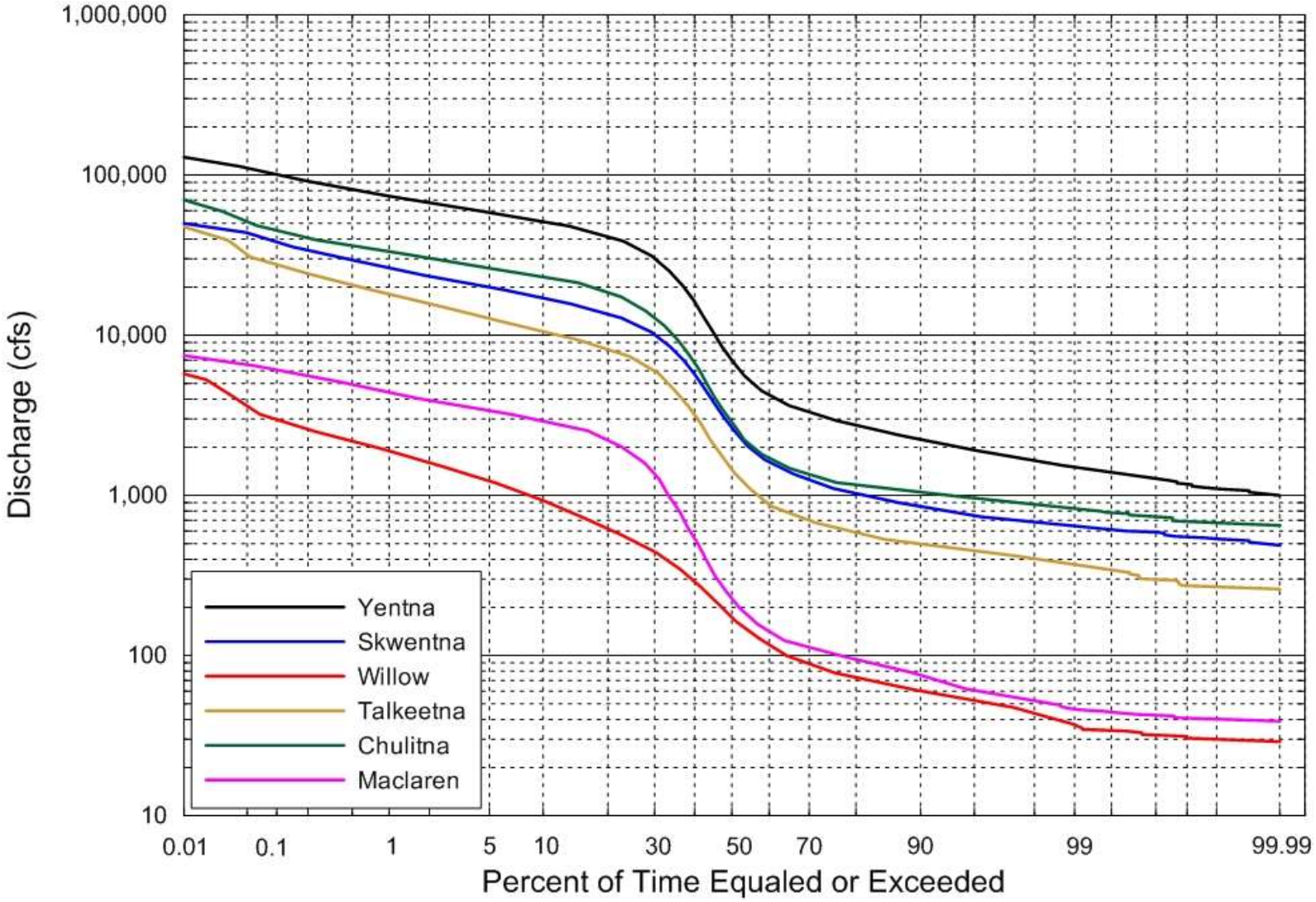

Figure 4.4-3. Annual flow-duration curves tributary gages for pre-Project conditions based on the USGS extended record.

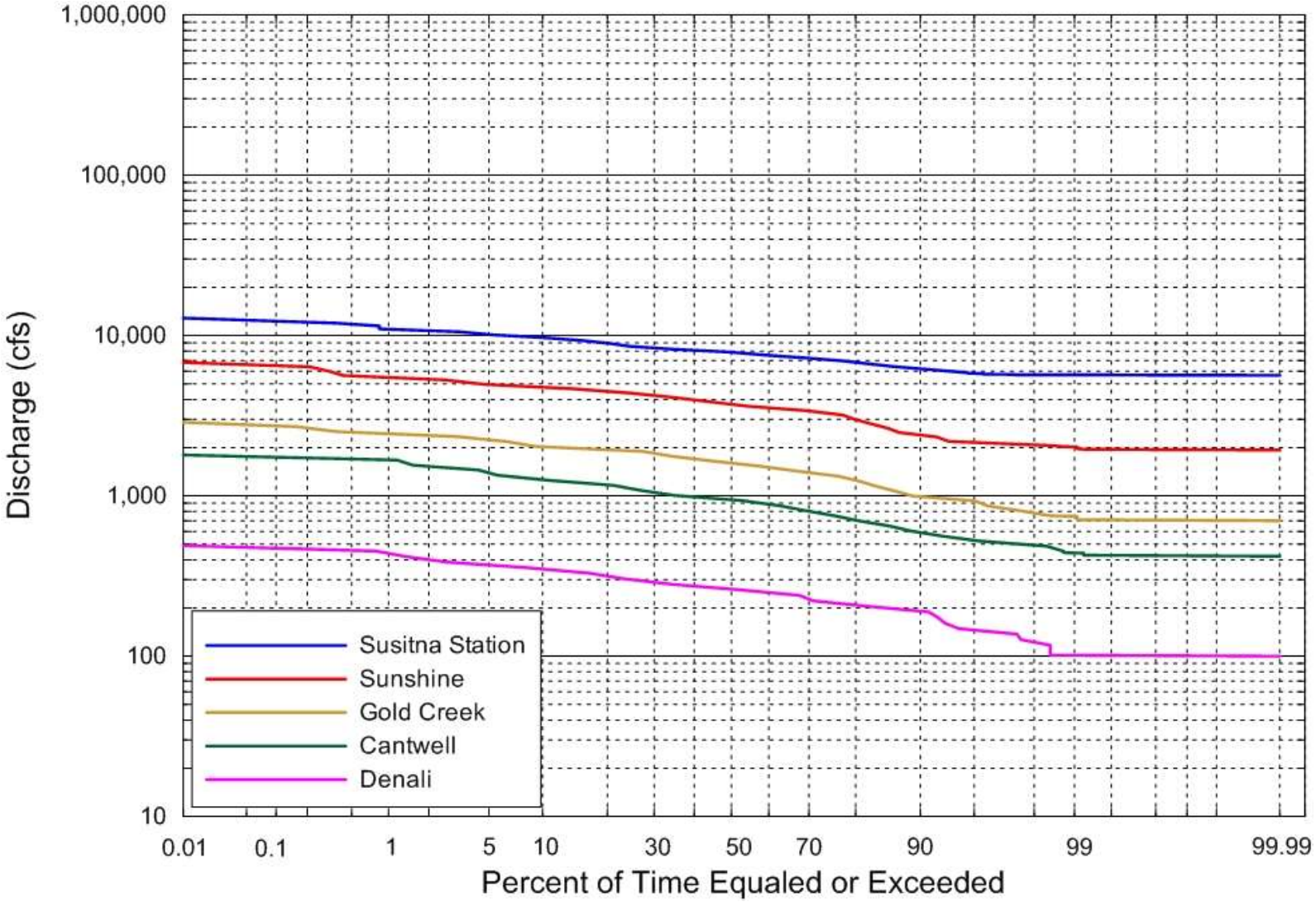

Figure 4.4-4. Monthly Flow-duration curves for January for mainstem gages for pre-Project conditions based on the USGS extended record.

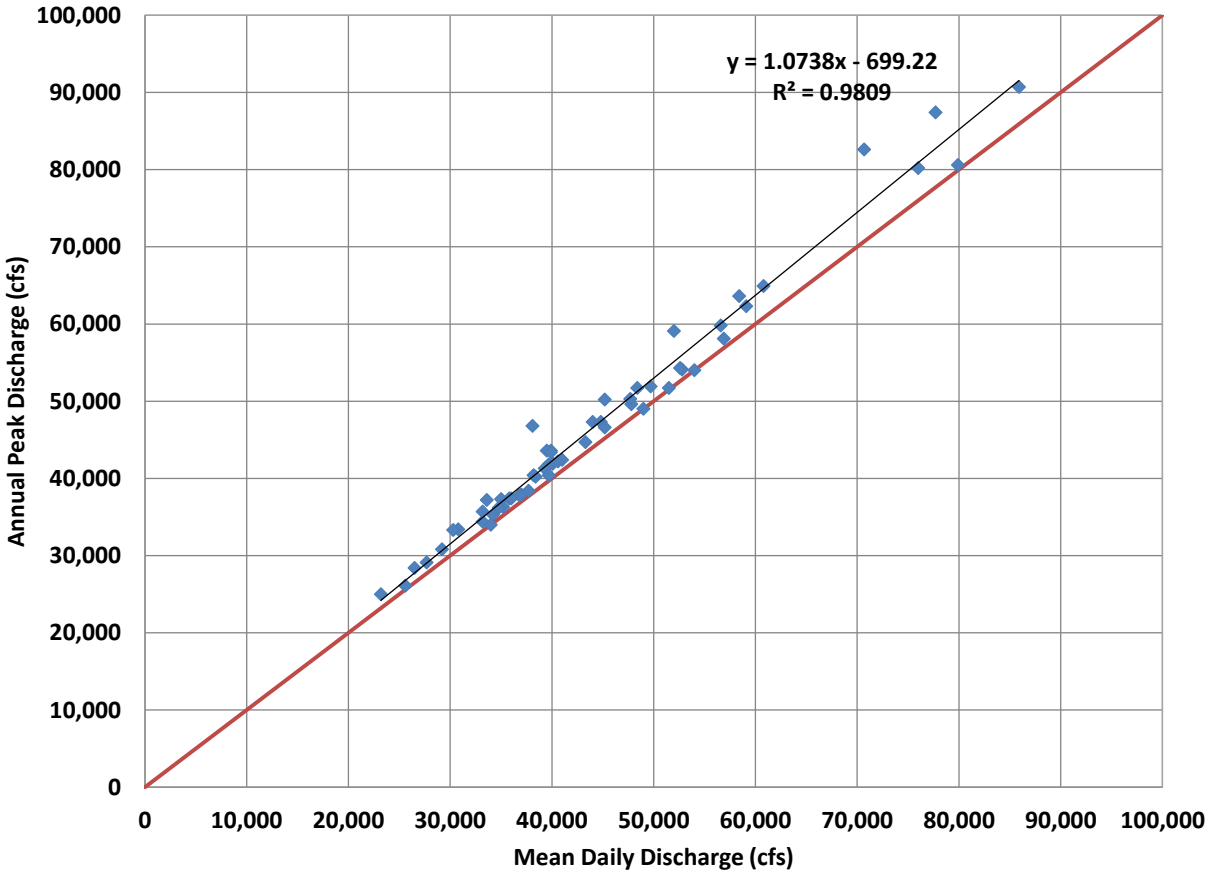

Figure 4.4-5. Relationship between recorded annual instantaneous peak discharge and the corresponding mean daily discharge at Gold Creek. Similar plots for other gages are provided in Appendix D.

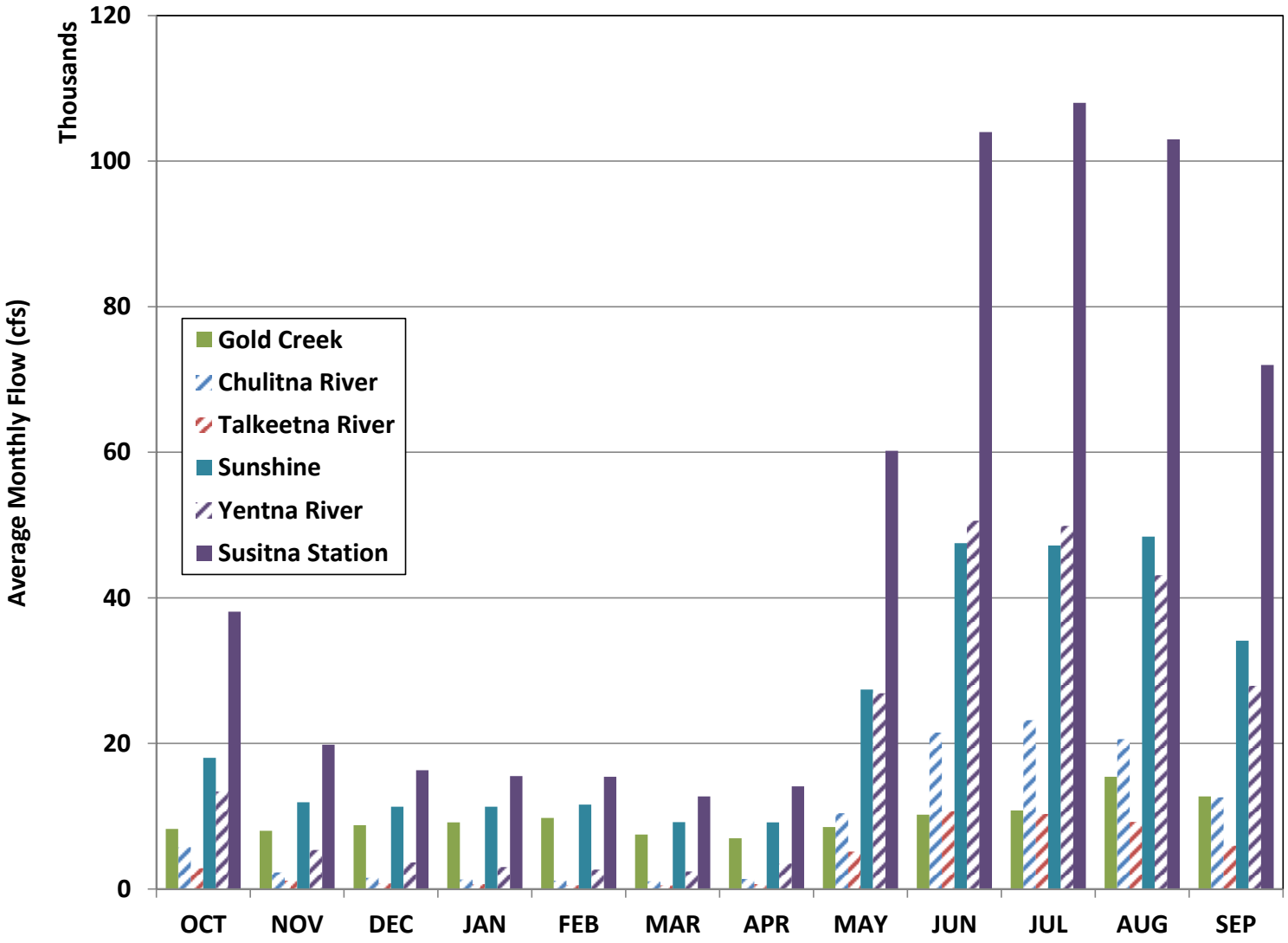

Figure 4.4-6. Average monthly flows (cfs) in the Susitna River under Maximum Load Following Scenario OS-1, based on the HEC-ResSim model results. Also shown are major tributary inflows.

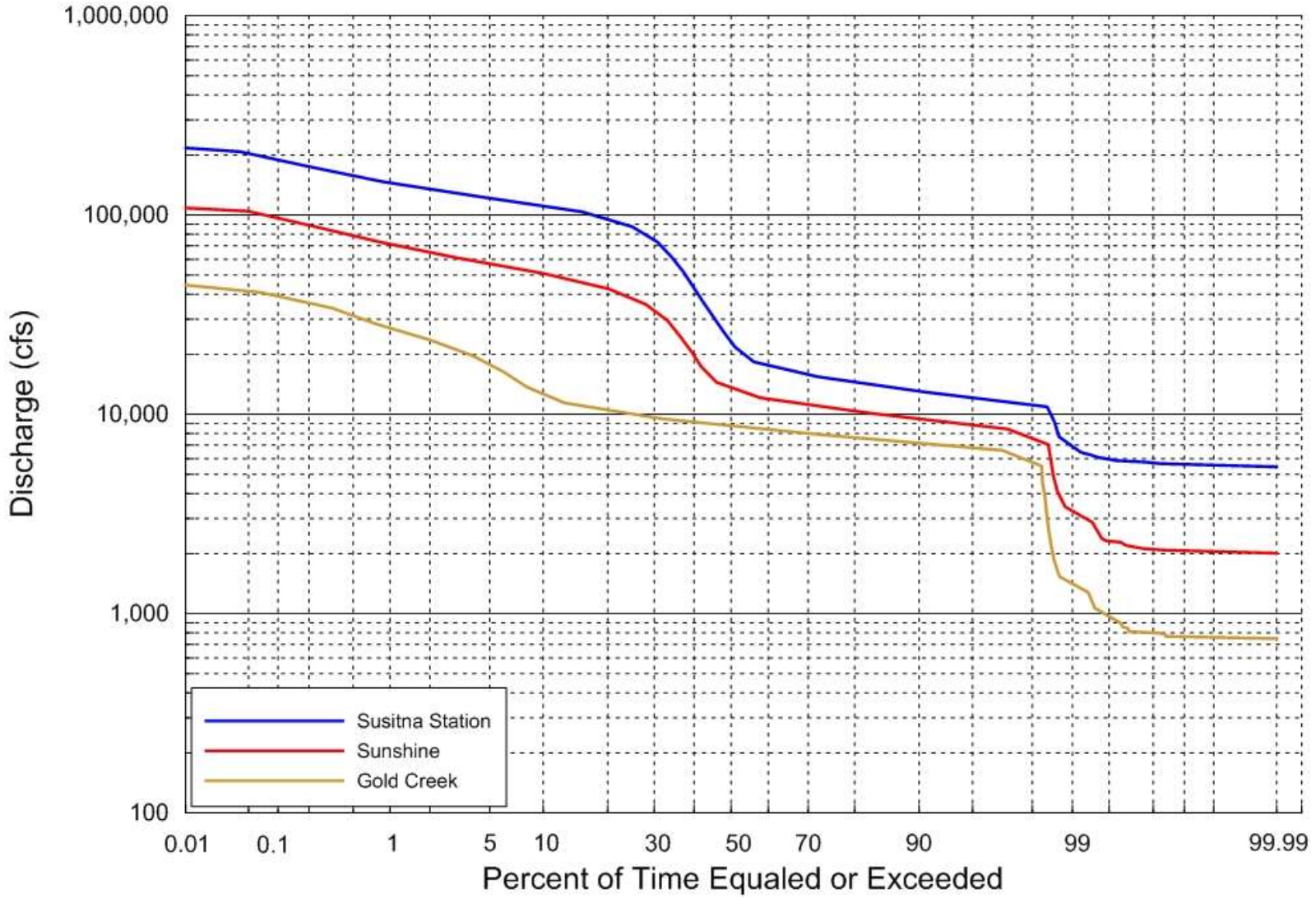

Figure 4.4-7. Annual flow-duration curves for three mainstem gages for Maximum Load Following OS-1 Conditions based on HEC-ResSim model.

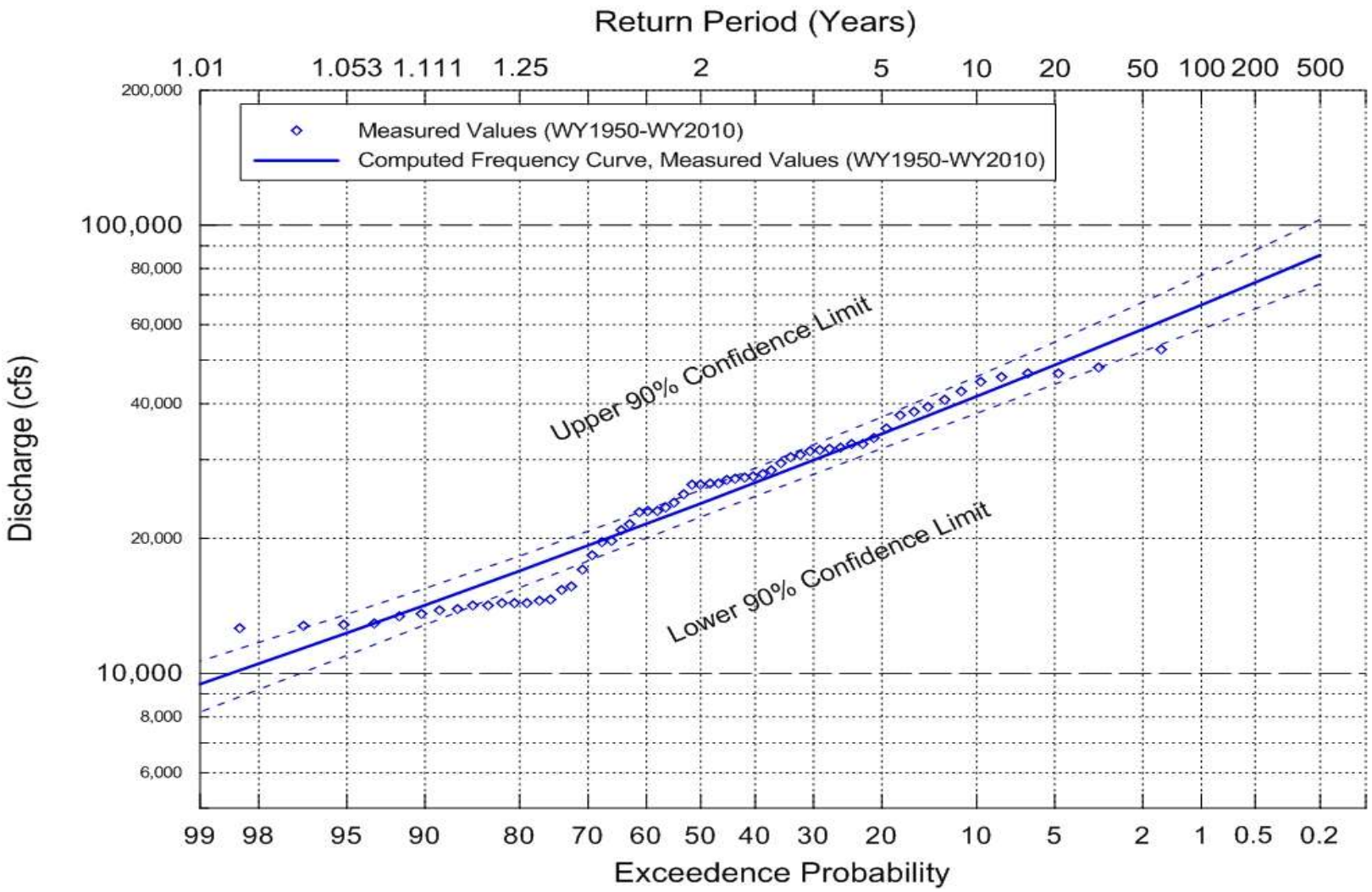

Figure 4.4-8. Flood-frequency curve for Susitna River at Gold Creek for Maximum Load Following OS-1 conditions based on the HEC-ResSim model.

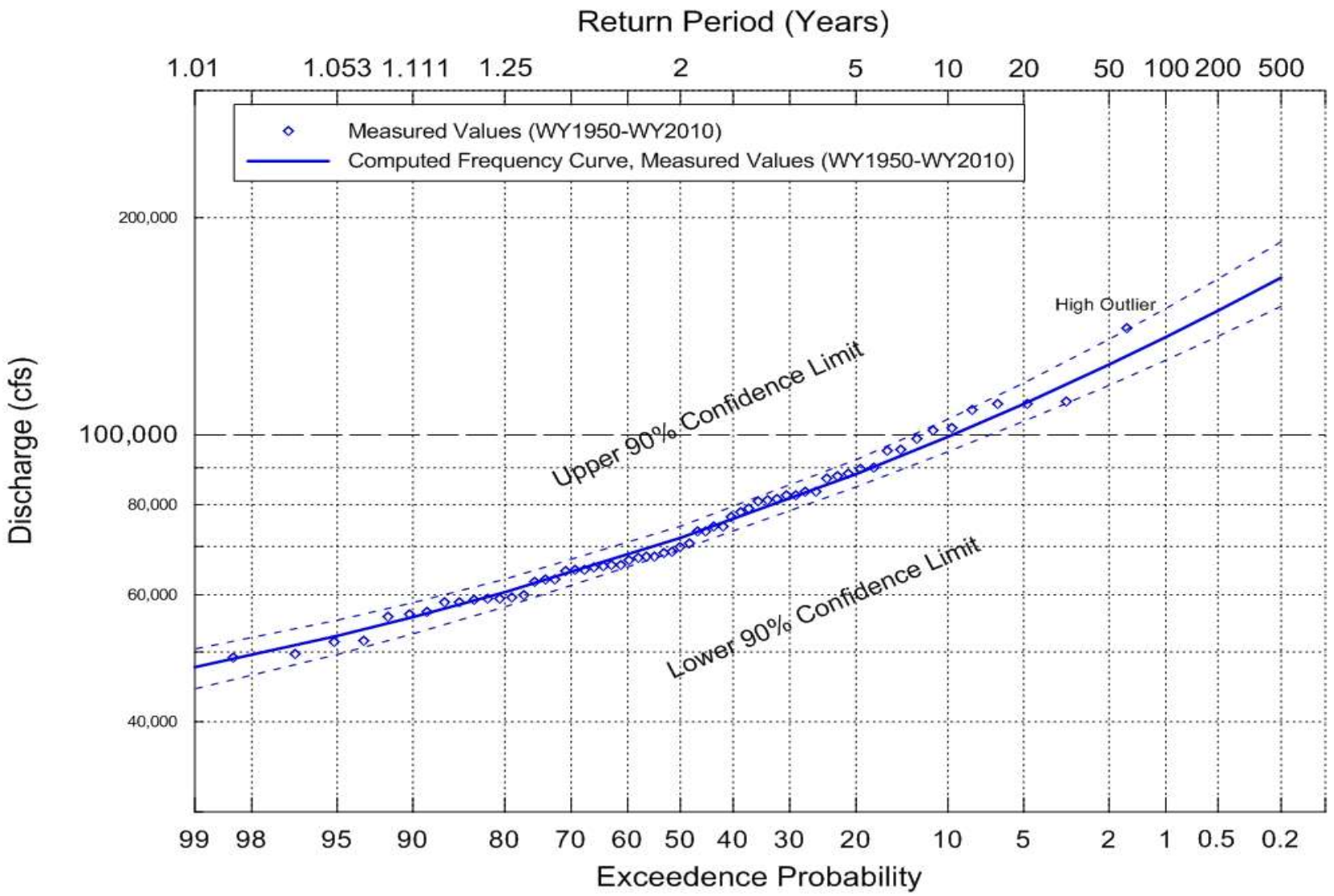

Figure 4.4-9. Flood-frequency curve for Susitna River at Sunshine for Maximum Load Following OS-1 conditions based on the HEC-ResSim model.

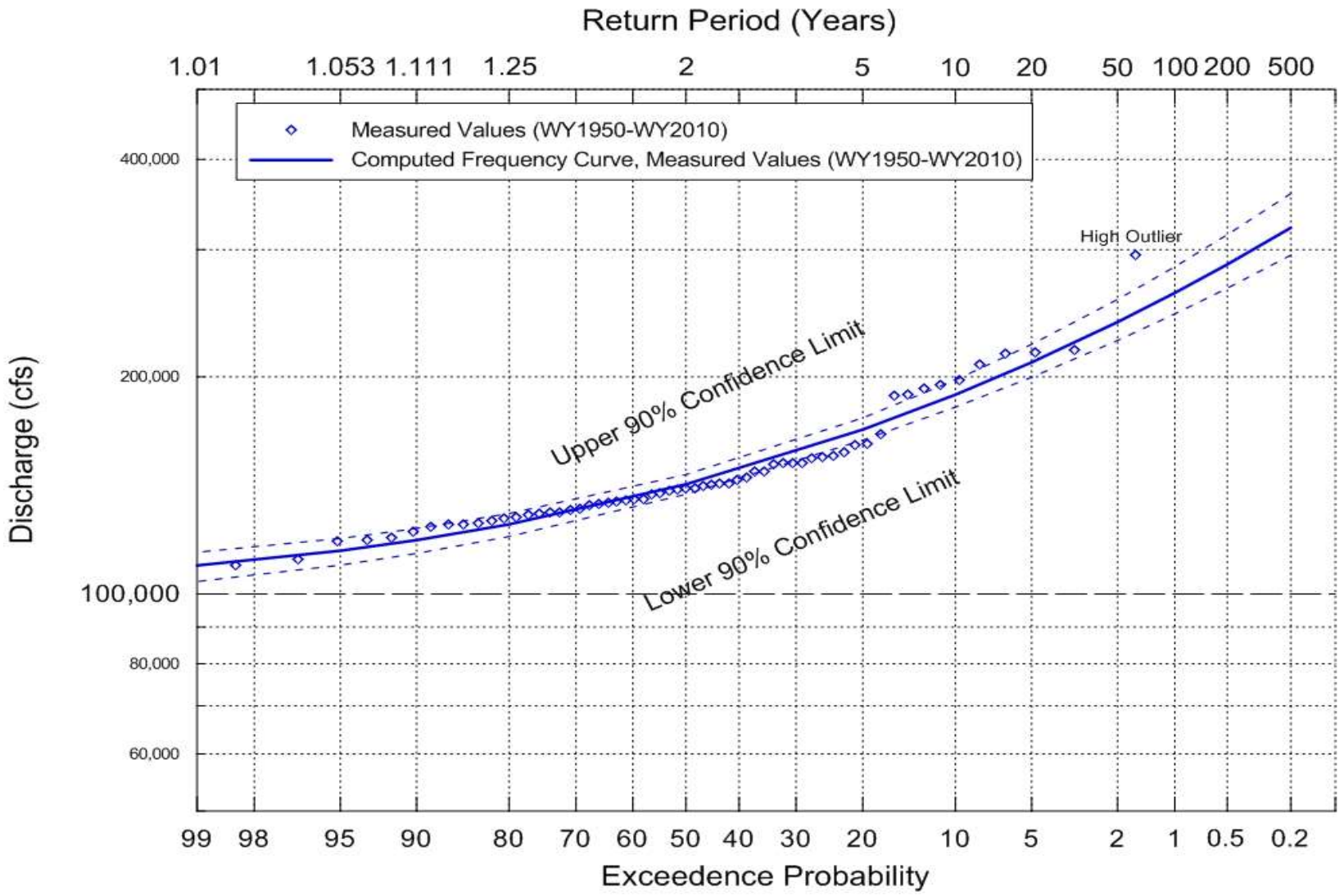

Figure 4.4-10. Flood-frequency curve for Susitna River at Susitna Station for Maximum Load Following OS-1 conditions based on estimated HEC-ResSim model output.

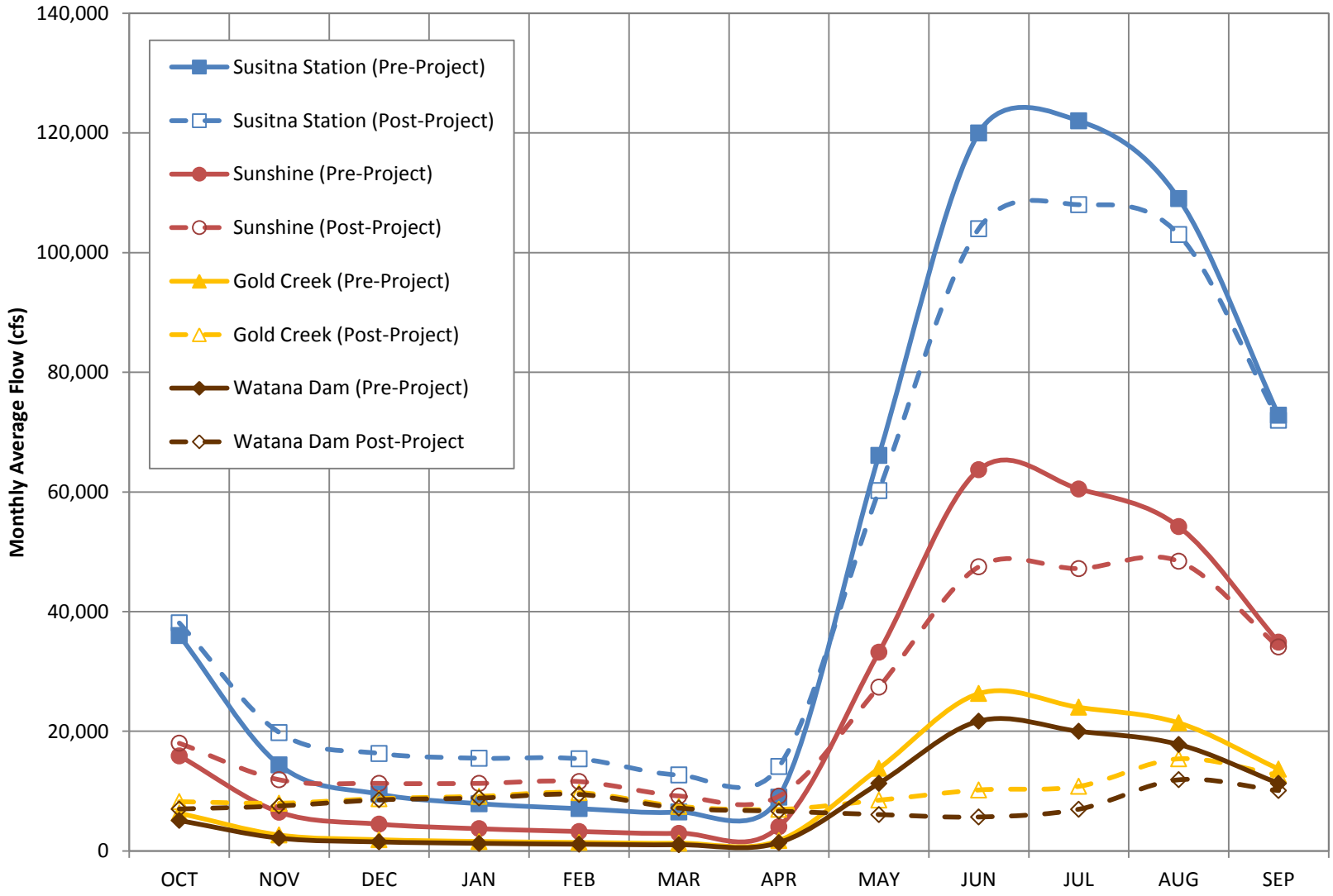

Figure 4.5-1. Average monthly flows (cfs) in the Susitna River watershed for pre-Project and Maximum Load Following OS-1 conditions.

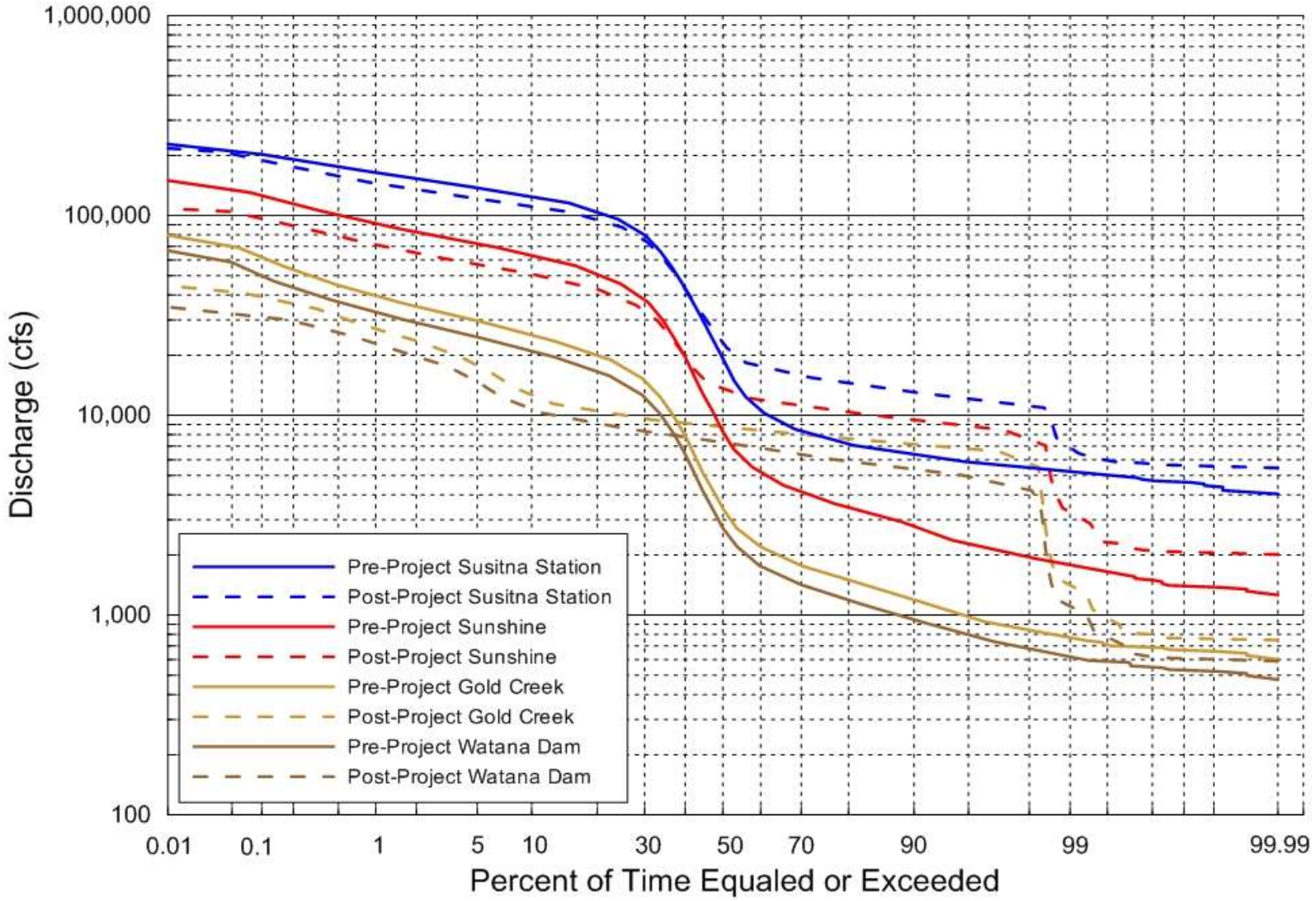

Figure 4.5-2. Annual flow-duration curve comparison for Pre-Project and Maximum Load Following OS-1 conditions.

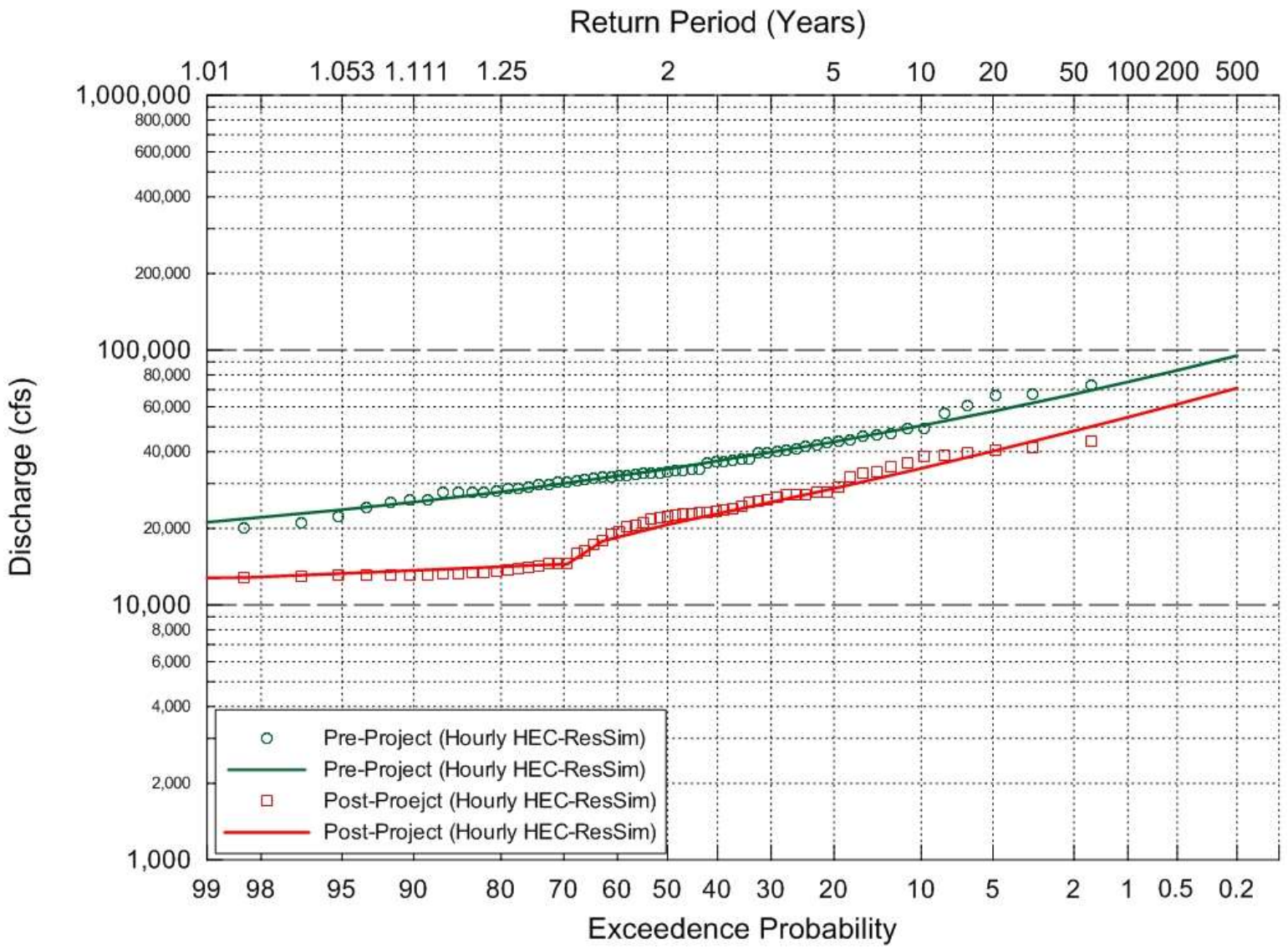

Figure 4.5-3. Flood-frequency curve for Susitna River at the Watana Dam for Maximum Load Following OS-1 conditions based on estimated HEC-ResSim model output.

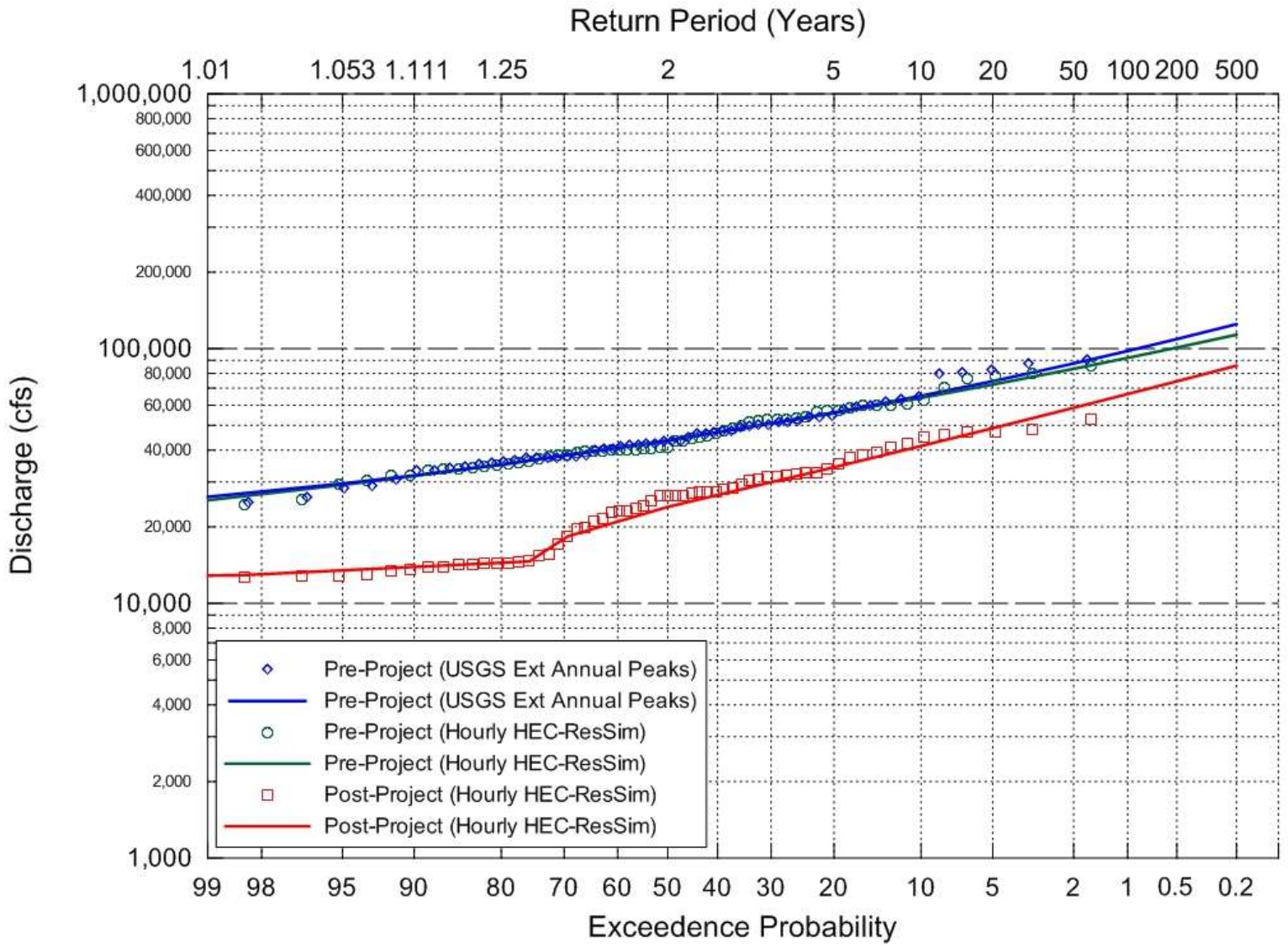

Figure 4.5-4. Flood-frequency curve for Susitna River at Gold Creek (USGS Gage No. 1529200) for Maximum Load Following OS-1 conditions based on estimated HEC-ResSim model output.

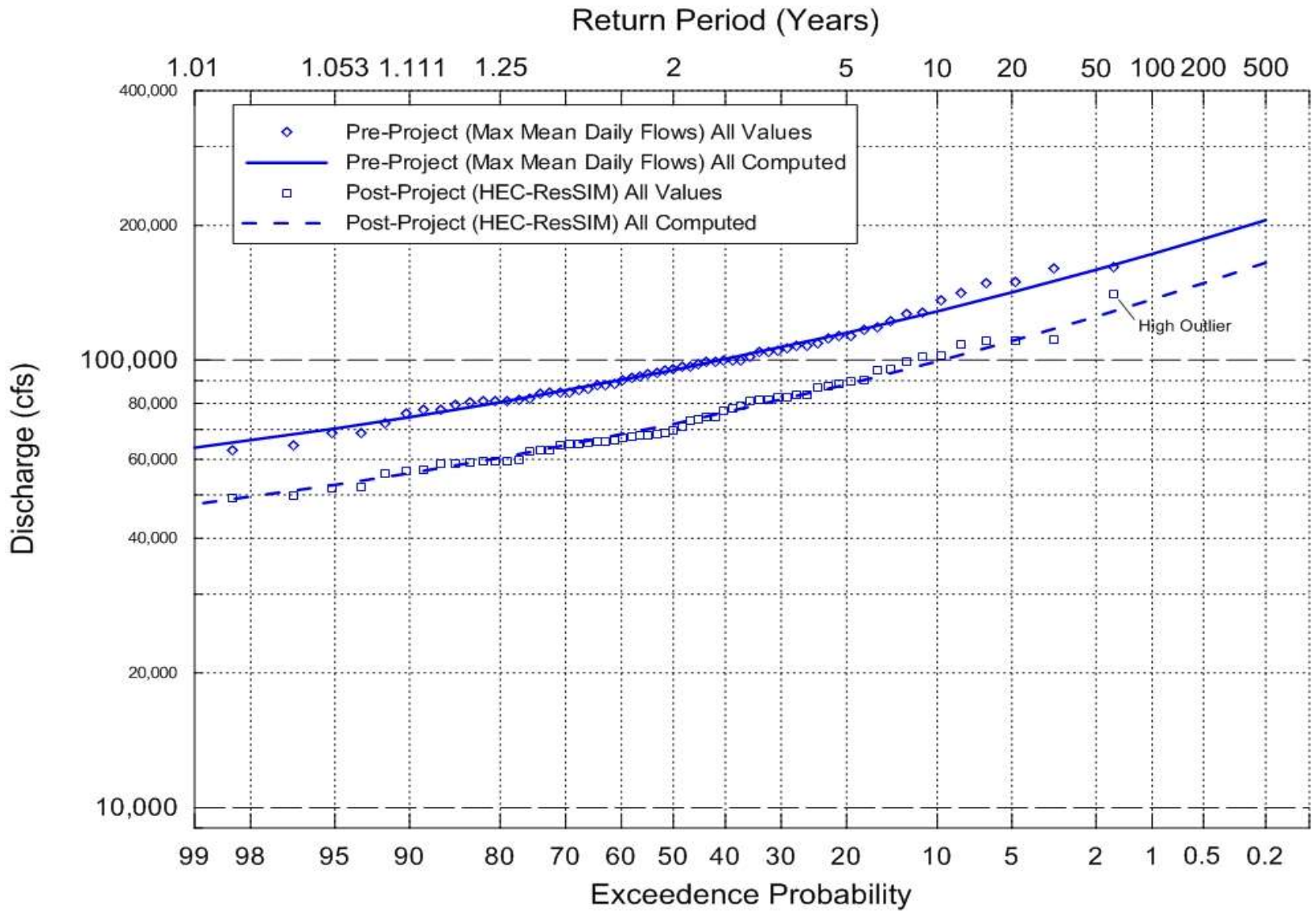

Figure 4.5-5. Flood-frequency curve for Susitna River at Sunshine (USGSG Gage No. 15292780) for Maximum Load Following OS-1 conditions **based on estimated HEC-ResSim model output.**

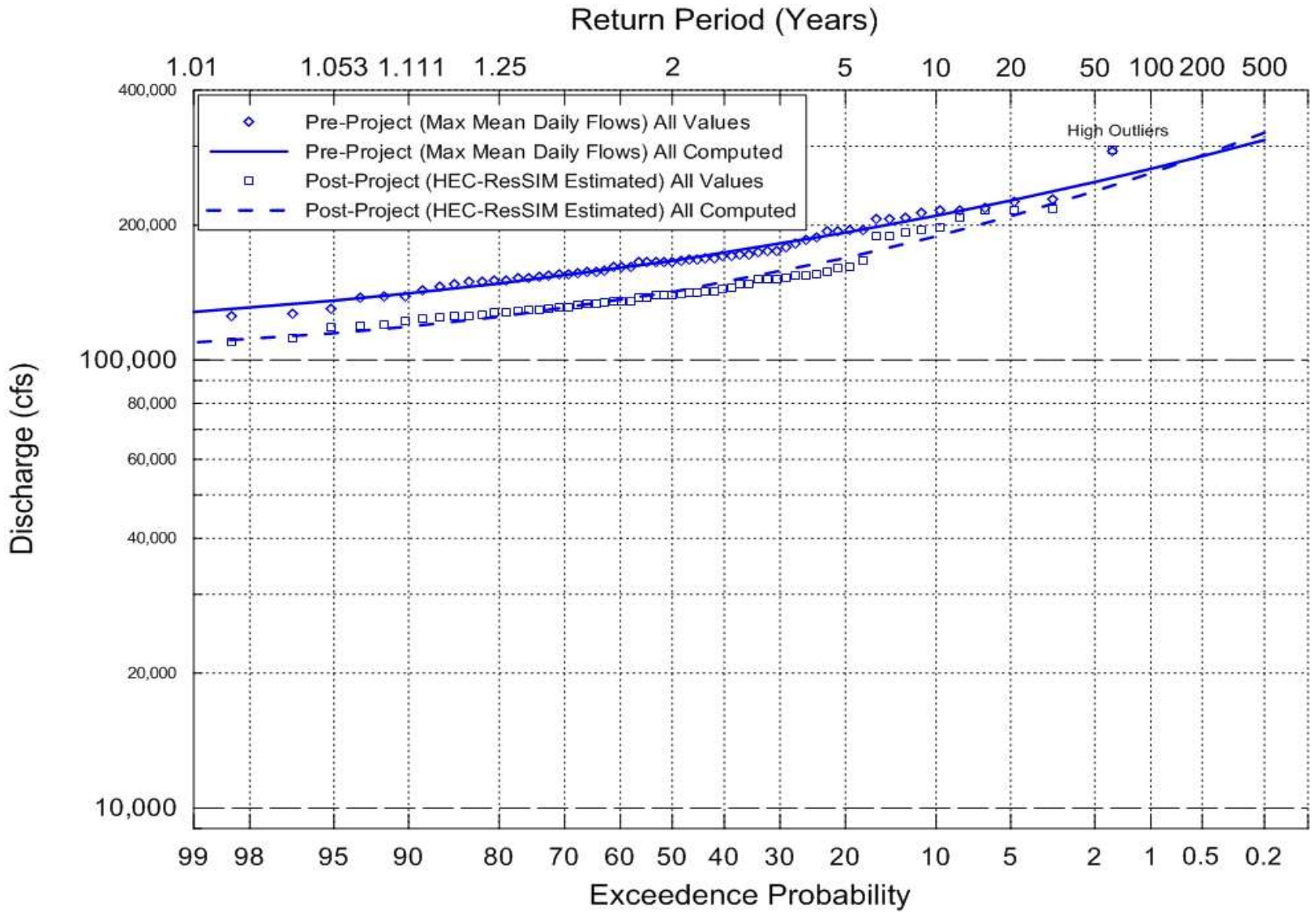

Figure 4.5-6. Flood-frequency curve for Susitna River at Susitna Station (USGS Gage No. 1524350) for Maximum Load Following OS-1 conditions based on estimated HEC-ResSim model output.

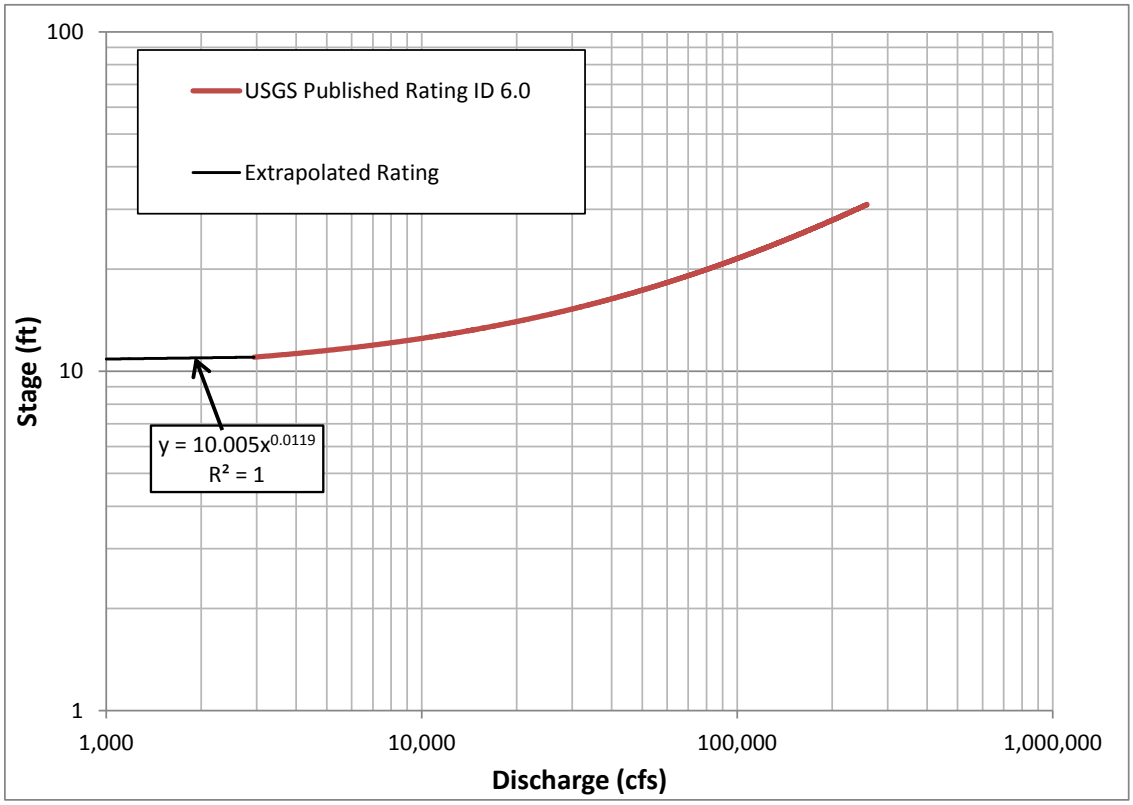

Figure 5.2-1. USGS Published and Extrapolated Stage-Discharge Rating for Susitna River USGS Gage at Sunshine.

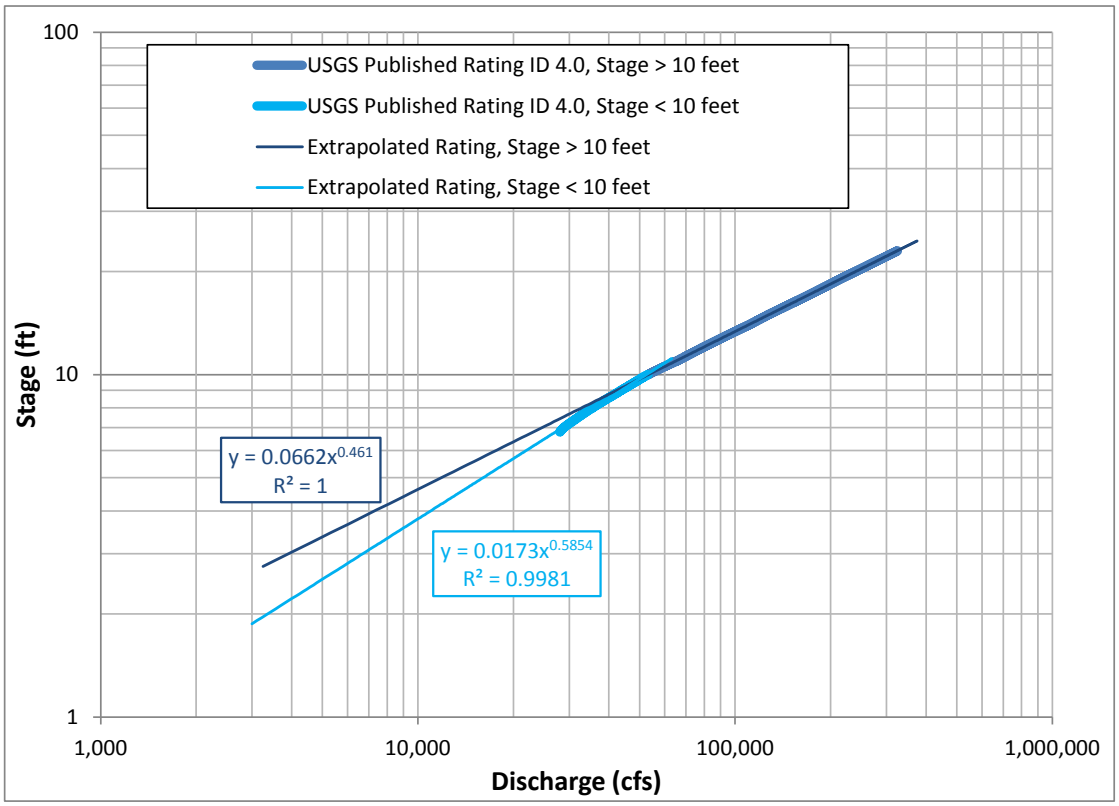

Figure 5.2-2. USGS Published and Extrapolated Stage-Discharge Ratings for Susitna River USGS Gage at Susitna Station.

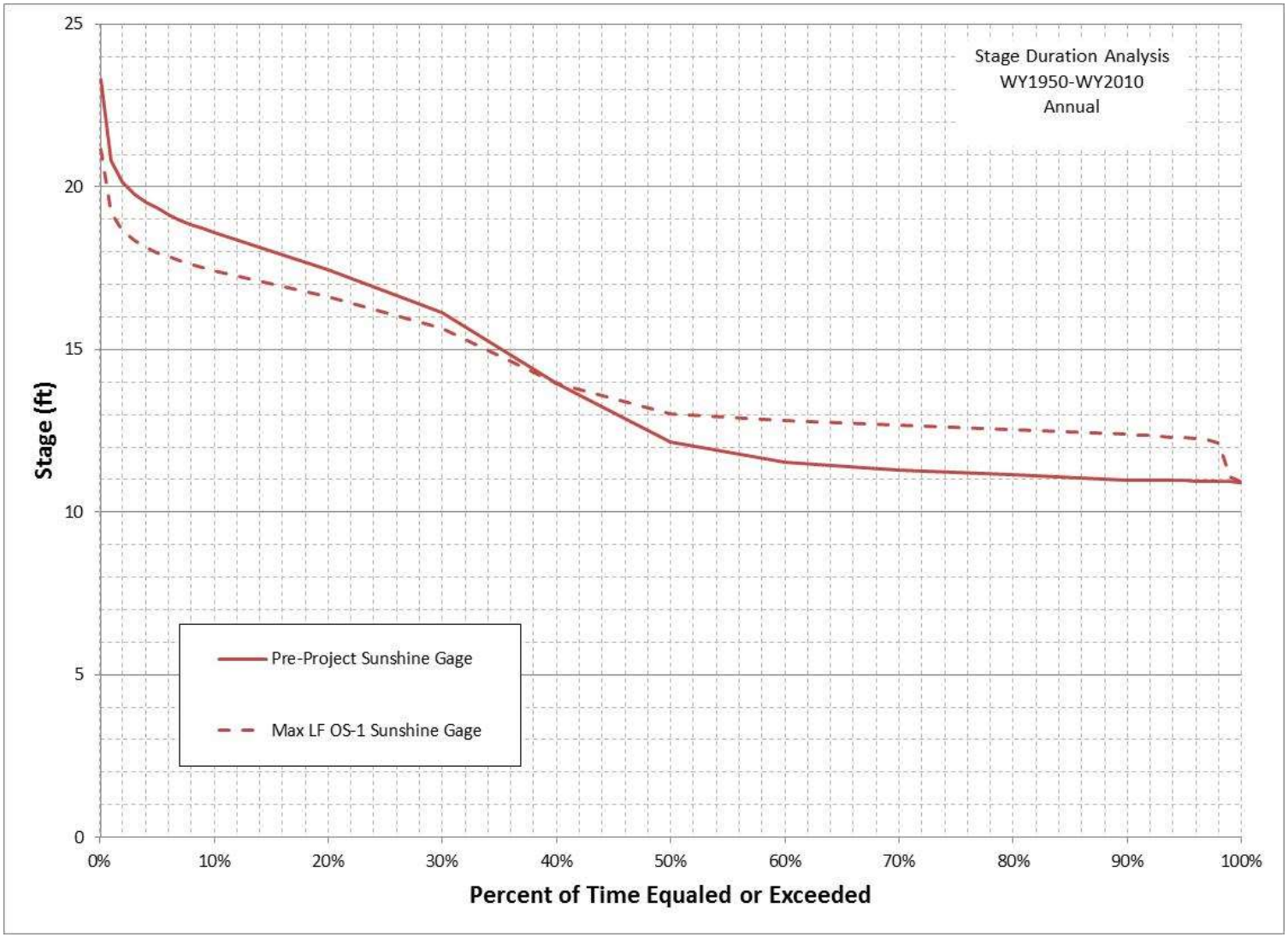

Figure 5.3-1. Annual Stage-exceedence Relationships for pre-Project and Max LF OS-1 Conditions, Sunshine Gage.

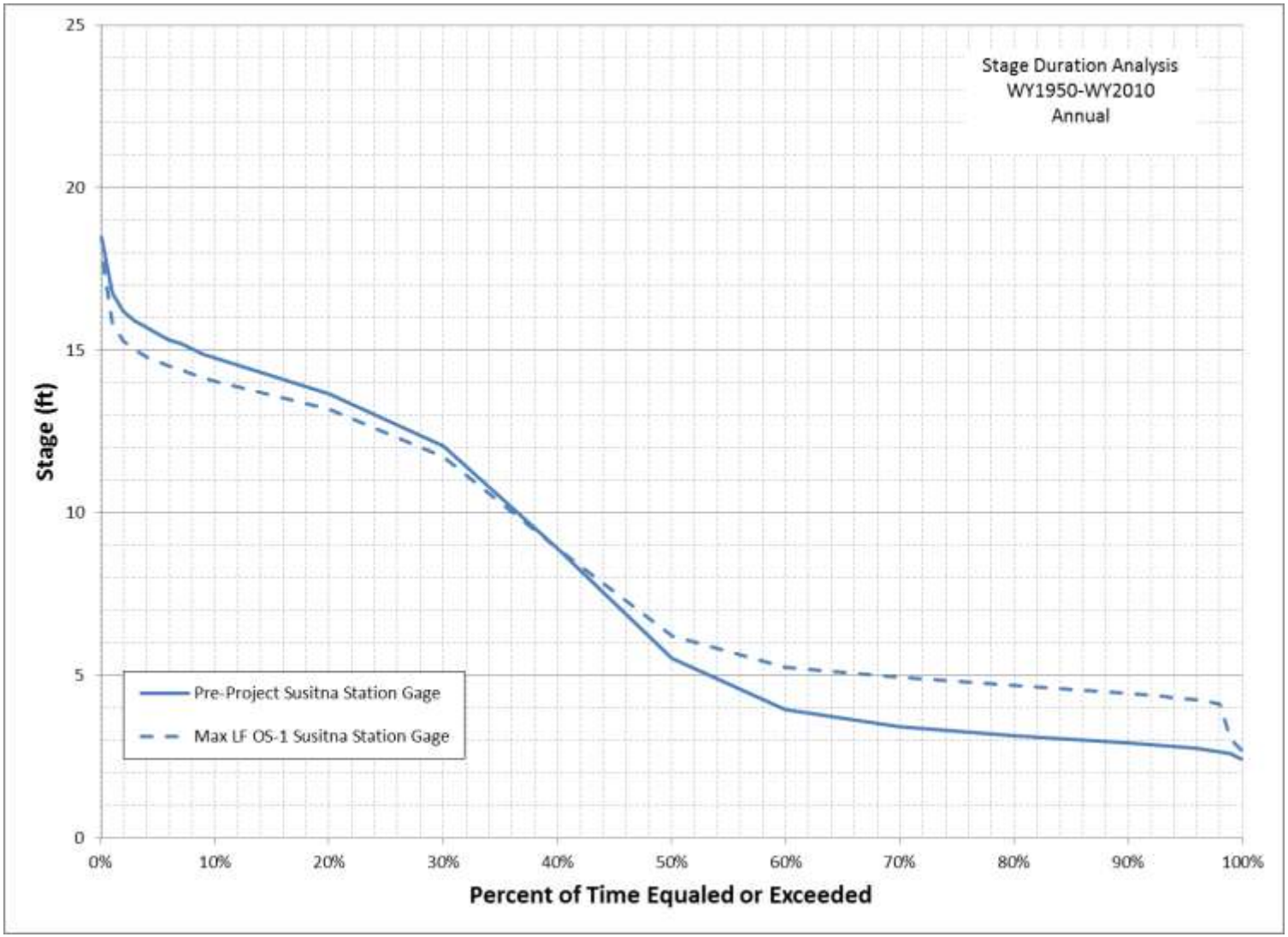

Figure 5.3-2. Annual Stage-exceedence Relationships for pre-Project and Max LF OS-1 Conditions, Susitna Station Gage.

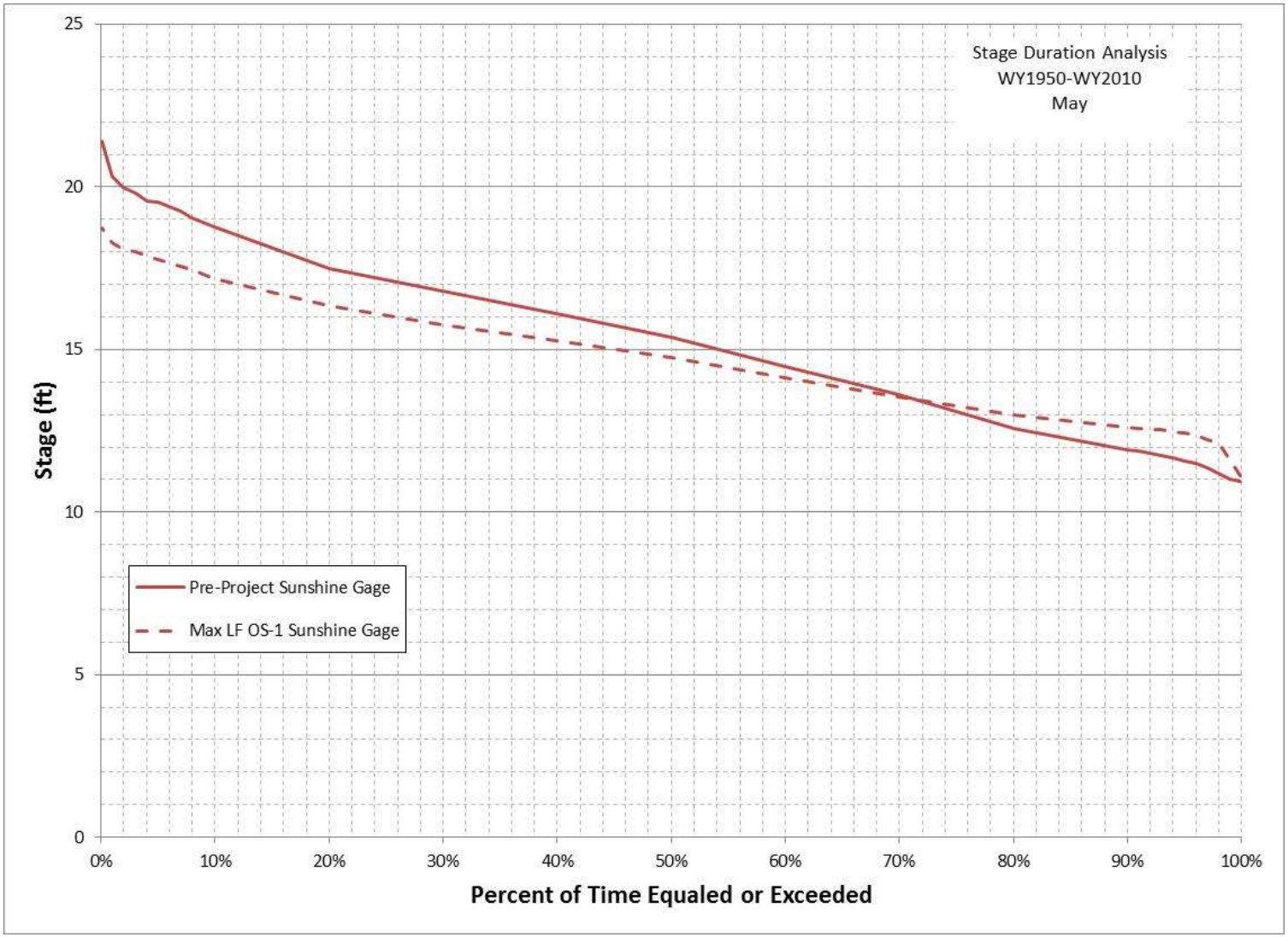

Figure 5.3-3. Monthly Stage-exceedence Relationships for May for pre-Project and Max LF OS-1 Conditions, Sunshine Gage.

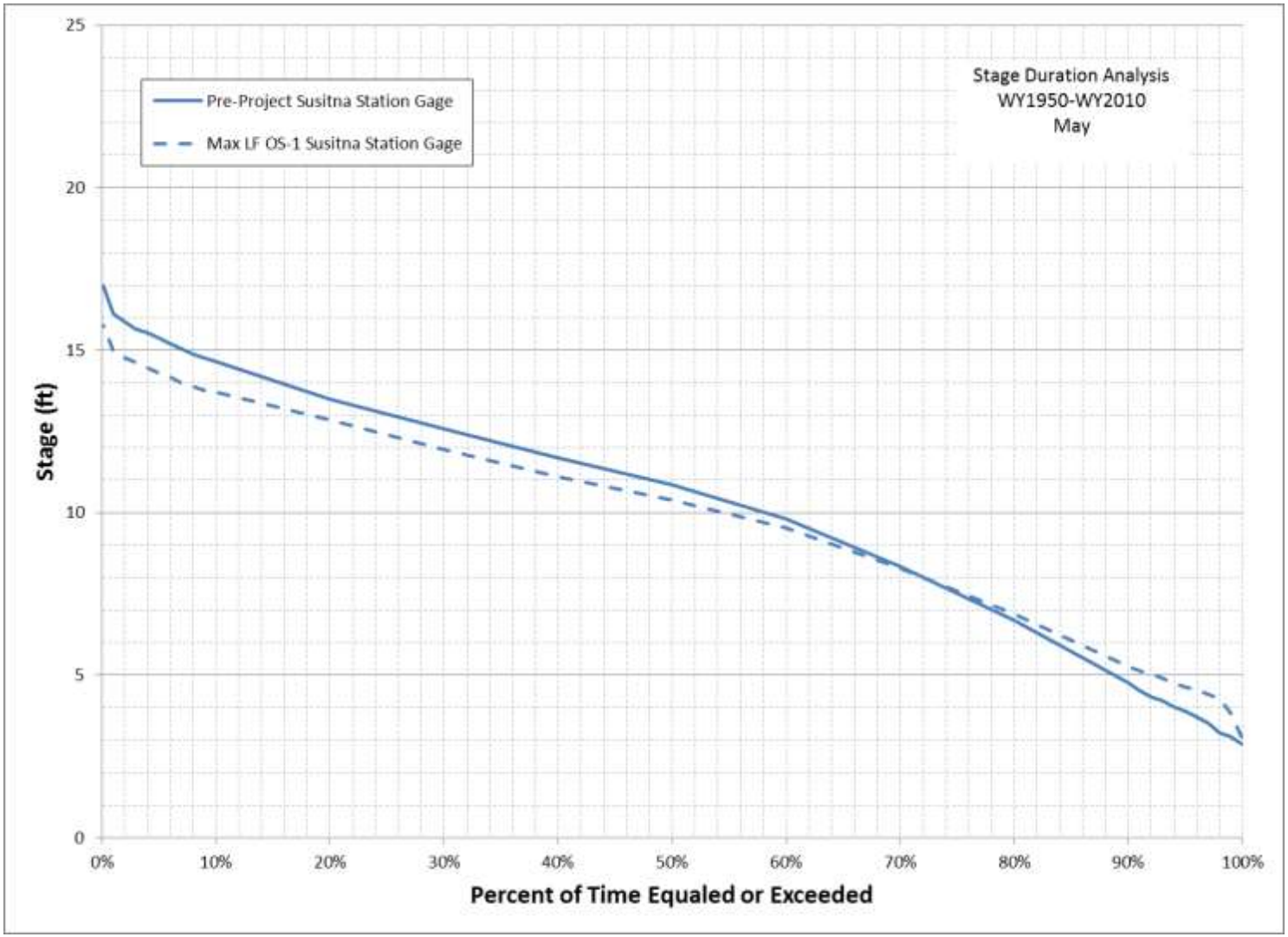

Figure 5.3-4. Monthly Stage-exceedence Relationships for May for pre-Project and Max LF OS-1 Conditions, Susitna Station Gage.

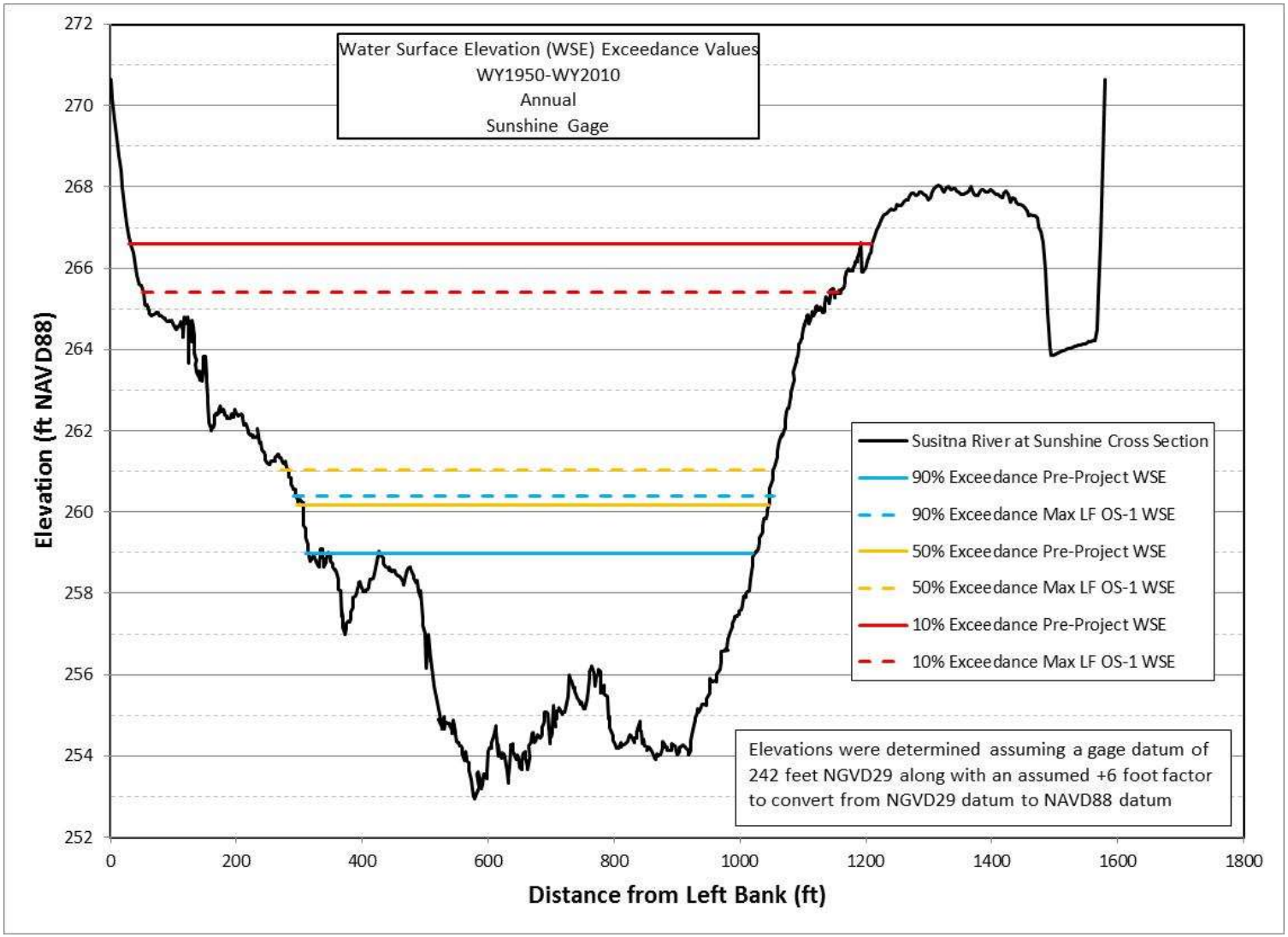

Figure 5.3-5. Select Annual Water-surface Elevation exceedence Values for pre-Project and Max LF OS-1 Conditions, Sunshine Gage.

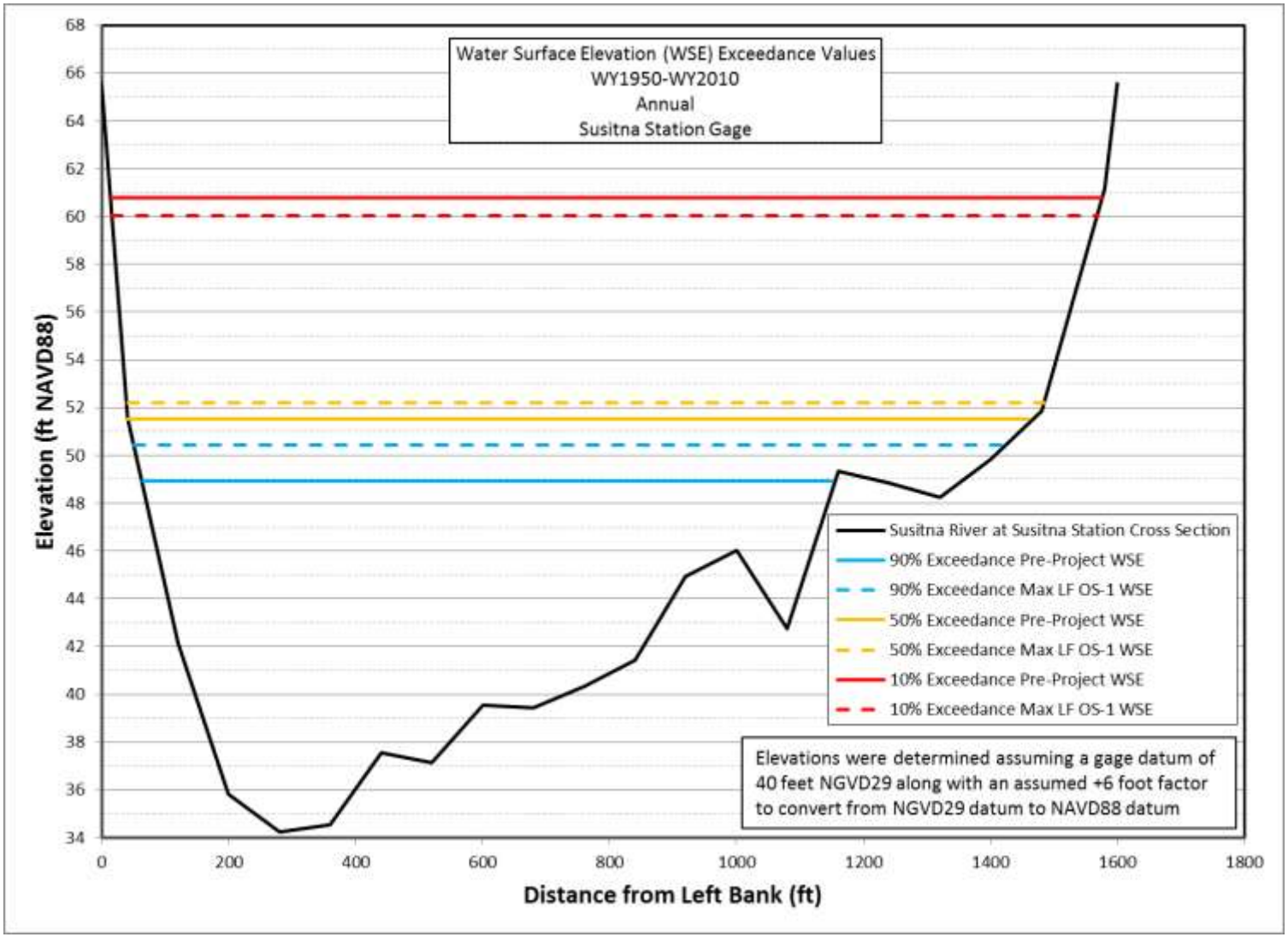

Figure 5.3-6. Select Annual Water-surface Elevation exceedence Values for pre-Project and Max LF OS-1 Conditions, Susitna Station Gage.

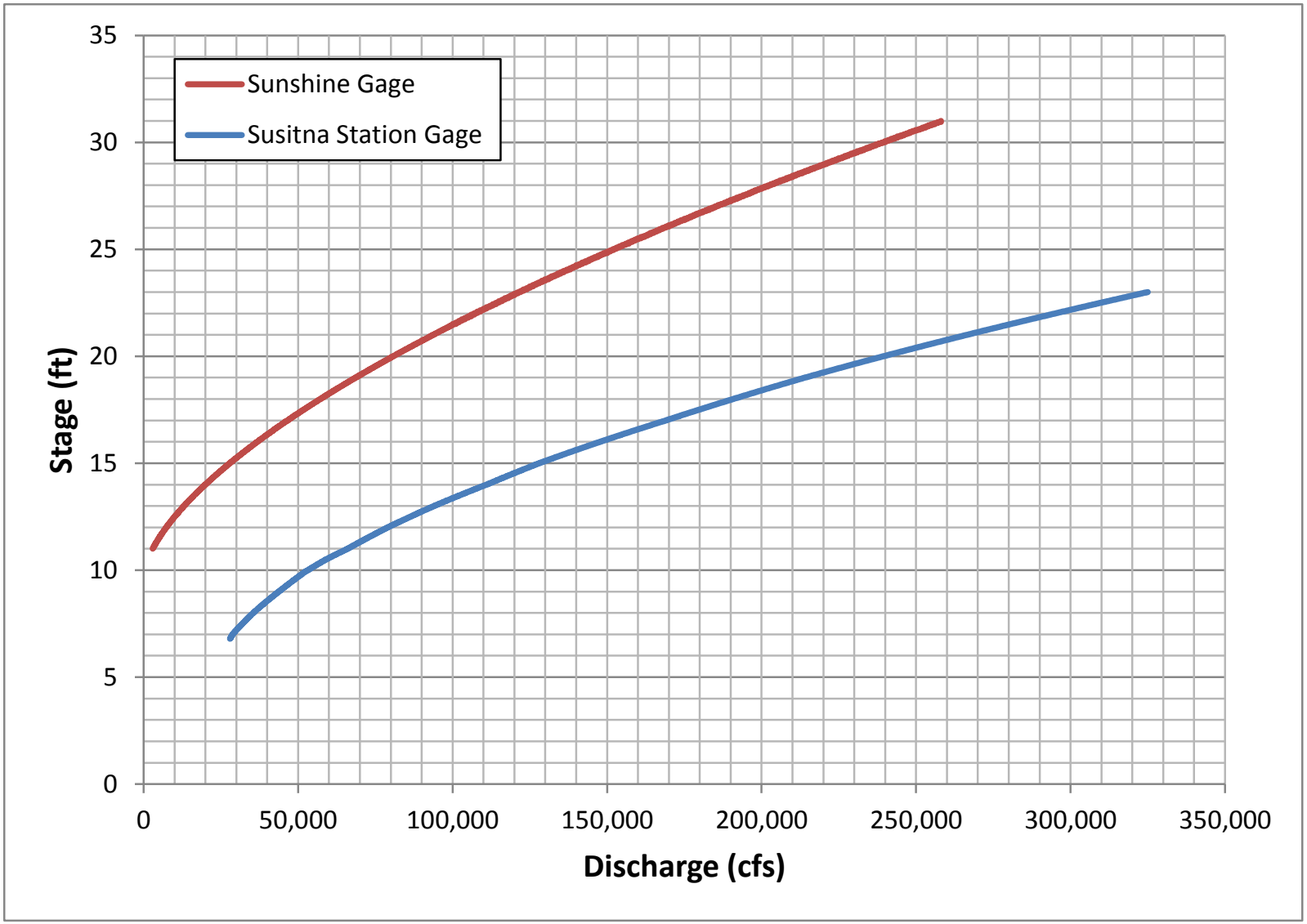

Figure 5.4-1. Comparison of Stage-Discharge Ratings for Susitna Station and Sunshine Gages.

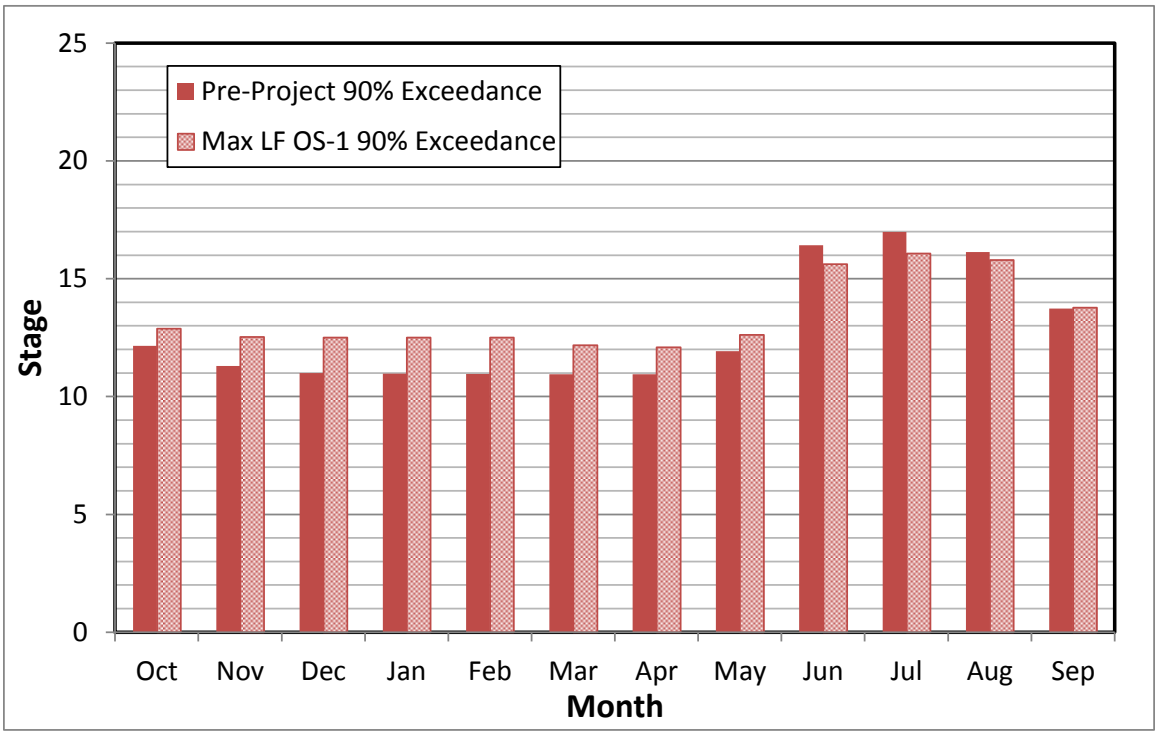

Figure 5.4-2. Monthly 90 percent pre-Project and Max LF OS-1 Stage-exceedence Values, Sunshine Gage.

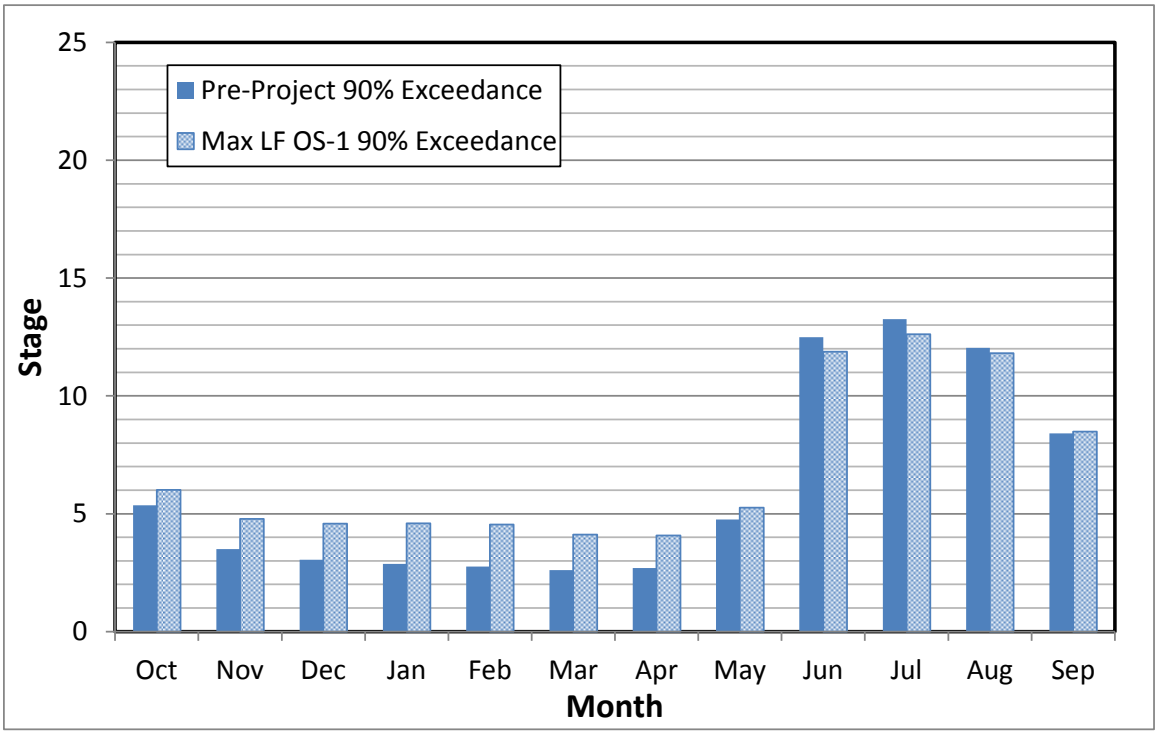

Figure 5.4-3. Monthly 90 percent pre-Project and Max LF OS-1 Stage-exceedence Values, Susitna Station Gage.

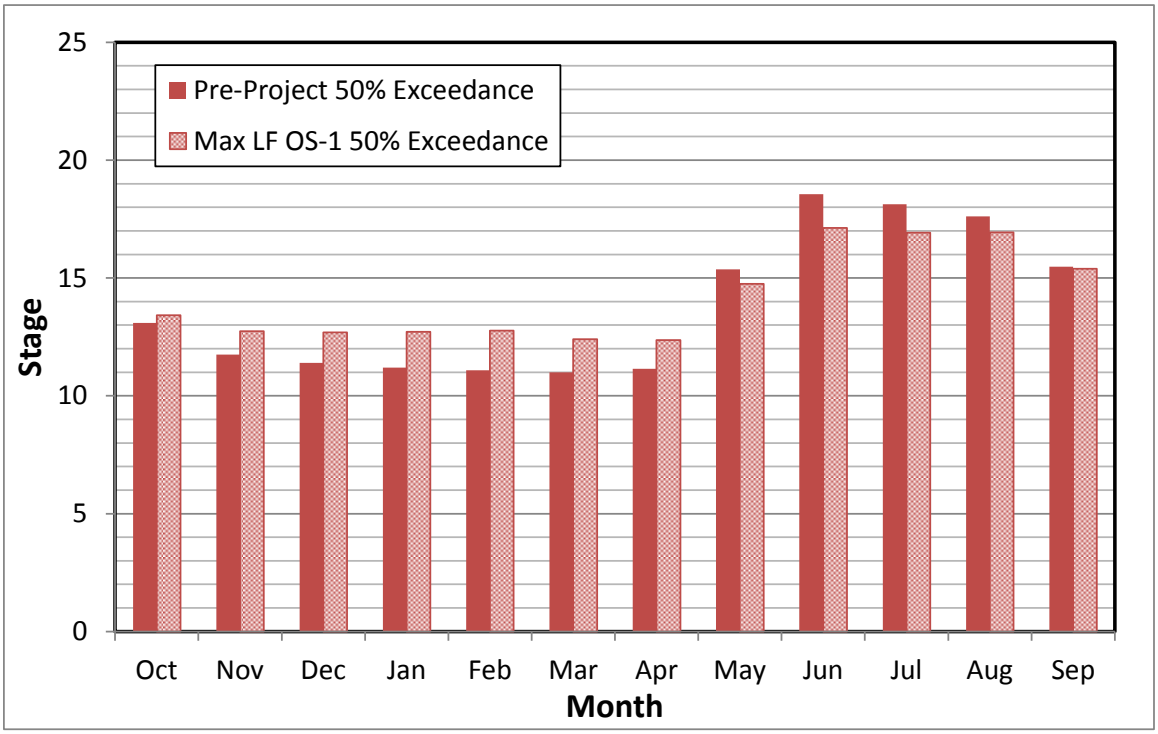

Figure 5.4-4. Monthly 50 percent pre-Project and Max LF OS-1 Stage-Exceedence Values, Sunshine Gage.

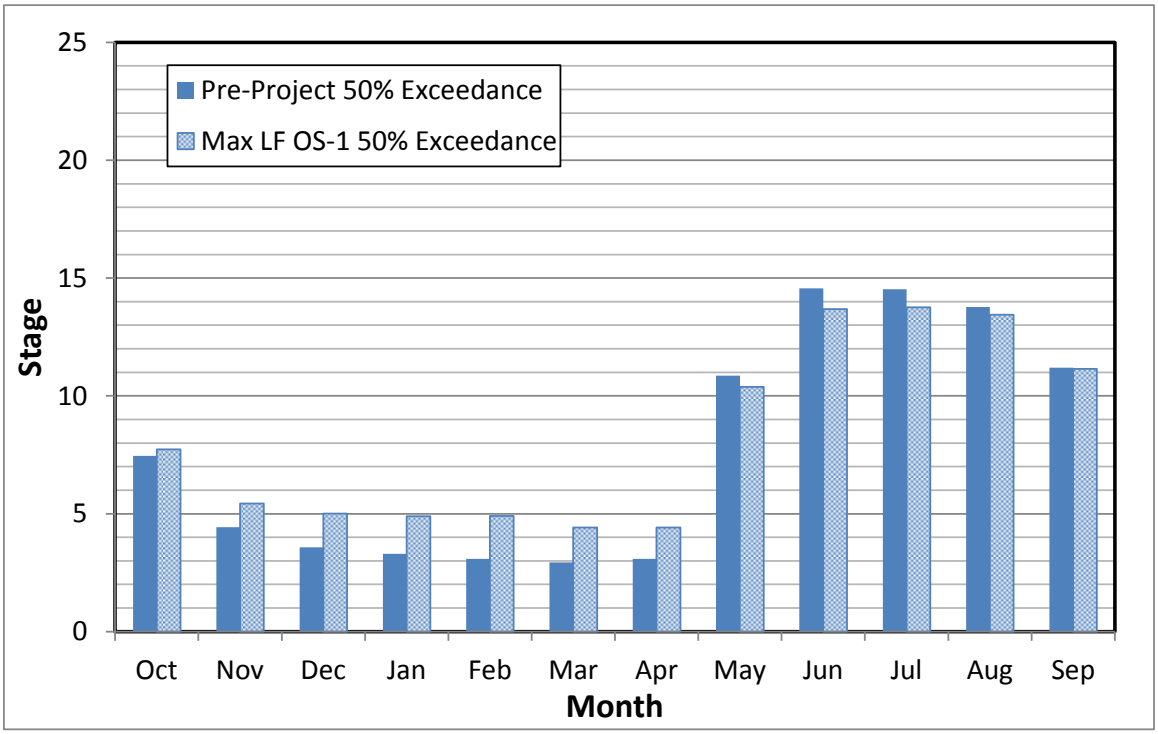

Figure 5.4-5. Monthly 50 percent pre-Project and Max LF OS-1 Stage-exceedence Values, Susitna Station Gage.

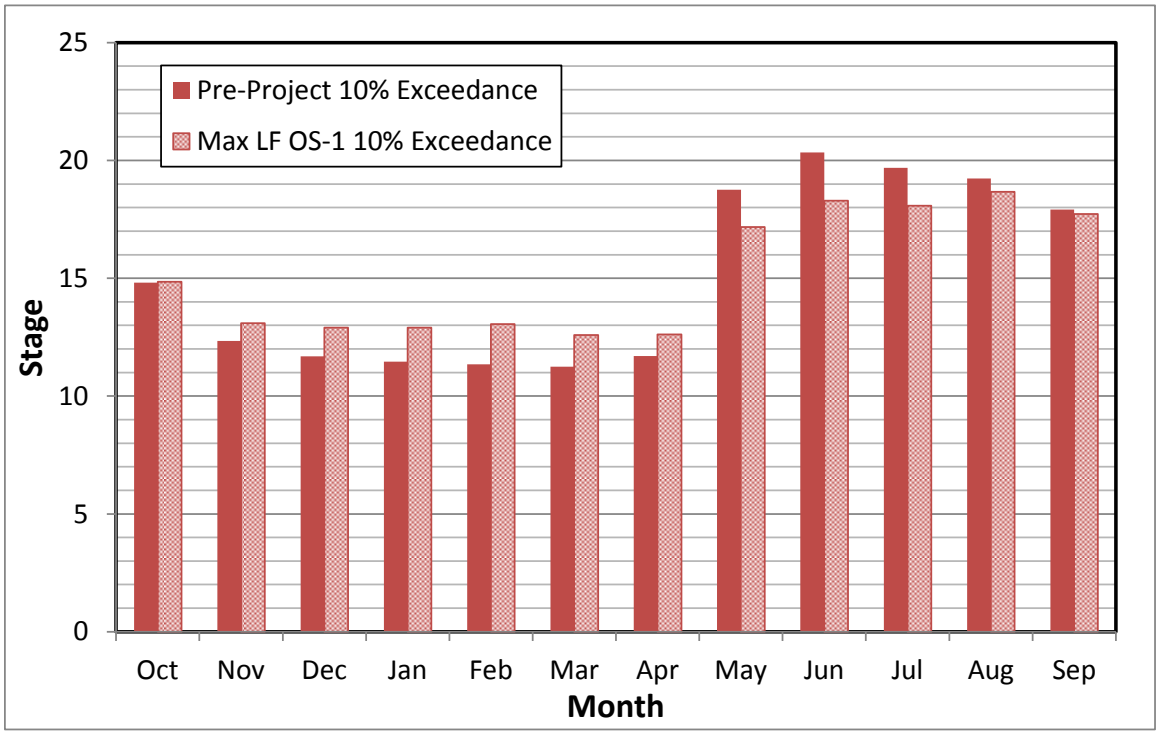

Figure 5.4-6. Monthly 10 percent pre-Project and Max LF OS-1 Stage-exceedence Values, Sunshine Gage.

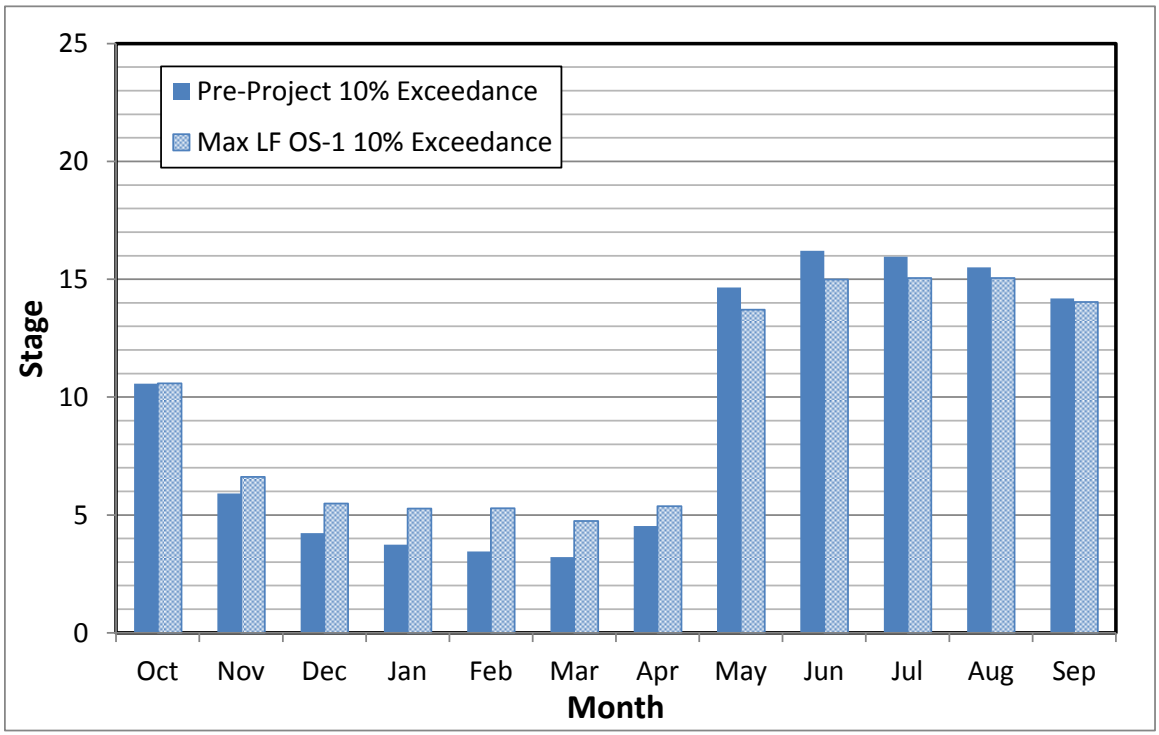

Figure 5.4-7. Monthly 10 percent pre-Project and Max LF OS-1 exceedence Values, Susitna Station Gage.

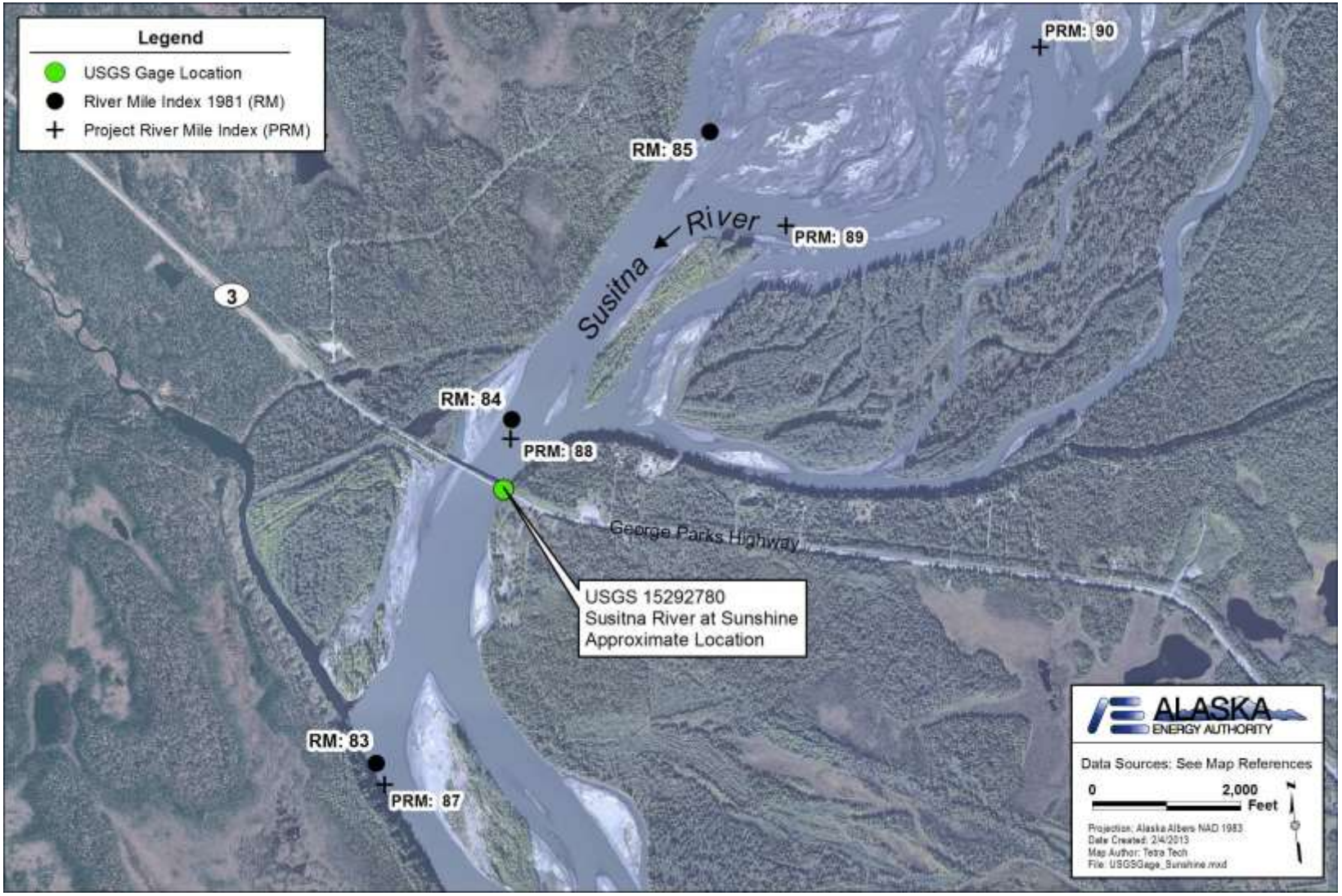

Figure 6.2-1. Vicinity Map for Susitna River at Sunshine Gage.

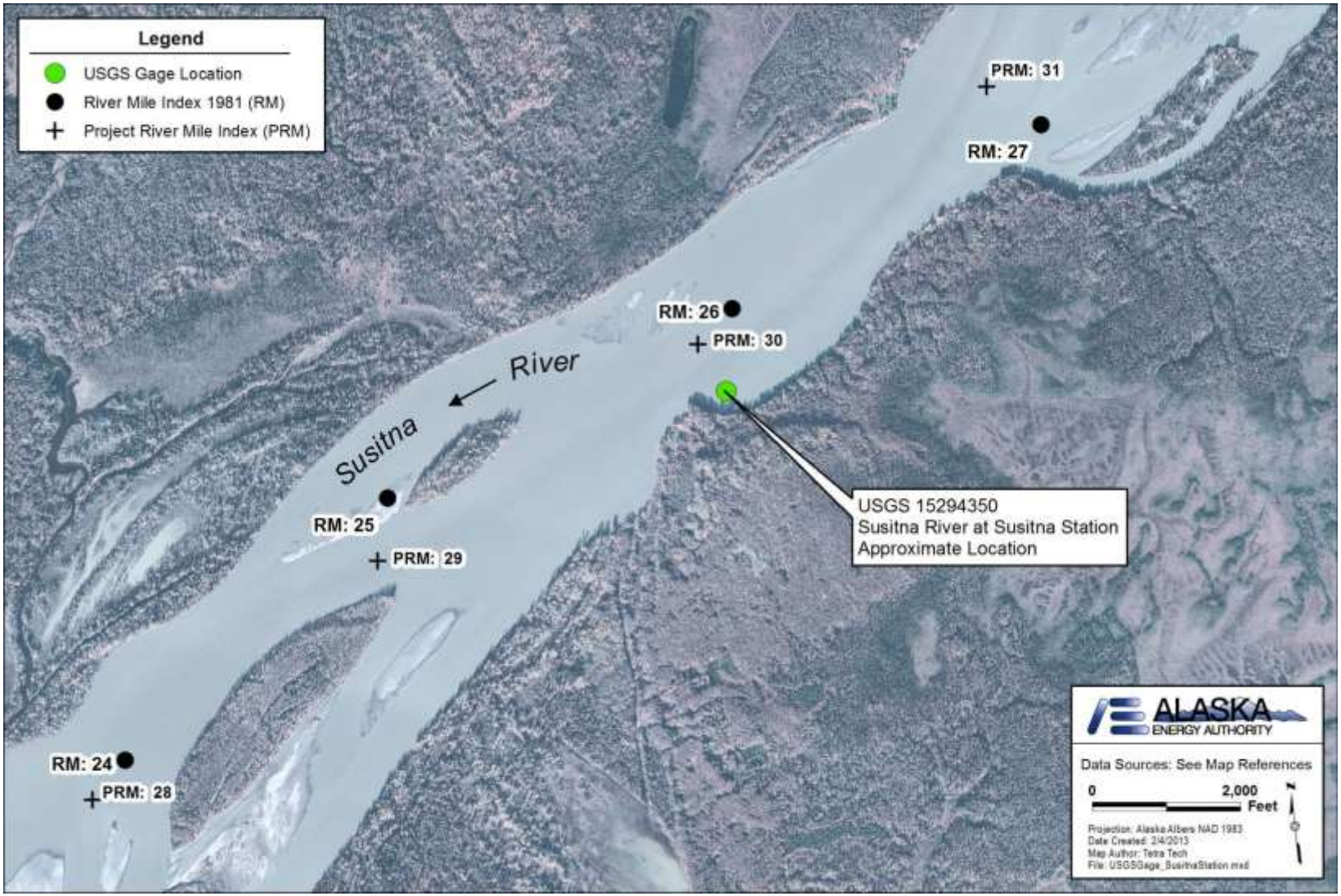

Figure 6.2-2. Vicinity Map for Susitna River at Susitna Station Gage.

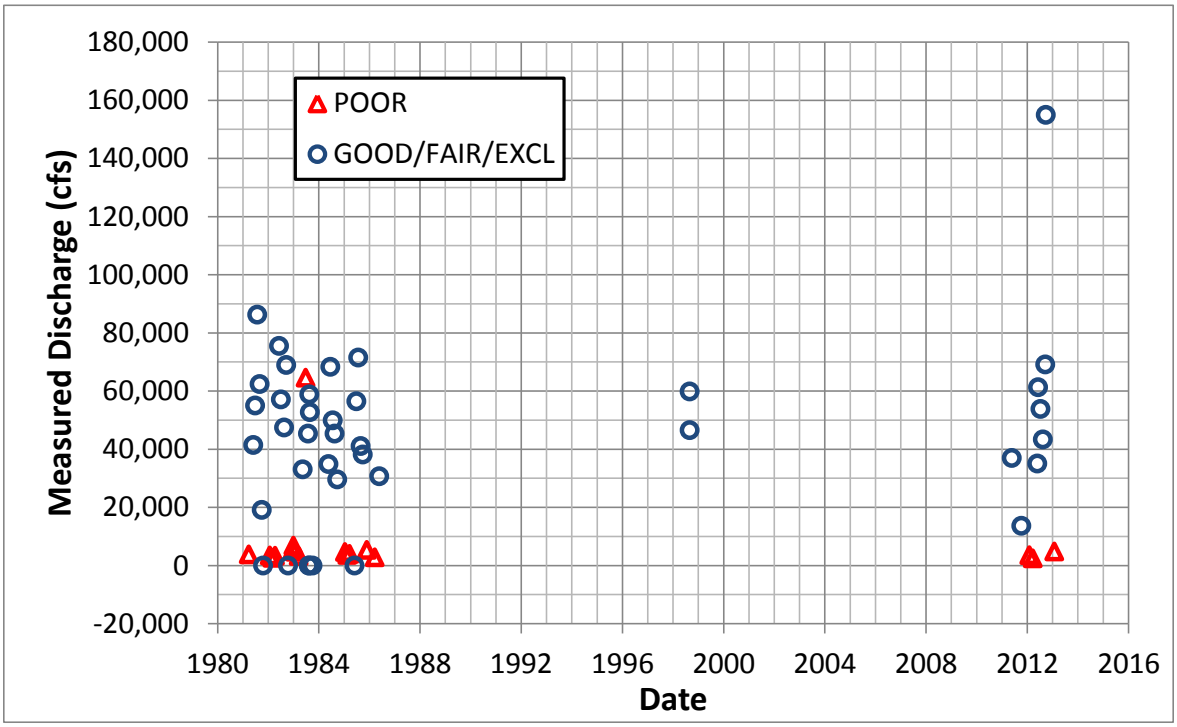

Figure 6.2-3. USGS Stage and Discharge Measurements at Susitna River at Sunshine Gage (USGS 15292780).

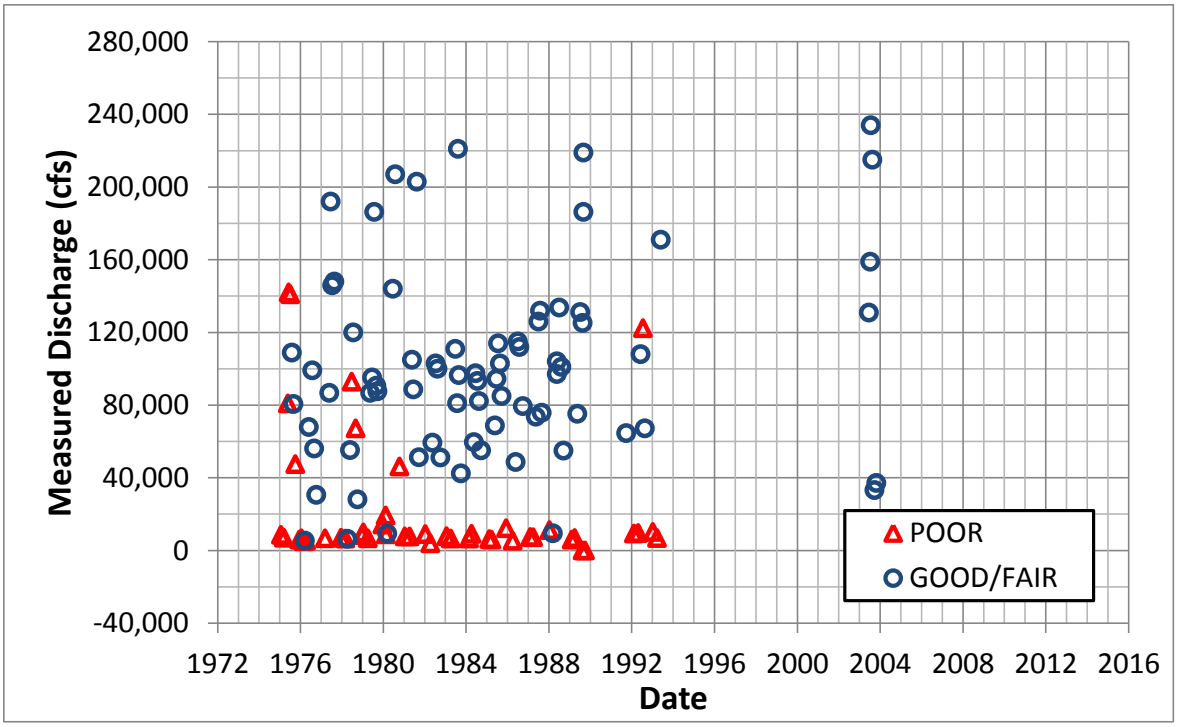

Figure 6.2-4. USGS Stage and Discharge Measurements at Susitna River at Susitna Station Gage (USGS 15294350).

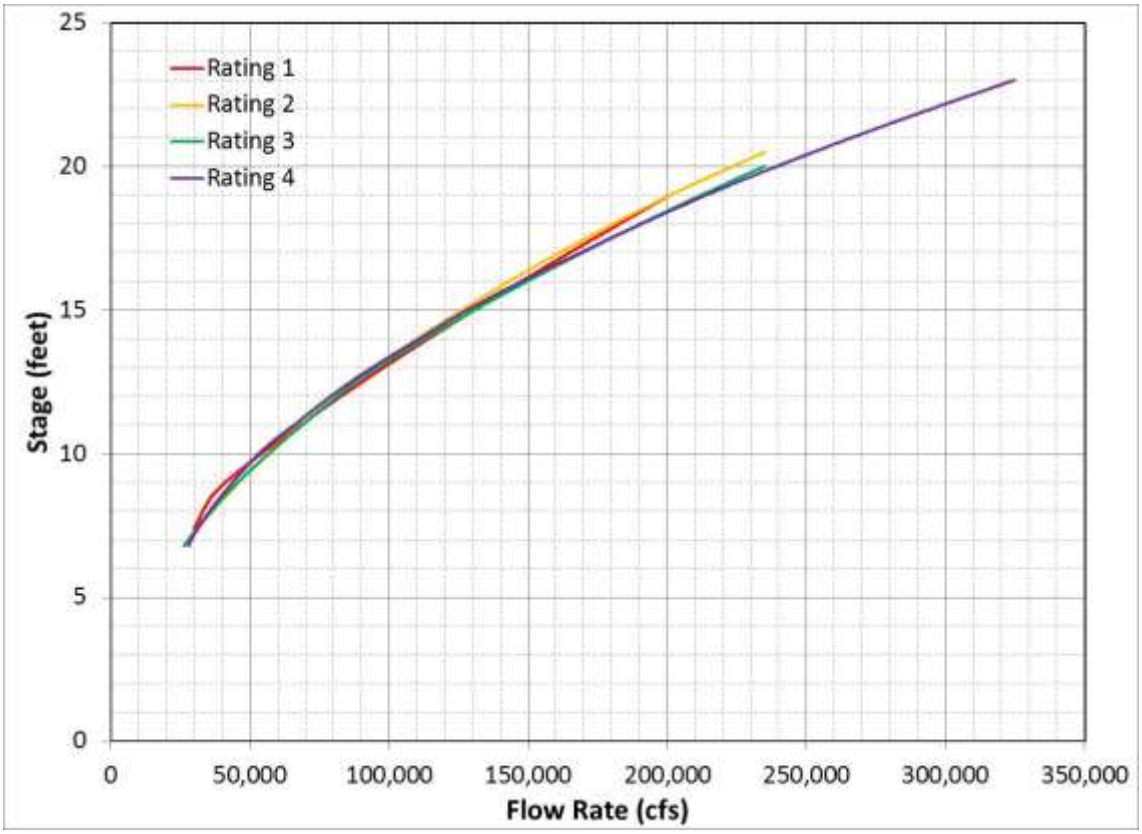

Figure 6.2-5. Historical Stage-Discharge Ratings for Susitna River at Susitna Station Gage.

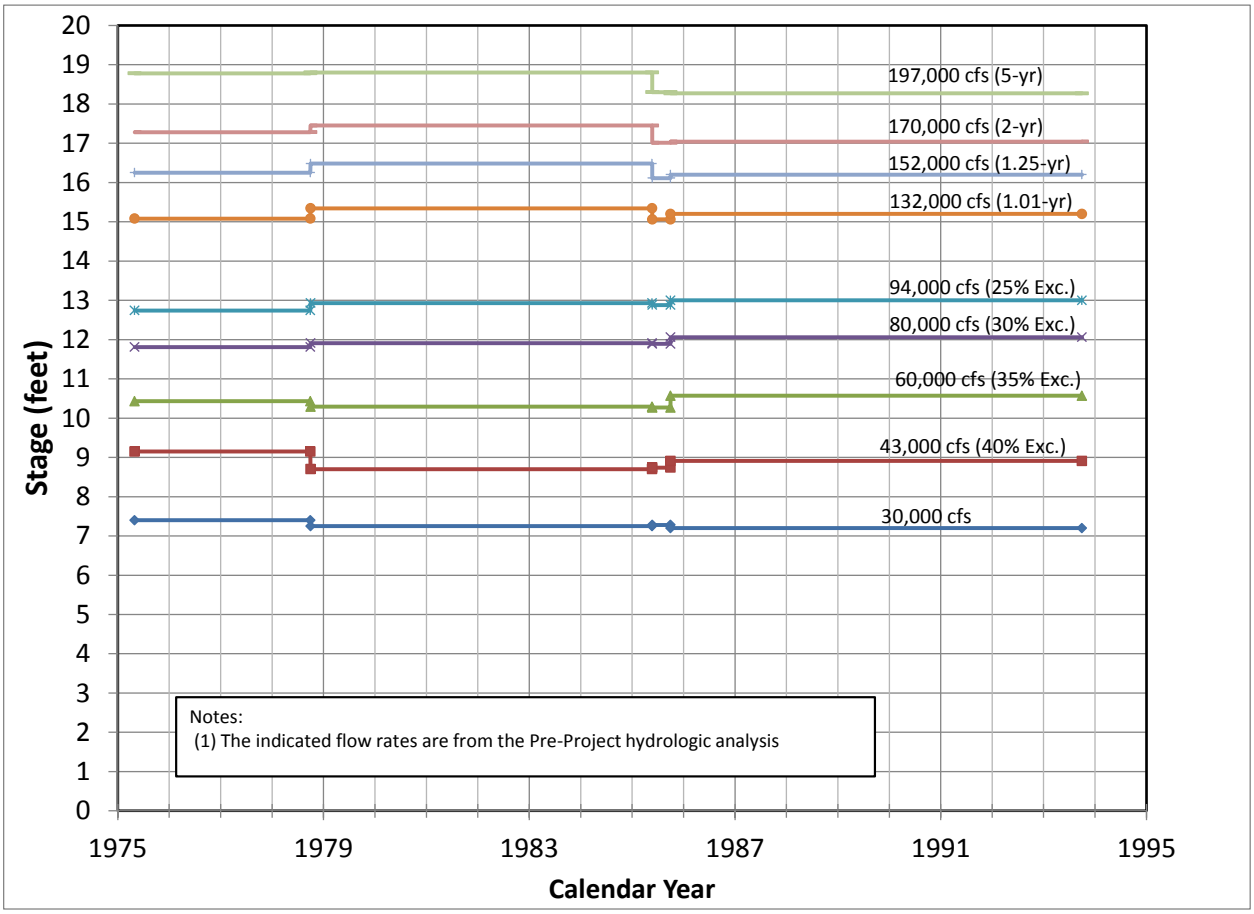

Figure 6.3-1. Specific Gage Curves for Susitna River at Susitna Station Gage.

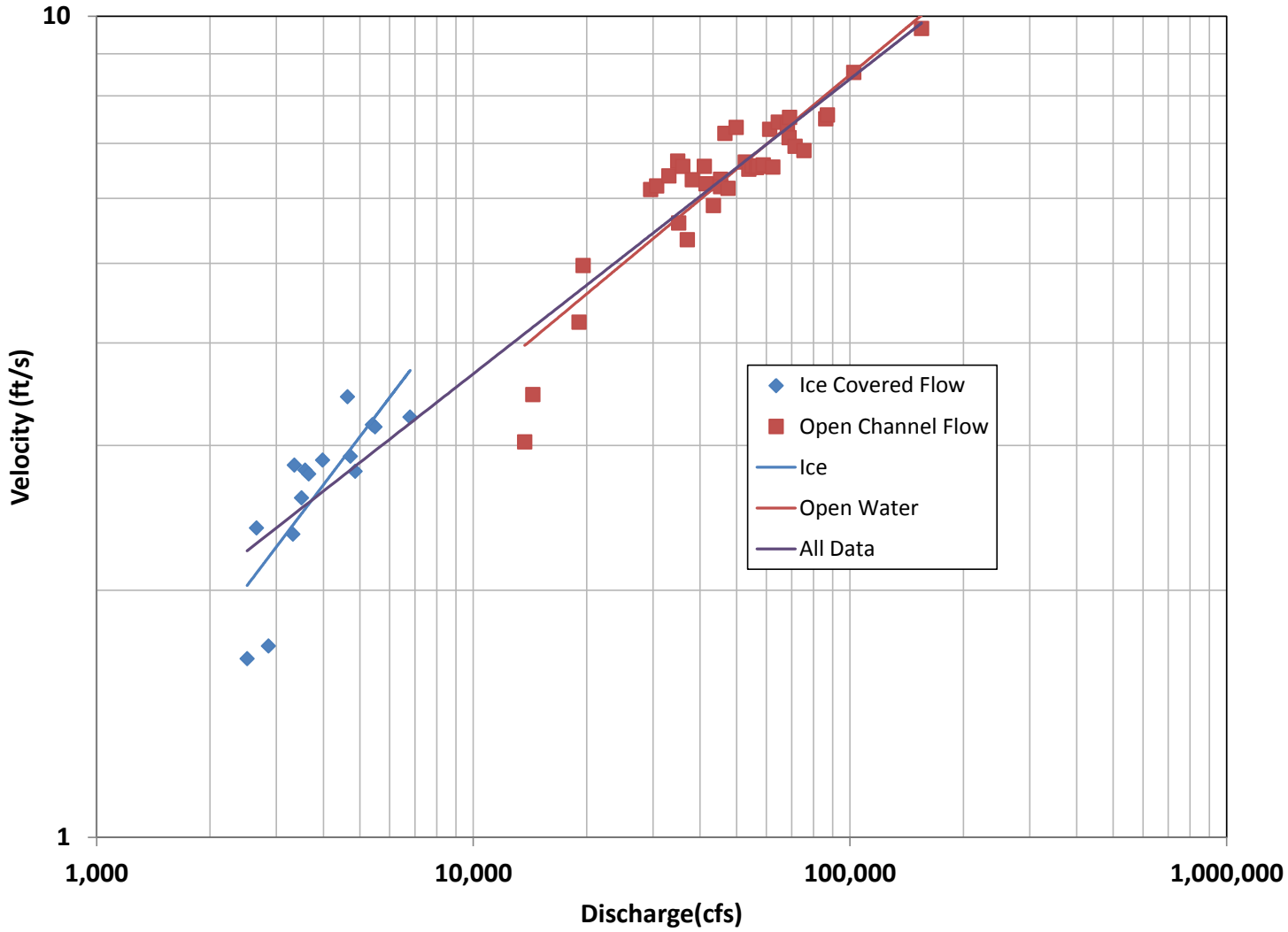

Figure 7.3.1. Velocity versus discharge for ice-covered and open-water conditions based on USGS measurements at the Susitna River at Sunshine gage.

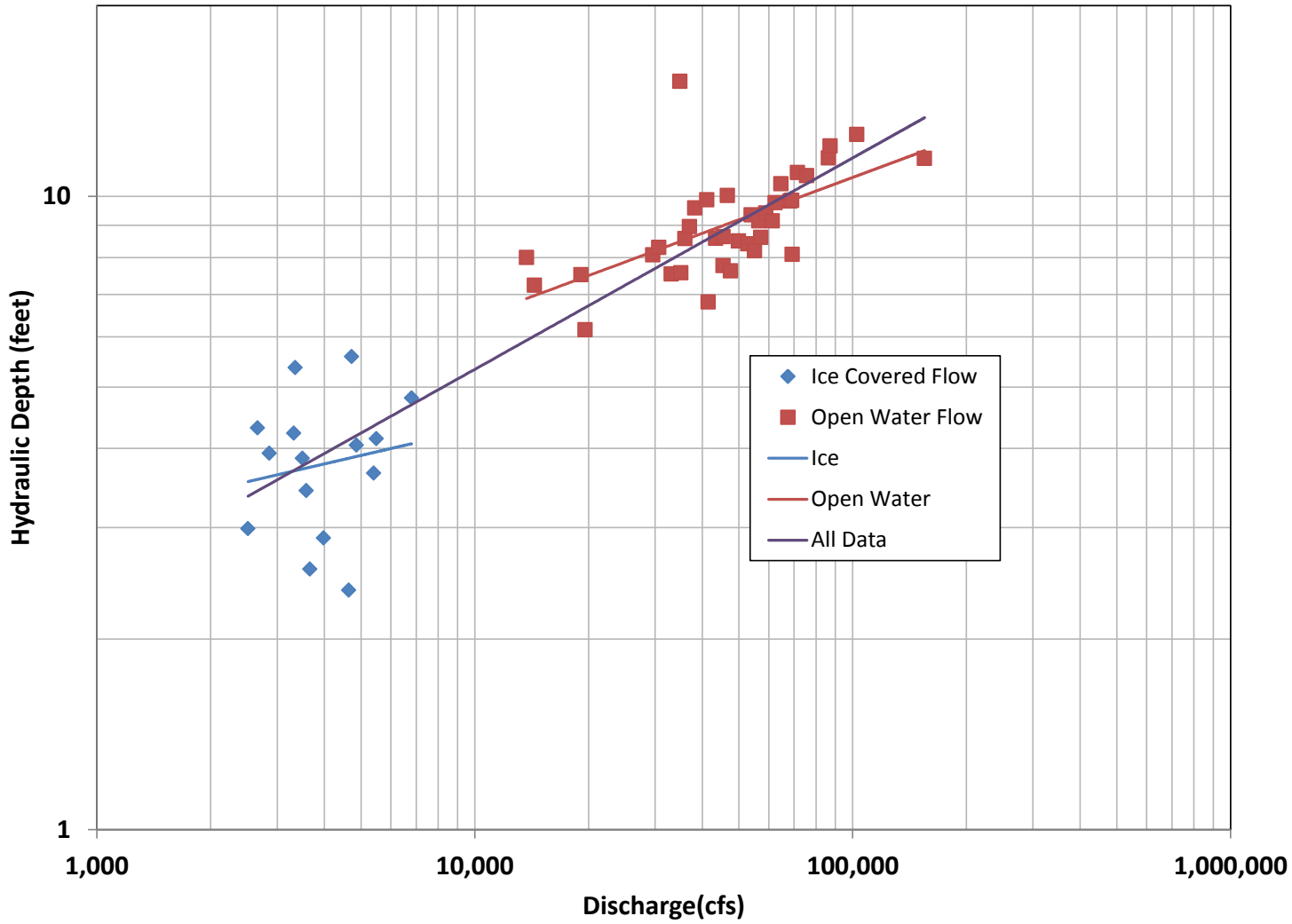

Figure 7.3.2. Hydraulic (i.e., average) depth versus discharge for ice-covered and open-water conditions based on USGS measurements at the Susitna River at Sunshine gage.

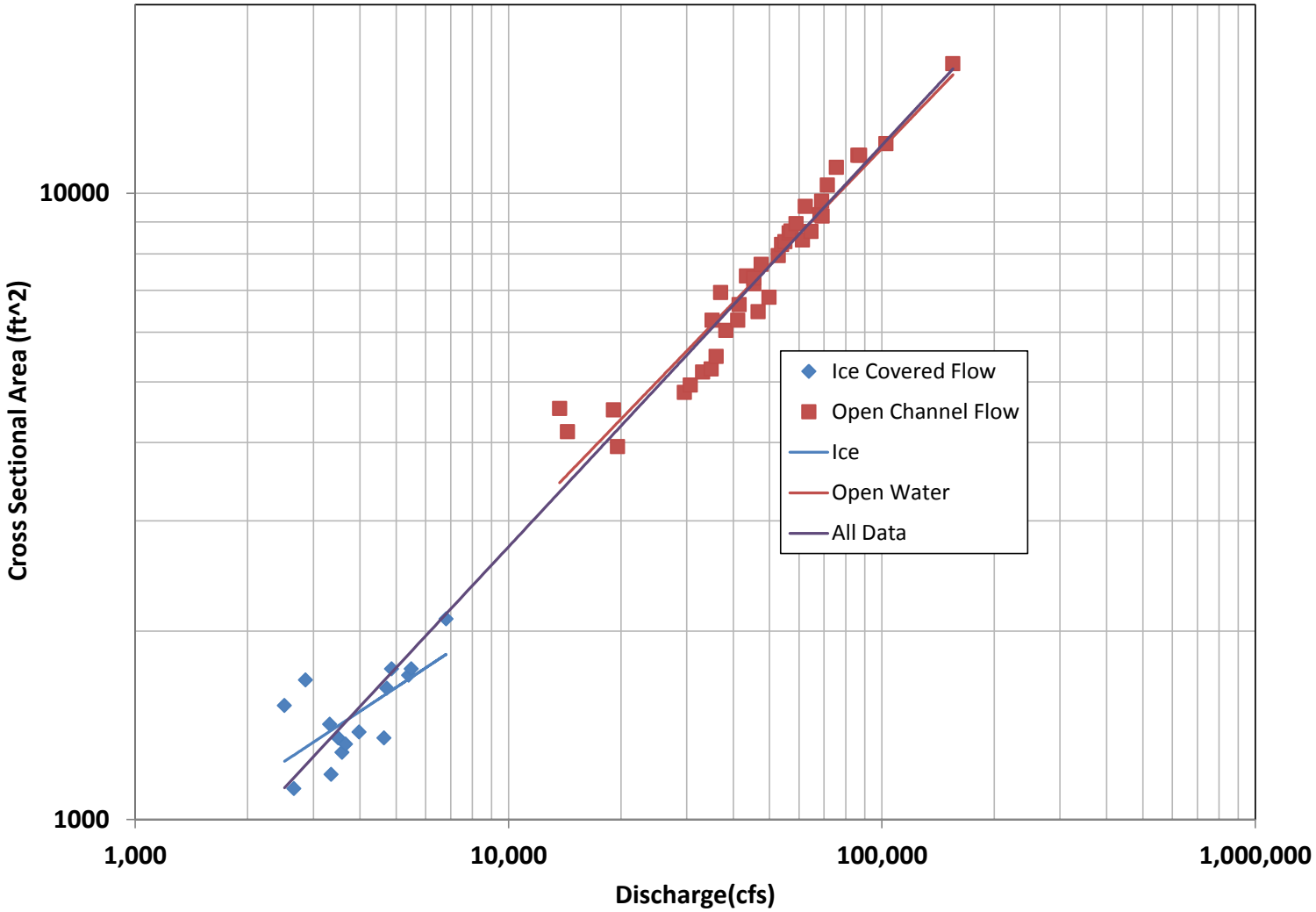

Figure 7.3.3. Cross-sectional area versus discharge for ice-covered and open-water conditions based on USGS measurements at the Susitna River at Sunshine gage.

APPENDIX A. AVERAGE MONTHLY FLOW (CFS) BY WATER YEAR FOR PRE-PROJECT CONDITIONS

Susitna-Watana Hydroelectric Project (FERC No. 14241)

Stream Flow Assessment

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

Tetra Tech

February 2013

Table A-1 – Average Monthly Flow for Susitna River near Denali for Pre-Project Conditions based on the USGS Extended Record

WY	Susitna River near Denali											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1950	1,320	432	238	202	183	179	191	2,850	5,640	7,220	6,080	1,620
1951	681	219	207	197	187	181	290	3,750	6,110	7,400	5,870	6,190
1952	1,040	463	305	252	200	192	194	1,360	9,050	8,070	6,060	3,630
1953	1,620	608	269	207	187	187	289	5,620	8,260	6,190	6,320	4,020
1954	1,040	342	234	219	200	184	222	5,150	8,180	6,200	8,440	3,110
1955	985	465	332	286	224	207	213	2,270	8,320	8,360	7,190	3,690
1956	902	306	219	199	198	196	197	4,860	9,090	9,050	7,480	5,330
1957	1,070	520	350	269	234	213	213	3,470	12,200	11,200	9,770	4,020
1958	1,280	610	288	219	150	120	210	1,160	8,370	9,150	6,540	1,880
1959	939	390	170	119	81	42	43	1,780	8,890	8,330	7,880	2,500
1960	1,580	760	575	444	321	275	265	3,350	5,240	9,040	7,910	4,820
1961	1,780	660	483	331	271	281	415	2,960	6,410	8,080	7,250	2,690
1962	1,290	680	440	280	240	220	280	2,200	9,090	10,200	9,450	3,650
1963	1,080	510	310	250	230	200	210	3,250	6,760	10,500	10,200	3,950
1964	925	290	185	140	140	110	130	910	11,600	7,580	6,550	2,630
1965	1,470	702	279	220	200	208	320	2,460	4,650	6,760	5,760	6,960
1966	920	300	240	210	200	200	280	1,630	6,850	8,290	6,430	3,200
1967	957	321	278	252	227	205	195	3,550	7,870	8,140	8,770	4,640
1968	911	471	382	344	320	312	368	4,930	9,010	11,800	9,830	2,190
1969	700	304	172	145	140	145	229	1,770	8,150	9,450	3,920	2,210
1970	1,000	501	339	265	221	193	319	2,210	5,010	8,450	6,220	1,950
1971	528	395	276	170	125	120	135	629	8,100	10,400	10,400	3,290
1972	1,040	478	380	339	307	286	270	3,470	6,560	10,400	8,660	2,780
1973	667	323	211	178	164	153	153	1,040	5,740	8,350	7,270	2,450
1974	876	462	366	310	271	235	262	2,540	5,640	9,550	9,290	5,450
1975	2,140	673	381	300	200	200	200	1,640	7,040	12,100	7,290	3,570
1976	1,540	375	169	112	97	90	123	1,810	5,940	8,560	10,100	1,820
1977	894	467	331	266	240	231	246	1,500	8,250	10,000	10,200	3,710
1978	1,150	652	439	348	300	246	263	2,030	5,250	8,990	8,640	3,620
1979	865	463	312	263	229	203	250	2,790	7,650	9,500	9,180	4,510
1980	2,160	878	533	395	330	290	280	1,890	6,410	11,800	7,170	2,640
1981	1,300	745	473	344	274	235	210	3,010	7,160	11,900	12,000	2,740

WY	Susitna River near Denali cont.											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1982	831	481	326	227	157	127	120	2,460	5,870	9,750	6,450	4,450
1983	1,150	439	363	330	300	277	281	1,970	7,450	10,500	8,050	2,600
1984	1,220	433	277	220	205	200	196	2,050	8,380	10,800	8,820	2,150
1985	1,300	611	438	357	306	291	376	2,480	8,060	10,500	7,220	3,860
1986	1,270	589	404	304	238	201	229	2,670	7,060	13,200	5,710	3,440
1987	3,920	615	325	267	253	249	344	3,170	7,170	9,400	7,140	3,580
1988	1,180	564	360	321	297	292	331	5,090	9,260	9,090	6,230	3,400
1989	1,540	503	281	251	234	265	331	3,230	8,160	8,500	8,950	6,060
1990	2,240	599	306	290	281	310	770	7,710	9,620	7,910	7,210	6,900
1991	1,280	406	308	283	275	234	276	2,240	8,910	7,600	6,180	3,100
1992	1,310	458	403	350	315	324	581	2,100	7,500	8,250	5,580	1,820
1993	721	476	369	320	275	253	412	6,260	7,790	6,540	5,870	7,070
1994	2,770	662	422	337	287	231	516	4,490	8,740	6,690	6,070	1,840
1995	819	447	337	284	252	249	377	4,910	7,340	7,900	5,430	5,650
1996	1,230	464	229	204	199	202	274	2,220	4,240	5,170	5,610	2,100
1997	638	350	299	262	230	200	260	2,280	5,650	7,610	7,720	3,500
1998	726	308	241	202	187	172	283	2,420	7,650	8,120	7,070	4,430
1999	1,610	551	379	285	204	155	207	2,300	7,110	6,980	7,560	2,680
2000	1,370	562	361	277	238	210	281	2,850	9,230	8,830	4,480	4,200
2001	1,730	556	377	307	254	222	261	2,320	8,750	6,350	6,420	2,360
2002	905	426	294	235	217	200	204	3,940	4,590	5,300	7,080	5,480
2003	3,140	1,070	441	229	294	214	431	2,250	7,650	8,520	6,210	3,180
2004	1,630	517	321	256	223	204	424	6,370	7,540	6,640	5,210	1,390
2005	975	409	294	260	230	244	831	8,480	9,450	8,200	6,910	7,370
2006	1,940	366	283	255	220	212	242	3,870	6,120	7,130	8,320	3,250
2007	3,270	598	333	269	232	202	345	3,330	4,780	6,760	6,160	4,050
2008	1,140	509	369	248	197	198	244	2,560	6,490	6,500	6,110	3,620
2009	1,110	315	258	253	225	219	678	6,170	6,970	5,980	5,100	2,820
2010	1,630	615	328	257	232	218	314	4,560	5,520	7,920	6,630	4,230
Average	1,330	503	326	263	229	212	293	3,120	7,400	8,580	7,300	3,640
Maximum	3,920	1,070	575	444	330	324	831	8,480	12,200	13,200	12,000	7,370
Minimum	528	219	169	112	81	42	43	629	4,240	5,170	3,920	1,390
Median	1,150	476	325	262	230	207	265	2,560	7,500	8,350	7,140	3,500

Table A-2 – Average Monthly Flow for Maclaren River near Paxson for Pre-Project Conditions based on the USGS Extended Record

WY	Maclaren River near Paxson											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1950	477	162	91	66	51	47	56	1,060	2,150	2,710	2,270	558
1951	240	83	70	61	52	47	102	1,390	2,310	2,720	2,240	2,360
1952	358	172	120	101	64	56	59	496	3,480	3,000	2,270	1,350
1953	575	219	108	70	52	52	102	2,130	3,090	2,380	2,390	1,530
1954	348	132	95	83	64	50	79	1,950	2,980	2,370	3,040	1,160
1955	333	173	129	113	89	70	76	853	3,200	3,130	2,780	1,380
1956	308	120	83	63	62	60	61	1,840	3,520	3,410	2,780	1,950
1957	360	191	135	108	95	76	76	1,380	3,270	2,790	2,440	2,270
1958	545	247	204	124	83	73	97	1,270	3,530	3,520	2,700	784
1959	378	115	123	129	95	62	78	587	2,880	2,680	2,080	856
1960	549	250	190	150	110	94	92	1,740	2,120	3,360	3,050	2,440
1961	687	195	149	110	94	96	145	1,240	2,680	3,370	3,300	1,170
1962	381	210	170	120	100	92	120	632	2,920	3,260	2,930	1,130
1963	383	210	130	100	91	80	83	2,130	3,110	4,650	3,140	1,210
1964	416	140	98	85	88	71	72	386	4,300	2,760	2,220	871
1965	379	147	49	44	42	41	62	984	2,270	3,220	2,410	2,100
1966	522	180	55	45	45	43	50	265	2,990	2,510	2,090	954
1967	369	95	70	65	60	55	53	1,020	3,630	3,250	3,610	1,420
1968	417	130	100	97	95	95	95	208	3,250	3,430	2,130	680
1969	265	121	69	58	55	58	95	849	2,610	2,690	974	470
1970	249	117	73	59	50	53	69	746	1,750	2,440	2,370	773
1971	301	192	131	83	60	55	66	365	3,410	3,530	3,660	1,170
1972	375	156	123	115	107	97	99	1,220	3,070	3,260	2,680	1,370
1973	550	243	136	87	65	53	51	576	2,910	2,860	2,270	821
1974	307	123	83	69	62	57	57	649	2,070	2,630	2,440	1,540
1975	385	232	140	115	110	100	103	768	3,180	3,650	1,980	1,570
1976	553	235	139	106	94	90	105	781	2,870	2,810	2,600	600
1977	302	168	119	97	92	90	93	366	3,940	3,830	3,390	1,300
1978	512	265	186	162	140	121	134	709	2,320	3,200	2,360	924
1979	307	192	142	122	110	100	111	634	2,430	3,060	2,220	1,140
1980	734	370	246	160	106	82	81	901	2,520	3,530	2,470	917
1981	368	257	202	159	130	111	95	1,160	2,500	3,670	4,120	1,110

WY	Maclaren River near Paxson cont.											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1982	443	230	170	138	93	77	69	496	1,940	2,730	1,680	1,560
1983	516	287	199	148	123	116	123	853	2,750	3,000	2,540	1,200
1984	481	200	121	95	90	83	88	967	3,140	2,940	2,400	598
1985	278	164	128	113	102	107	110	1,560	4,230	3,340	1,530	1,140
1986	380	145	101	100	100	115	105	992	2,610	4,760	1,910	1,340
1987	1,480	255	142	114	105	100	132	1,170	2,550	3,090	2,410	1,220
1988	316	161	121	111	102	96	99	1,640	2,980	2,780	2,120	1,220
1989	490	179	135	119	105	103	118	1,030	2,920	2,510	2,820	1,810
1990	681	205	134	129	126	135	283	2,700	3,380	2,470	2,480	2,650
1991	430	142	124	110	94	84	106	901	3,060	2,460	1,760	940
1992	337	133	116	106	99	104	122	551	2,730	2,940	2,270	804
1993	252	174	136	116	102	95	151	2,270	2,820	2,310	2,080	2,560
1994	931	225	153	126	110	93	185	1,540	3,260	2,380	2,160	649
1995	278	162	127	110	101	100	144	1,750	2,650	2,820	1,910	2,040
1996	422	164	90	79	75	74	99	742	1,510	1,790	1,940	745
1997	210	125	111	99	90	80	98	758	1,850	2,610	2,650	1,170
1998	248	113	93	81	76	71	105	822	2,580	2,820	2,350	1,460
1999	548	180	133	106	81	65	81	759	2,440	2,320	2,680	897
2000	468	183	128	104	92	83	105	941	3,390	3,190	1,450	1,410
2001	585	181	133	112	97	87	99	811	3,230	2,300	2,300	816
2002	307	155	114	94	87	79	80	1,410	1,640	1,890	2,560	1,910
2003	1,050	359	158	93	116	85	149	767	2,700	3,130	2,220	1,120
2004	580	177	120	98	85	74	152	2,280	2,650	2,350	1,850	470
2005	326	140	110	99	85	84	279	3,120	3,590	2,970	2,440	2,650
2006	666	135	106	97	87	84	96	1,430	2,230	2,530	3,110	1,120
2007	1,120	211	128	108	96	86	129	1,280	1,780	2,400	2,180	1,390
2008	378	181	142	100	79	80	98	931	2,320	2,330	2,160	1,300
2009	372	114	95	95	86	85	254	2,250	2,480	2,110	1,820	1,010
2010	547	207	122	99	90	84	118	1,680	2,020	2,860	2,350	1,520
Average	465	182	125	102	88	81	106	1,140	2,800	2,920	2,420	1,290
Maximum	1,480	370	246	162	140	135	283	3,120	4,300	4,760	4,120	2,650
Minimum	210	83	49	44	42	41	50	208	1,510	1,790	974	470
Median	383	177	124	101	92	83	99	967	2,820	2,820	2,360	1,170

Table A-3 – Average Monthly Flow for Susitna River near Cantwell for Pre-Project Conditions based on the USGS Extended Record

WY	Susitna River near Cantwell											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1950	3,920	1,540	842	594	452	415	501	7,260	12,600	14,500	12,700	5,160
1951	2,330	758	638	554	471	424	954	8,930	13,300	14,500	12,600	13,600
1952	3,420	1,640	1,120	940	578	507	530	3,390	20,900	17,000	13,400	9,180
1953	5,100	2,110	1,000	638	471	471	955	12,300	17,600	12,900	13,200	9,690
1954	3,440	1,240	879	758	578	447	721	11,000	16,300	13,000	16,700	8,150
1955	3,290	1,650	1,210	1,060	819	638	698	5,850	19,300	17,800	16,400	9,050
1956	3,030	1,120	758	566	560	542	548	11,300	21,400	20,200	15,800	11,700
1957	3,570	1,830	1,270	1,000	879	698	698	8,750	19,500	15,000	13,100	12,700
1958	5,100	2,400	1,970	1,160	763	667	900	8,170	16,600	14,700	14,400	4,680
1959	2,930	1,280	887	848	763	566	729	10,200	15,000	16,100	19,800	10,800
1960	4,050	1,710	1,310	1,090	850	696	759	10,000	9,840	14,800	15,200	13,100
1961	4,840	1,800	1,610	1,460	1,030	1,070	1,590	9,690	15,700	14,800	16,700	6,720
1962	3,280	1,800	1,400	1,300	1,000	940	1,200	10,000	28,300	20,900	16,000	9,410
1963	4,330	2,200	1,400	1,000	850	760	720	11,300	15,000	22,800	18,200	9,190
1964	3,850	1,300	877	644	586	429	465	2,810	34,600	17,000	11,500	5,350
1965	3,130	1,910	921	760	680	709	1,100	8,820	16,400	18,300	13,400	12,900
1966	3,120	1,000	750	700	650	650	875	4,390	18,500	12,200	12,700	6,520
1967	2,320	780	720	680	640	560	513	9,450	19,600	16,900	19,200	10,300
1968	3,080	1,490	1,330	1,230	1,200	1,200	1,220	9,270	19,500	17,500	10,900	5,410
1969	2,410	1,060	618	508	485	548	998	7,470	12,300	13,500	6,600	3,380
1970	1,640	815	543	437	426	463	887	7,580	9,910	13,900	12,300	5,210
1971	2,150	1,530	1,050	731	503	470	529	1,910	22,000	18,100	22,700	9,800
1972	4,060	2,050	1,370	1,070	922	881	876	9,690	20,000	16,700	15,600	9,420
1973	2,940	1,340	858	698	698	578	594	5,160	17,900	11,600	13,000	5,660
1974	2,260	893	598	504	446	415	574	10,400	11,400	12,000	10,300	7,720
1975	2,270	1,000	942	889	862	819	936	9,800	20,900	17,900	11,500	10,400
1976	4,800	1,180	626	563	548	519	806	7,960	15,700	12,100	12,700	4,250
1977	2,350	1,580	1,430	1,080	951	879	988	8,070	24,400	14,700	12,300	7,960
1978	4,690	2,130	1,540	1,200	981	943	1,000	7,530	12,200	13,500	10,400	5,360
1979	3,000	1,510	988	817	749	698	849	8,840	15,900	18,700	13,100	6,750
1980	4,530	2,550	1,440	1,030	858	819	984	7,490	17,400	20,500	14,900	8,570
1981	5,470	2,490	1,660	1,690	1,190	919	1,220	12,100	14,000	20,900	22,800	9,420

WY	Susitna River near Cantwell cont.											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1982	3,830	1,630	1,300	1,060	698	573	573	8,220	16,500	16,500	11,000	9,940
1983	3,310	1,600	1,400	1,300	1,200	1,150	1,210	8,200	16,500	16,200	17,000	8,660
1984	5,380	2,130	1,600	1,500	1,500	1,480	1,400	8,570	18,800	17,700	14,300	5,140
1985	2,760	1,630	1,170	990	880	844	1,030	5,540	15,800	19,900	12,700	7,520
1986	3,090	1,370	891	729	674	660	735	7,250	15,500	18,900	11,000	8,110
1987	8,020	2,080	1,150	949	890	879	1,220	8,210	14,800	19,300	13,900	8,440
1988	3,640	1,480	940	916	879	879	931	11,100	19,200	16,600	12,500	8,720
1989	4,760	1,810	1,180	1,180	1,060	1,060	1,270	8,690	17,300	15,200	14,400	9,790
1990	4,990	1,800	1,090	1,040	1,000	1,090	2,590	16,500	21,800	15,100	15,300	16,900
1991	4,270	1,460	1,310	1,120	1,060	952	948	3,750	16,500	13,600	11,700	7,780
1992	3,580	1,450	1,310	1,160	1,060	1,100	1,250	3,800	14,900	16,500	13,500	6,380
1993	2,660	1,640	1,210	1,100	1,030	963	1,520	13,400	15,100	12,400	12,000	13,700
1994	6,210	2,000	1,510	1,220	1,050	895	1,950	9,260	20,000	13,400	11,900	5,850
1995	2,760	1,660	1,240	1,090	1,010	1,000	1,710	11,300	15,900	16,400	11,700	12,200
1996	4,000	1,590	844	727	690	638	789	4,120	9,970	10,200	10,900	6,520
1997	2,080	1,140	1,010	907	817	730	900	6,000	12,200	15,600	15,800	8,520
1998	2,360	1,030	848	735	689	644	969	5,990	15,700	16,500	14,600	10,200
1999	4,740	1,790	1,230	968	740	592	743	5,840	14,700	14,600	16,200	7,060
2000	4,200	1,830	1,180	947	839	759	964	7,190	19,900	18,700	10,400	9,770
2001	4,980	1,810	1,230	1,030	884	792	902	5,640	20,100	14,200	14,000	6,490
2002	2,950	1,570	1,120	908	832	760	776	7,320	10,500	11,600	15,300	10,300
2003	6,870	3,300	1,550	973	1,330	886	1,300	5,000	15,700	18,800	13,600	8,560
2004	5,050	1,490	1,070	862	744	626	1,640	15,200	16,300	12,900	11,300	3,980
2005	1,990	1,020	946	842	722	605	1,580	17,400	22,200	17,300	14,100	14,700
2006	5,130	1,270	877	819	812	795	900	10,100	15,000	14,900	19,700	7,750
2007	6,530	1,890	1,380	1,200	1,120	1,030	1,350	11,000	12,600	13,800	12,300	8,540
2008	3,070	1,940	1,680	1,090	784	795	982	7,480	13,500	14,100	12,600	9,190
2009	3,400	909	758	810	758	783	2,800	14,700	14,900	12,400	11,800	7,870
2010	4,410	1,680	1,090	860	789	761	1,090	12,600	12,800	17,800	12,900	10,100
Average	3,800	1,600	1,130	938	820	755	1,030	8,630	16,900	15,800	13,900	8,620
Maximum	8,020	3,300	1,970	1,690	1,500	1,480	2,800	17,400	34,600	22,800	22,800	16,900
Minimum	1,640	758	543	437	426	415	465	1,910	9,840	10,200	6,600	3,380
Median	3,570	1,600	1,120	947	817	759	948	8,570	16,300	15,600	13,200	8,560

Table A-4 – Average Monthly Flow for Susitna River at Gold Creek for Pre-Project Conditions based on the USGS Extended Record

WY	Susitna River at Gold Creek											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1950	6,330	2,580	1,440	1,030	788	726	870	11,500	19,600	22,600	19,900	8,300
1951	3,850	1,300	1,100	960	820	740	1,620	14,100	20,800	22,600	19,700	21,200
1952	5,570	2,740	1,900	1,600	1,000	880	920	5,420	32,400	26,400	20,900	14,500
1953	8,200	3,500	1,700	1,100	820	820	1,620	19,300	27,300	20,200	20,600	15,300
1954	5,600	2,100	1,500	1,300	1,000	780	1,240	17,300	25,300	20,400	26,100	12,900
1955	5,370	2,760	2,050	1,790	1,400	1,100	1,200	9,320	29,900	27,600	25,800	14,300
1956	4,950	1,900	1,300	980	970	940	950	17,700	33,300	31,100	24,500	18,300
1957	5,810	3,050	2,140	1,700	1,500	1,200	1,200	13,800	30,200	23,300	20,500	19,800
1958	8,210	3,950	3,260	1,960	1,310	1,150	1,530	12,900	25,700	22,900	22,500	7,550
1959	4,810	2,150	1,510	1,450	1,310	980	1,250	16,000	23,300	25,000	31,200	16,900
1960	6,560	2,850	2,200	1,850	1,450	1,200	1,300	15,800	15,500	23,000	23,600	20,500
1961	7,790	3,000	2,690	2,450	1,750	1,810	2,650	17,400	29,500	24,600	22,100	13,400
1962	5,920	2,700	2,100	1,900	1,500	1,400	1,700	12,600	43,300	25,900	23,600	15,900
1963	6,720	2,800	2,000	1,600	1,500	1,000	830	19,000	26,000	34,400	23,700	12,300
1964	6,450	2,250	1,490	1,050	966	713	745	4,310	50,600	22,900	16,400	9,570
1965	6,290	2,800	1,210	960	860	900	1,360	13,000	25,700	27,800	21,100	19,400
1966	7,210	2,100	1,630	1,400	1,300	1,300	1,780	9,650	33,000	19,900	21,800	11,800
1967	4,160	1,600	1,500	1,500	1,400	1,200	1,170	15,500	29,500	26,800	32,600	16,900
1968	4,900	2,350	2,050	1,980	1,900	1,900	1,910	16,200	31,600	26,400	17,200	8,820
1969	3,820	1,630	882	724	723	816	1,510	11,000	15,500	16,100	8,880	5,090
1970	3,120	1,220	866	824	768	776	1,080	11,400	18,600	22,700	20,000	9,120
1971	5,290	3,410	2,290	1,440	1,040	950	1,080	3,750	32,900	23,900	31,900	14,400
1972	5,850	3,090	2,510	2,240	2,030	1,820	1,710	21,900	34,400	22,800	19,300	12,400
1973	4,830	2,250	1,460	1,200	1,200	1,000	1,030	8,240	27,800	18,300	20,300	9,070
1974	3,730	1,520	1,030	874	777	724	992	16,200	17,900	18,800	16,200	12,200
1975	3,740	1,700	1,600	1,520	1,470	1,400	1,590	15,400	32,300	27,700	18,100	16,300
1976	7,740	1,990	1,080	974	950	900	1,370	12,600	24,400	18,900	19,800	6,880
1977	3,870	2,650	2,400	1,830	1,620	1,500	1,680	12,700	38,000	22,900	19,200	12,600
1978	7,570	3,530	2,590	2,030	1,670	1,600	1,700	11,900	19,100	21,000	16,400	8,610
1979	4,910	2,530	1,680	1,400	1,290	1,200	1,450	13,900	24,700	28,900	20,500	10,800
1980	7,310	4,190	2,420	1,750	1,470	1,400	1,670	12,100	29,100	32,700	21,000	13,300
1981	7,720	3,570	1,910	2,010	1,980	1,590	2,040	16,600	19,300	33,900	37,900	13,800

WY	Susitna River at Gold Creek cont.											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1982	7,460	3,260	1,880	1,680	1,490	1,350	1,780	13,400	26,100	24,100	15,300	17,800
1983	6,890	2,630	2,360	2,260	2,000	1,690	1,900	14,900	24,500	21,100	24,500	13,600
1984	8,300	3,150	2,260	2,050	1,970	1,900	1,810	13,000	26,800	23,500	20,400	9,430
1985	5,670	3,090	2,390	1,940	1,640	1,730	1,980	11,200	26,300	26,500	19,900	15,600
1986	6,940	2,670	1,930	1,660	1,560	1,390	1,570	12,100	20,000	21,900	17,300	12,900
1987	12,700	3,450	1,950	1,610	1,520	1,500	2,050	13,000	23,000	29,900	21,800	13,300
1988	5,920	2,480	1,600	1,560	1,500	1,500	1,590	17,400	29,700	25,700	19,500	13,800
1989	7,670	3,010	2,000	2,000	1,800	1,800	2,140	13,700	26,800	23,700	22,400	15,400
1990	8,030	3,000	1,850	1,760	1,700	1,850	4,250	25,600	33,800	23,500	23,700	26,500
1991	6,900	2,450	2,200	1,900	1,800	1,620	1,610	6,050	25,600	21,200	18,300	12,300
1992	5,820	2,440	2,200	1,960	1,800	1,870	2,100	6,100	23,100	25,500	21,100	10,200
1993	4,380	2,730	2,040	1,860	1,750	1,640	2,540	20,900	23,500	19,300	18,700	21,300
1994	9,910	3,330	2,530	2,060	1,790	1,530	3,220	14,600	31,100	21,000	18,600	9,360
1995	4,530	2,780	2,100	1,850	1,720	1,700	2,850	17,700	24,700	25,500	18,400	19,100
1996	6,480	2,660	1,440	1,250	1,190	1,100	1,350	6,610	15,700	16,000	17,100	10,400
1997	3,510	1,960	1,750	1,630	1,510	1,400	1,640	9,660	19,100	24,400	24,700	13,600
1998	3,940	1,780	1,550	1,410	1,350	1,290	1,750	9,620	24,600	25,800	22,800	16,200
1999	7,740	3,040	2,110	1,700	1,420	1,220	1,410	9,380	23,100	22,900	25,400	11,400
2000	6,890	3,100	2,020	1,670	1,540	1,440	1,720	11,500	31,300	29,500	16,400	15,500
2001	8,110	3,070	2,100	1,770	1,590	1,480	1,620	9,020	31,000	22,000	21,800	10,400
2002	4,840	2,630	1,900	1,550	1,420	1,300	1,330	11,500	16,500	18,100	23,800	16,300
2003	11,000	5,390	2,590	1,650	2,240	1,510	2,170	8,020	24,300	29,200	21,100	13,500
2004	8,110	2,500	1,810	1,470	1,280	1,080	2,730	23,600	25,300	20,200	17,700	6,450
2005	3,300	1,730	1,610	1,440	1,240	1,050	2,610	26,900	34,300	26,800	22,000	22,900
2006	8,240	2,140	1,500	1,400	1,390	1,360	1,540	15,700	23,300	23,100	30,800	12,300
2007	10,400	3,140	2,320	2,020	1,910	1,740	2,270	17,200	19,700	21,600	19,300	13,500
2008	5,020	3,220	2,810	1,840	1,340	1,360	1,670	11,900	21,100	22,000	19,700	14,500
2009	5,530	1,550	1,300	1,390	1,300	1,340	4,550	22,900	23,100	19,400	18,500	12,500
2010	7,120	2,810	1,840	1,470	1,350	1,300	1,850	19,600	20,000	27,500	20,100	15,800
Average	6,320	2,670	1,890	1,590	1,420	1,300	1,740	13,800	26,300	24,000	21,400	13,700
Maximum	12,700	5,390	3,260	2,450	2,240	1,900	4,550	26,900	50,600	34,400	37,900	26,500
Minimum	3,120	1,220	866	724	723	713	745	3,750	15,500	16,000	8,880	5,090
Median	6,290	2,700	1,910	1,630	1,450	1,340	1,620	13,000	25,600	23,300	20,500	13,500

Table A-5 – Average Monthly Flow for Chulitna River near Talkeetna for Pre-Project Conditions based on the USGS Extended Record

WY	Chulitna River near Talkeetna											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1950	5,320	1,870	1,130	1,020	924	903	959	10,500	18,200	21,500	18,900	7,080
1951	2,970	1,100	1,040	993	942	910	1,340	13,000	19,000	21,700	18,700	19,400
1952	4,530	1,990	1,300	1,180	1,010	965	979	4,620	26,200	23,400	18,900	13,100
1953	7,010	2,630	1,200	1,040	942	942	1,350	17,900	23,900	19,400	19,600	14,200
1954	4,540	1,460	1,150	1,100	1,010	926	1,070	16,500	23,400	19,400	23,800	11,700
1955	4,290	2,000	1,420	1,280	1,130	1,040	1,070	8,320	24,500	24,100	21,800	13,200
1956	3,930	1,330	1,100	1,000	997	986	990	15,500	26,300	25,900	22,000	17,000
1957	4,700	2,240	1,490	1,200	1,150	1,070	1,070	12,100	24,900	22,000	19,800	18,800
1958	6,990	3,020	2,430	1,390	1,040	948	1,220	10,500	23,200	25,000	20,800	8,000
1959	4,200	1,880	1,260	1,100	1,050	738	890	7,410	23,700	25,700	22,100	9,960
1960	4,720	2,280	1,700	1,450	1,100	933	1,000	13,900	17,400	23,700	19,300	12,400
1961	5,140	1,950	1,750	1,450	1,100	1,080	1,600	10,100	20,500	27,400	24,600	16,000
1962	5,780	2,400	1,500	1,300	1,000	930	1,170	7,740	20,600	27,200	22,000	13,500
1963	3,510	1,500	1,550	1,600	1,300	846	700	11,100	17,700	28,900	18,400	11,300
1964	8,060	2,300	1,000	1,010	820	770	1,130	2,350	40,300	24,400	20,300	9,230
1965	5,640	2,900	2,100	1,600	1,400	1,300	1,400	7,450	20,100	23,200	22,500	22,300
1966	6,070	1,620	1,350	1,200	1,100	1,100	1,300	3,970	21,700	23,700	27,700	12,200
1967	4,680	1,680	1,500	1,460	1,260	1,050	972	12,400	25,500	35,600	33,700	12,500
1968	3,480	1,660	1,400	1,240	1,200	1,150	1,350	10,900	29,000	30,100	20,700	7,380
1969	2,900	1,480	1,140	974	900	824	1,330	6,000	18,600	20,800	11,300	6,700
1970	4,580	1,890	1,320	1,200	1,150	1,100	1,440	9,640	19,700	26,100	24,700	11,300
1971	3,830	2,210	1,400	1,110	950	934	982	4,470	22,200	27,300	23,800	11,100
1972	5,440	2,160	1,430	1,170	1,040	939	893	9,760	17,900	25,800	21,000	12,100
1973	5,520	2,130	1,440	1,260	1,170	1,110	1,110	6,610	21,100	19,700	20,500	8,990
1974	3,720	1,910	1,490	1,300	1,190	1,100	1,200	10,800	17,600	20,700	20,000	13,300
1975	6,120	2,380	1,550	1,310	1,150	1,100	1,110	7,480	23,400	26,500	19,600	15,400
1976	6,320	1,560	1,110	1,020	977	960	1,110	7,480	20,400	21,400	21,200	7,170
1977	3,810	2,090	1,780	1,290	1,160	1,120	1,160	7,620	27,200	22,800	21,400	13,100
1978	6,030	2,470	1,760	1,450	1,240	1,120	1,170	7,280	16,600	23,500	18,900	9,800
1979	3,520	2,120	1,590	1,340	1,220	1,150	1,340	13,000	22,900	26,100	20,700	11,600
1980	8,020	3,620	1,950	1,610	1,410	1,300	1,680	9,140	22,500	34,900	20,800	8,240
1981	5,710	3,210	2,020	1,620	1,410	1,170	1,440	9,970	22,400	29,900	33,200	12,000

WY	Chulitna River near Talkeetna cont.											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1982	4,830	2,250	1,220	1,030	873	789	1,070	6,290	18,400	25,600	20,400	18,200
1983	5,500	2,510	1,850	1,570	1,040	1,050	1,250	8,880	18,900	22,300	22,200	11,000
1984	8,620	2,920	2,390	2,050	1,510	1,260	1,380	7,310	18,600	22,300	22,800	9,920
1985	4,730	2,670	2,160	1,900	1,400	1,160	1,130	5,710	18,900	27,100	20,800	13,200
1986	6,360	1,900	1,480	1,320	1,130	959	956	4,750	14,700	22,800	17,900	14,800
1987	17,600	4,070	2,210	1,600	1,410	1,300	1,770	11,000	20,800	23,500	20,700	11,600
1988	3,490	2,240	1,880	1,580	1,370	1,240	1,230	11,600	21,800	21,300	17,700	11,100
1989	5,210	2,230	1,880	1,370	1,200	1,170	1,230	7,650	22,800	18,600	25,000	18,700
1990	8,810	3,120	2,060	1,940	1,930	2,070	3,910	22,300	25,900	18,700	18,900	21,100
1991	4,570	1,580	1,320	1,240	975	877	1,520	13,100	25,700	21,100	14,000	8,730
1992	3,890	1,330	1,150	1,090	1,080	1,130	1,360	5,870	22,200	23,700	18,500	8,570
1993	3,160	2,400	1,870	1,390	1,170	1,100	1,820	19,900	23,900	20,600	18,300	24,000
1994	11,200	3,360	1,880	1,520	1,330	1,140	2,110	15,400	26,300	19,300	19,400	6,350
1995	3,680	1,900	1,490	1,270	1,170	1,160	1,290	14,800	21,600	22,000	16,600	16,700
1996	5,200	2,140	1,150	1,050	1,020	1,060	1,520	10,200	13,600	17,900	18,600	7,660
1997	2,850	1,560	1,350	1,250	1,160	1,070	1,280	8,150	16,700	22,000	22,400	11,600
1998	3,220	1,390	1,190	1,080	1,030	984	1,370	8,280	22,000	23,500	20,300	13,900
1999	6,440	2,460	1,690	1,320	1,080	928	1,080	7,900	20,800	20,300	22,800	9,560
2000	5,720	2,510	1,610	1,290	1,180	1,100	1,340	9,720	28,200	26,600	14,000	13,400
2001	6,770	2,480	1,680	1,380	1,230	1,130	1,250	7,790	25,100	17,500	18,500	8,910
2002	4,150	1,830	1,310	1,150	1,090	1,010	1,020	14,100	14,400	16,000	21,400	19,100
2003	12,600	4,970	2,020	1,050	1,120	989	2,150	9,600	21,400	24,600	18,200	9,630
2004	6,130	2,760	1,570	1,300	1,160	1,080	1,720	16,700	19,500	20,000	16,100	6,290
2005	5,810	2,440	1,510	1,330	1,200	1,310	4,130	27,000	29,500	23,400	19,500	22,600
2006	7,910	1,700	1,480	1,330	1,120	1,080	1,200	9,870	16,700	19,800	24,700	11,900
2007	13,100	2,940	1,310	1,100	940	828	1,550	6,930	12,000	19,000	19,000	14,700
2008	5,620	2,080	1,250	1,070	985	988	1,150	8,120	18,700	18,500	18,900	11,900
2009	5,090	1,690	1,340	1,300	1,160	1,130	1,700	17,000	19,500	17,800	14,800	9,780
2010	7,490	3,390	1,610	1,310	1,200	1,120	1,550	9,790	15,200	21,600	20,500	12,700
Average	5,750	2,260	1,550	1,300	1,140	1,060	1,370	10,400	21,500	23,200	20,600	12,600
Maximum	17,600	4,970	2,430	2,050	1,930	2,070	4,130	27,000	40,300	35,600	33,700	24,000
Minimum	2,850	1,100	1,000	974	820	738	700	2,350	12,000	16,000	11,300	6,290
Median	5,210	2,160	1,490	1,290	1,130	1,070	1,250	9,720	21,400	22,800	20,400	11,900

Table A-6 – Average Monthly Flow for Talkeetna River near Talkeetna for Pre-Project Conditions based on the USGS Extended Record

WY	Talkeetna River near Talkeetna											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1950	2,580	1,020	591	507	459	449	477	4,780	8,240	9,550	8,370	3,400
1951	1,540	550	519	495	469	452	700	5,880	8,770	9,540	8,280	8,960
1952	2,260	1,080	741	621	502	480	488	2,240	13,800	11,200	8,830	6,040
1953	3,360	1,390	661	519	469	469	697	8,100	11,600	8,500	8,680	6,370
1954	2,270	822	581	550	502	460	550	7,250	10,700	8,570	11,100	5,360
1955	2,170	1,090	800	698	564	519	535	3,850	12,700	11,700	11,000	5,950
1956	1,990	742	550	499	497	491	493	7,450	14,300	13,300	10,400	7,700
1957	2,350	1,210	839	661	581	535	535	5,760	12,900	9,850	8,650	8,330
1958	3,360	1,580	1,300	767	536	498	617	5,170	10,400	10,200	9,300	3,570
1959	2,020	896	632	559	537	428	489	5,040	10,000	10,700	11,300	5,860
1960	2,490	1,130	855	722	562	497	524	6,410	7,270	9,970	9,220	7,140
1961	2,840	1,070	959	833	611	615	910	5,990	10,600	11,000	9,940	6,550
1962	2,660	1,140	782	692	537	510	620	4,430	13,400	11,200	9,740	6,430
1963	2,190	911	778	719	619	459	405	6,370	9,370	13,200	9,070	5,340
1964	3,370	1,030	547	507	450	413	516	1,470	17,100	9,820	8,400	3,820
1965	3,120	1,570	1,100	720	620	540	580	3,470	11,100	12,200	11,200	10,600
1966	4,440	1,460	876	711	526	395	422	2,410	13,000	10,100	10,700	5,370
1967	2,390	897	750	637	546	471	427	4,110	9,290	12,600	14,200	6,970
1968	2,030	1,250	987	851	777	743	983	8,840	14,100	11,200	7,550	4,120
1969	1,640	827	556	459	401	380	519	3,870	5,210	7,080	3,790	2,070
1970	1,450	765	587	504	458	440	545	3,950	7,980	10,300	8,750	5,990
1971	2,820	1,650	1,100	679	459	402	503	2,140	19,000	11,800	16,800	5,990
1972	2,630	1,310	845	727	628	481	519	3,520	12,700	12,000	9,580	8,710
1973	3,630	1,370	889	748	654	574	577	3,860	12,200	7,680	9,930	3,860
1974	1,810	960	745	645	559	482	535	5,680	8,030	7,750	7,700	4,760
1975	1,970	1,000	774	694	586	508	522	4,080	13,200	12,100	8,490	7,960
1976	2,880	773	558	524	480	470	613	3,440	10,600	9,030	8,090	3,210
1977	1,860	1,100	1,070	700	549	506	548	4,240	18,300	9,340	8,000	5,960
1978	3,270	1,120	860	746	576	485	534	2,950	7,430	10,800	7,000	3,570
1979	1,660	1,140	932	762	652	577	710	7,790	12,000	14,400	8,270	4,040
1980	3,380	1,720	868	808	741	700	1,040	4,820	11,400	13,900	7,220	5,400
1981	2,600	1,140	717	652	535	545	671	4,530	6,590	15,400	14,700	4,380

WY	Talkeetna River near Talkeetna cont.											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1982	2,350	1,240	708	650	467	285	480	3,310	12,900	11,100	7,270	9,560
1983	3,350	1,240	1,080	836	580	565	669	4,550	9,010	8,700	8,800	3,940
1984	3,280	1,100	781	690	626	600	555	4,010	9,330	8,900	9,760	3,820
1985	2,200	1,160	897	717	548	498	522	4,170	10,400	11,100	10,200	8,430
1986	3,320	1,000	783	681	590	400	396	2,540	6,210	9,150	8,030	6,890
1987	10,000	1,990	1,120	832	737	659	894	5,060	9,710	11,100	9,870	5,360
1988	1,720	1,140	965	818	707	606	595	5,270	10,100	9,670	7,970	5,120
1989	2,500	1,130	965	697	577	550	600	3,630	10,700	8,360	12,400	8,550
1990	4,100	1,550	1,050	996	990	1,060	1,910	11,500	13,100	8,450	8,710	11,000
1991	2,210	820	673	610	407	340	716	6,160	12,800	9,970	6,360	4,080
1992	1,900	672	540	494	480	521	690	2,800	10,400	11,200	8,530	3,990
1993	1,570	1,210	961	716	552	502	907	10,200	11,600	9,210	8,390	12,100
1994	5,150	1,660	968	790	675	531	1,050	6,920	13,600	8,640	8,830	3,010
1995	1,810	973	773	637	548	540	629	6,740	10,300	10,200	7,480	7,630
1996	2,500	1,090	538	457	440	467	749	4,720	6,180	8,070	8,370	3,600
1997	1,420	808	698	616	545	478	609	3,790	7,610	10,200	10,500	5,380
1998	1,590	718	569	481	446	413	660	3,990	10,400	11,100	9,240	6,330
1999	3,060	1,240	873	666	486	374	492	3,670	9,690	9,480	11,400	4,440
2000	2,740	1,270	834	648	562	500	658	4,490	15,200	13,800	6,340	6,230
2001	3,200	1,250	869	715	598	525	613	3,620	12,300	8,010	8,360	4,150
2002	2,020	943	665	539	493	430	439	7,200	6,540	7,210	10,100	8,700
2003	5,740	2,400	1,020	464	513	417	1,020	4,440	9,840	12,000	8,270	4,460
2004	2,920	1,380	816	656	541	482	843	7,530	8,710	8,950	7,230	2,990
2005	2,780	1,230	777	682	579	666	1,970	14,200	16,500	10,900	8,700	11,000
2006	3,700	880	771	671	514	479	573	4,680	7,700	9,050	13,300	5,440
2007	6,150	1,460	665	500	382	309	717	3,270	5,480	8,520	8,590	6,700
2008	2,690	1,060	615	479	414	416	531	3,790	8,520	8,460	8,540	5,440
2009	2,450	873	694	654	547	517	823	7,790	8,870	7,960	6,710	4,540
2010	3,530	1,680	834	665	575	515	763	4,500	6,860	9,930	9,220	5,800
Average	2,840	1,160	801	655	553	502	670	5,120	10,700	10,300	9,210	5,940
Maximum	10,000	2,400	1,300	996	990	1,060	1,970	14,200	19,000	15,400	16,800	12,100
Minimum	1,420	550	519	457	382	285	396	1,470	5,210	7,080	3,790	2,070
Median	2,580	1,130	782	666	547	491	595	4,500	10,400	9,970	8,710	5,440

Table A-7 – Average Monthly Flow for Susitna River at Sunshine for Pre-Project Conditions based on the USGS Extended Record

WY	Susitna River at Sunshine											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1950	15,000	5,820	3,150	2,210	1,670	1,530	1,860	28,100	48,400	56,400	49,500	19,800
1951	8,860	2,830	2,370	2,060	1,740	1,560	3,580	34,600	51,300	56,600	48,900	52,300
1952	13,100	6,200	4,210	3,520	2,150	1,880	1,970	13,000	77,200	64,900	51,400	35,400
1953	19,600	8,000	3,750	2,370	1,740	1,740	3,580	47,700	66,800	50,300	51,300	37,600
1954	13,100	4,680	3,280	2,830	2,150	1,650	2,690	42,900	63,000	50,700	64,500	31,500
1955	12,600	6,230	4,550	3,970	3,060	2,370	2,600	22,600	71,500	67,500	61,800	35,100
1956	11,500	4,220	2,830	2,100	2,080	2,010	2,030	43,000	78,900	75,200	60,700	45,600
1957	13,600	6,920	4,780	3,750	3,280	2,600	2,600	33,500	72,500	58,100	51,200	49,300
1958	19,600	9,100	7,440	4,360	2,850	2,480	3,370	31,700	63,800	57,000	54,500	18,000
1959	11,200	4,800	3,320	3,170	2,850	2,100	2,720	38,900	58,200	62,200	73,400	40,900
1960	15,500	6,450	4,910	4,080	3,170	2,590	2,830	38,400	38,200	56,400	58,800	50,300
1961	18,600	6,810	6,070	5,500	3,870	4,000	5,970	43,000	70,300	61,700	55,200	32,700
1962	14,000	6,090	4,680	4,210	3,280	3,060	3,750	30,600	97,200	64,400	59,000	39,000
1963	15,900	6,320	4,440	3,520	3,280	2,150	1,760	45,100	65,300	81,300	58,800	30,000
1964	15,200	5,030	3,280	2,260	2,070	1,510	1,580	10,000	103,000	58,700	44,700	23,800
1965	16,600	7,460	3,900	2,790	2,460	2,410	3,230	28,800	64,100	68,900	55,600	51,900
1966	20,700	6,060	4,190	3,500	3,050	2,850	3,690	21,500	76,200	52,500	57,200	30,800
1967	11,400	4,170	3,740	3,540	3,240	2,800	2,670	35,200	68,500	66,600	76,200	42,200
1968	12,000	6,110	5,110	4,730	4,460	4,400	4,850	41,900	76,000	66,200	44,900	23,000
1969	9,370	4,100	2,400	2,000	1,910	2,030	3,400	26,500	37,500	42,100	22,600	12,400
1970	7,810	3,290	2,420	2,230	2,070	2,050	2,710	27,600	47,400	58,600	51,600	26,700
1971	14,200	8,670	5,720	3,530	2,510	2,280	2,650	10,300	79,300	61,600	76,000	36,700
1972	14,800	7,490	5,620	4,950	4,420	3,850	3,720	44,900	78,000	60,600	51,400	36,900
1973	14,900	6,160	3,930	3,240	3,070	2,620	2,670	21,700	67,600	47,200	53,000	23,000
1974	9,550	4,160	2,950	2,520	2,240	2,040	2,560	38,000	46,900	48,500	43,000	30,600
1975	9,870	4,530	3,950	3,660	3,420	3,180	3,530	34,700	76,400	69,000	47,900	43,400
1976	18,700	4,630	2,730	2,510	2,400	2,300	3,330	28,800	61,400	50,300	50,200	17,800
1977	9,870	6,340	5,850	4,200	3,610	3,350	3,720	30,100	88,000	57,900	49,500	33,600
1978	19,100	7,890	5,790	4,620	3,730	3,490	3,730	26,600	48,200	56,200	42,400	21,600
1979	11,300	6,210	4,380	3,590	3,210	2,960	3,610	37,100	63,400	72,200	51,600	26,500
1980	18,900	10,200	5,500	4,260	3,660	3,480	4,560	30,300	69,700	77,400	51,200	33,000
1981	18,200	8,010	4,380	4,430	4,200	3,550	4,530	36,200	50,900	85,600	84,900	32,500

WY	Susitna River at Sunshine cont.											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1982	16,500	7,030	4,040	3,500	3,230	2,880	3,800	26,600	62,800	63,000	45,600	48,800
1983	16,200	6,300	5,610	5,220	4,660	3,480	4,200	31,400	58,100	55,400	60,600	30,000
1984	21,300	8,270	5,550	4,900	4,600	4,500	4,550	25,900	59,300	59,100	58,700	23,900
1985	12,400	6,250	4,880	4,560	3,820	3,750	4,090	25,800	60,900	68,000	55,000	40,800
1986	16,700	6,080	4,310	3,700	3,380	2,880	3,100	22,000	46,900	56,000	45,900	35,200
1987	36,600	9,390	5,180	4,080	3,740	3,580	4,940	32,600	58,200	71,200	55,500	33,600
1988	13,300	6,120	4,300	3,960	3,660	3,500	3,640	41,100	69,900	63,500	50,100	34,200
1989	17,900	7,030	4,970	4,490	3,960	3,920	4,570	30,900	65,900	58,500	60,100	42,800
1990	21,600	7,780	4,870	4,630	4,510	4,890	10,700	62,800	78,400	57,900	58,300	63,200
1991	16,000	5,470	4,780	4,170	3,700	3,290	3,920	21,200	66,000	55,400	44,900	29,400
1992	13,400	5,200	4,580	4,110	3,810	3,990	4,650	15,600	59,800	64,500	53,300	25,300
1993	10,200	6,690	5,030	4,290	3,840	3,580	5,820	53,200	61,100	51,500	48,800	56,800
1994	27,000	8,550	5,880	4,750	4,090	3,430	7,290	38,900	74,400	53,800	49,200	22,000
1995	10,900	6,320	4,790	4,140	3,780	3,740	5,850	44,000	61,100	63,600	47,100	48,200
1996	15,800	6,340	3,300	2,860	2,730	2,630	3,510	20,300	39,700	43,400	46,100	25,000
1997	9,510	5,330	4,600	4,120	3,740	3,370	4,150	25,800	50,600	64,000	64,700	36,100
1998	10,700	4,730	3,860	3,380	3,190	3,000	4,480	25,500	64,300	67,200	60,000	42,800
1999	20,800	8,270	5,770	4,420	3,410	2,770	3,440	25,000	60,500	60,100	65,800	30,300
2000	18,500	8,430	5,500	4,300	3,830	3,490	4,420	30,700	79,600	75,500	43,500	41,000
2001	21,700	8,340	5,740	4,710	4,020	3,630	4,120	23,600	73,900	54,200	54,300	25,900
2002	11,900	6,010	4,260	3,480	3,200	2,900	2,960	31,800	42,000	46,200	59,300	44,600
2003	30,000	13,600	6,090	3,550	4,630	3,230	5,470	22,200	61,300	70,600	52,900	32,400
2004	19,500	6,600	4,380	3,520	3,030	2,620	6,070	56,000	61,800	52,800	45,500	16,600
2005	10,600	5,010	3,970	3,510	3,030	2,840	7,970	68,800	81,900	66,300	55,900	59,200
2006	21,200	5,060	3,770	3,440	3,180	3,080	3,510	36,100	54,800	58,200	72,600	31,900
2007	29,300	7,850	4,980	4,220	3,840	3,450	5,060	36,900	45,900	54,800	50,300	36,400
2008	13,500	7,250	5,750	3,880	2,950	2,980	3,680	28,100	53,600	54,800	50,900	36,100
2009	13,900	4,040	3,300	3,380	3,080	3,100	9,340	54,900	57,600	49,800	45,900	30,600
2010	18,800	7,680	4,460	3,530	3,200	3,040	4,370	44,000	48,900	66,200	52,700	39,200
Average	15,900	6,490	4,490	3,720	3,260	2,960	4,030	33,200	63,700	60,500	54,200	34,900
Maximum	36,600	13,600	7,440	5,500	4,660	4,890	10,700	68,800	103,000	85,600	84,900	63,200
Minimum	7,810	2,830	2,370	2,000	1,670	1,510	1,580	10,000	37,500	42,100	22,600	12,400
Median	15,000	6,300	4,460	3,700	3,240	2,980	3,690	31,400	63,000	58,700	52,700	33,600

Table A-8 – Average Monthly Flow for Willow Creek near Willow for Pre-Project Conditions based on the USGS Extended Record

WY	Willow Creek near Willow											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1950	290	132	87	73	52	56	55	141	886	658	559	326
1951	166	97	88	78	63	52	65	422	1,140	848	774	923
1952	298	130	99	69	45	43	48	300	1,480	1,120	753	686
1953	292	192	104	88	62	51	65	503	1,060	534	763	476
1954	196	123	88	63	51	43	55	400	563	679	852	560
1955	278	142	54	60	50	38	34	200	1,080	1,280	914	529
1956	200	103	78	61	51	34	51	279	971	1,010	704	556
1957	201	143	92	71	59	36	54	626	1,130	584	436	896
1958	355	193	115	72	63	47	60	315	703	472	569	277
1959	249	117	89	54	50	47	52	405	1,270	807	1,130	563
1960	249	139	87	84	60	43	58	651	719	672	661	643
1961	282	152	117	135	73	54	62	373	1,010	872	790	637
1962	328	161	91	100	79	73	74	300	1,500	959	872	617
1963	227	125	102	92	72	67	71	554	1,350	1,590	1,290	406
1964	349	149	104	79	68	60	72	163	1,450	801	559	369
1965	272	156	112	87	77	75	94	256	838	859	780	1,000
1966	369	172	124	86	74	63	68	197	925	660	721	444
1967	247	170	113	78	69	64	68	472	1,260	1,040	889	577
1968	207	122	93	85	83	79	77	643	1,430	1,000	459	257
1969	132	72	60	71	67	56	65	348	550	474	351	195
1970	183	121	92	76	62	60	60	383	728	748	753	405
1971	263	173	115	86	72	56	57	133	1,080	1,030	1,330	367
1972	215	159	97	88	75	60	56	254	1,370	1,190	563	706
1973	422	191	117	89	79	73	71	323	1,100	678	698	344
1974	210	132	100	91	79	60	63	654	1,060	725	483	368
1975	222	143	99	85	75	65	63	283	1,190	1,170	639	882
1976	329	162	119	81	70	58	61	267	1,150	758	433	235
1977	183	133	118	88	75	66	73	356	1,800	1,030	483	801
1978	374	154	126	83	73	60	76	291	647	607	307	259
1979	232	91	110	83	74	75	100	1,050	1,430	1,150	398	368
1980	402	364	152	112	85	73	102	473	1,410	1,290	955	700
1981	288	127	57	57	53	58	86	481	484	1,020	1,290	367

WY	Willow Creek near Willow cont.											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1982	398	177	99	96	74	34	75	579	1,190	816	500	1,080
1983	409	150	119	94	78	64	103	600	889	338	766	565
1984	631	170	118	95	84	72	75	394	828	579	537	380
1985	177	82	69	66	70	67	66	340	1,340	1,230	1,130	952
1986	419	131	91	69	53	42	51	371	608	669	612	705
1987	1,200	191	137	101	77	61	87	497	823	573	581	632
1988	264	96	80	67	74	62	88	632	997	672	563	587
1989	408	185	128	90	74	69	141	577	1,140	541	784	808
1990	475	215	138	109	99	98	205	1,580	1,500	481	378	1,140
1991	321	181	144	104	83	71	89	782	1,230	704	402	463
1992	269	165	126	93	73	59	67	456	1,260	582	440	437
1993	188	102	76	62	60	64	75	968	1,020	356	439	1,180
1994	508	248	141	110	105	65	100	501	1,540	727	538	365
1995	263	154	121	97	80	72	100	574	1,040	691	524	592
1996	254	136	106	82	68	56	72	397	528	392	525	313
1997	169	147	101	82	74	68	82	455	923	488	666	538
1998	237	141	119	100	88	80	91	308	965	608	773	509
1999	321	166	124	100	83	70	64	280	941	626	700	425
2000	344	198	149	112	93	76	86	375	1,340	1,060	607	700
2001	351	181	126	89	75	66	78	376	1,470	660	457	325
2002	190	95	71	60	56	50	46	664	662	310	666	905
2003	794	246	130	94	134	59	98	328	790	496	469	401
2004	449	169	83	70	58	50	85	829	634	228	210	340
2005	622	164	123	111	92	75	258	1,620	1,580	701	651	1,260
2006	403	100	71	60	54	51	50	555	928	558	1,680	654
2007	790	212	115	79	66	50	84	359	580	362	412	632
2008	300	119	72	60	52	51	66	414	822	745	553	505
2009	262	127	103	88	57	50	117	943	708	337	370	290
2010	354	134	106	94	69	48	74	457	541	563	528	529
Average	332	153	105	84	71	60	79	487	1,040	745	666	573
Maximum	1,200	364	152	135	134	98	258	1,620	1,800	1,590	1,680	1,260
Minimum	132	72	54	54	45	34	34	133	484	228	210	195
Median	288	149	104	85	73	60	72	405	1,040	679	607	538

Table A-9 – Average Monthly Flow for Skwentna River near Skwentna for Pre-Project Conditions based on the USGS Extended Record

WY	Skwentna River near Skwentna											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1950	4,510	1,950	1,120	813	631	585	694	7,950	13,100	15,100	13,400	5,870
1951	2,830	1,020	867	762	657	596	1,240	9,650	13,800	15,100	13,300	14,100
1952	4,010	2,060	1,460	1,240	792	702	732	3,790	19,700	17,000	13,800	9,880
1953	5,790	2,590	1,310	867	657	657	1,240	12,900	17,500	13,600	13,900	10,400
1954	4,040	1,600	1,160	1,020	792	626	968	11,700	16,700	13,700	16,900	8,920
1955	3,890	2,070	1,560	1,380	1,090	867	942	6,490	18,400	17,700	16,100	9,800
1956	3,590	1,460	1,020	777	770	747	755	11,600	20,000	19,500	16,100	12,400
1957	4,180	2,280	1,630	1,310	1,160	942	942	9,230	18,700	15,500	13,800	13,400
1958	5,810	2,910	2,420	1,500	1,020	903	1,190	8,860	17,000	15,200	14,400	5,370
1959	3,500	1,640	1,170	1,120	1,020	777	976	10,500	15,600	16,500	18,600	11,100
1960	3,530	1,850	1,400	1,100	961	843	835	10,500	13,400	16,700	16,000	9,170
1961	3,890	1,600	1,600	1,400	1,150	1,150	1,700	11,200	20,600	16,500	13,900	12,000
1962	4,600	2,200	1,400	1,200	860	760	1,000	6,610	15,600	14,900	12,100	6,720
1963	2,800	1,250	1,100	1,000	810	700	650	7,760	14,000	20,400	12,000	7,180
1964	5,360	1,550	840	970	750	600	840	1,640	27,300	16,500	12,700	6,220
1965	4,430	1,790	1,300	920	800	740	770	4,810	17,200	19,400	14,000	13,100
1966	4,120	1,580	1,150	1,100	1,100	1,100	1,300	4,500	19,600	14,200	17,300	9,810
1967	5,580	1,400	900	720	650	650	780	1,790	14,400	14,700	15,800	9,520
1968	3,830	1,560	1,180	1,020	1,000	950	1,290	13,500	20,800	17,500	10,600	3,860
1969	1,930	678	624	600	600	626	1,490	11,100	19,600	13,700	7,470	3,780
1970	5,650	1,610	832	766	700	650	728	11,700	22,900	21,100	13,000	6,660
1971	2,920	2,020	1,180	865	721	613	607	5,960	25,400	20,600	15,900	6,020
1972	3,020	1,330	1,100	989	898	811	742	8,050	15,300	16,800	13,400	9,260
1973	4,550	2,340	1,320	910	702	606	727	6,350	15,200	13,800	9,870	6,160
1974	3,540	1,700	1,260	1,020	902	811	1,010	6,770	10,700	11,700	10,500	11,800
1975	4,560	2,330	919	800	750	750	767	7,850	19,100	19,500	11,700	8,470
1976	4,700	1,970	1,260	971	897	800	1,270	8,810	15,100	14,600	11,100	8,160
1977	6,200	2,880	2,870	2,830	1,820	1,200	1,200	8,910	36,700	25,300	20,200	10,300
1978	5,800	2,370	1,550	1,210	944	841	1,020	9,010	13,800	18,100	13,700	7,480
1979	4,940	1,580	1,550	1,160	1,040	981	1,600	11,700	15,000	15,800	16,200	7,450
1980	7,250	4,190	2,230	1,780	1,620	1,350	1,960	11,800	24,800	28,600	13,900	8,780
1981	5,630	2,690	1,480	1,240	1,270	925	2,140	22,400	24,700	21,400	16,500	7,640

WY	Skwentna River near Skwentna cont.											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1982	5,180	2,270	1,480	1,170	986	777	770	5,160	16,000	14,000	10,500	15,200
1983	4,400	2,010	1,470	1,190	1,150	1,100	1,570	9,040	16,900	15,500	16,300	5,530
1984	3,790	1,930	1,280	944	828	817	2,040	10,800	17,300	18,200	18,500	6,640
1985	4,820	1,560	1,080	1,060	1,020	938	895	6,730	16,800	20,300	16,000	10,400
1986	5,700	1,720	1,340	1,170	1,050	895	1,020	8,030	15,500	17,500	13,500	9,950
1987	13,200	2,740	1,440	1,180	1,140	1,110	1,530	8,540	14,500	20,000	17,000	9,990
1988	5,010	3,000	1,960	1,660	1,500	1,460	1,730	11,000	19,500	20,400	13,600	9,240
1989	5,840	2,160	1,060	935	933	1,060	1,370	9,170	15,700	17,800	23,200	15,900
1990	7,920	2,890	1,360	1,280	1,250	1,390	3,200	17,200	20,800	16,400	14,300	14,900
1991	4,880	1,780	1,140	1,140	1,140	988	1,330	7,810	19,200	17,300	14,400	9,430
1992	5,280	2,230	1,920	1,650	1,460	1,490	3,180	7,580	14,600	16,400	11,400	5,530
1993	2,960	2,160	1,760	1,460	1,170	1,070	1,910	13,800	15,600	13,100	12,700	14,000
1994	6,930	2,470	1,910	1,570	1,370	1,180	2,380	10,000	19,000	14,100	12,600	6,560
1995	3,310	2,090	1,600	1,420	1,320	1,310	2,130	11,900	16,000	16,900	12,400	12,900
1996	4,630	1,990	1,120	980	932	867	1,050	4,670	10,700	10,900	11,600	7,270
1997	2,590	1,470	1,270	1,120	992	869	1,110	6,880	13,200	16,500	16,600	9,530
1998	2,890	1,300	1,030	875	812	751	1,200	6,710	16,500	17,200	15,500	11,300
1999	5,560	2,260	1,590	1,210	883	680	894	6,670	15,600	15,600	16,800	8,070
2000	4,980	2,300	1,520	1,180	1,020	909	1,200	8,150	20,100	19,100	11,500	10,800
2001	5,820	2,280	1,580	1,300	1,090	956	1,110	6,310	19,300	14,700	14,500	7,230
2002	3,520	1,980	1,450	1,200	1,110	1,020	1,040	7,820	11,300	12,300	15,400	11,100
2003	7,620	3,900	1,950	1,280	1,700	1,170	1,630	5,650	16,200	18,300	14,100	9,270
2004	5,710	1,890	1,390	1,140	1,000	852	2,030	15,400	16,800	13,600	12,000	4,620
2005	2,450	1,330	1,250	1,120	973	826	1,930	17,300	20,700	17,400	14,700	15,200
2006	5,800	1,630	1,160	1,090	1,080	1,060	1,190	10,300	15,100	15,400	18,700	8,510
2007	7,190	2,340	1,760	1,550	1,460	1,340	1,720	11,600	13,300	14,500	13,000	9,300
2008	3,640	2,400	2,110	1,410	1,050	1,060	1,290	8,200	14,200	14,600	13,200	9,960
2009	3,980	1,200	1,020	1,080	1,020	1,050	3,250	14,900	15,500	13,100	12,500	8,630
2010	5,070	2,100	1,410	1,140	1,060	1,020	1,410	13,200	13,500	17,700	13,500	10,800
Average	4,780	2,020	1,400	1,160	1,020	916	1,330	9,280	17,400	16,700	14,200	9,320
Maximum	13,200	4,190	2,870	2,830	1,820	1,490	3,250	22,400	36,700	28,600	23,200	15,900
Minimum	1,930	678	624	600	600	585	607	1,640	10,700	10,900	7,470	3,780
Median	4,600	1,990	1,340	1,140	1,000	869	1,200	8,860	16,500	16,500	13,900	9,270

Table A-10 – Average Monthly Flow for Yentna River near Susitna Station for Pre-Project Conditions based on the USGS Extended Record

WY	Yentna River near Susitna Station											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1950	12,600	4,770	2,550	1,780	1,340	1,230	1,490	23,700	40,200	47,000	41,400	16,600
1951	7,320	2,280	1,910	1,650	1,400	1,250	2,920	29,100	42,100	47,100	41,100	42,900
1952	10,900	5,080	3,430	2,850	1,730	1,510	1,580	10,500	59,000	51,600	41,900	29,500
1953	16,400	6,590	3,040	1,910	1,400	1,400	2,920	39,700	53,000	42,600	43,000	31,800
1954	10,900	3,820	2,660	2,280	1,730	1,320	2,170	36,300	51,000	42,600	51,900	26,600
1955	10,400	5,110	3,710	3,220	2,470	1,910	2,100	19,000	55,200	53,400	49,000	29,600
1956	9,560	3,430	2,280	1,690	1,670	1,620	1,640	34,800	59,700	57,900	48,700	37,700
1957	11,300	5,680	3,900	3,040	2,660	2,100	2,100	27,300	56,000	48,000	43,300	41,400
1958	16,400	7,510	6,120	3,560	2,300	2,000	2,730	26,500	51,400	47,800	43,700	15,000
1959	9,270	3,920	2,690	2,560	2,300	1,690	2,200	31,200	47,800	50,400	56,100	33,200
1960	10,000	5,260	3,990	3,130	2,750	2,410	2,390	29,400	37,600	46,600	44,600	25,700
1961	11,000	4,560	4,550	4,000	3,290	3,300	4,840	31,400	57,300	46,100	38,900	33,600
1962	13,000	6,240	3,990	3,420	2,460	2,180	2,860	18,600	43,700	41,800	33,800	18,900
1963	7,930	3,570	3,140	2,860	2,320	2,000	1,860	21,800	39,300	57,000	33,600	20,200
1964	15,100	4,410	2,400	2,770	2,150	1,720	2,400	4,650	75,800	46,000	35,500	17,500
1965	12,500	5,090	3,710	2,630	2,290	2,120	2,210	13,500	47,900	54,000	39,100	36,600
1966	11,600	4,490	3,280	3,140	3,140	3,140	3,700	12,700	54,500	39,700	48,300	27,500
1967	15,700	3,990	2,570	2,060	1,860	1,860	2,230	5,090	40,300	41,200	44,000	26,700
1968	10,800	4,440	3,370	2,920	2,860	2,720	3,690	37,600	57,900	48,800	29,600	10,900
1969	5,480	1,940	1,790	1,720	1,720	1,790	4,230	31,000	54,600	38,200	21,000	10,700
1970	15,900	4,570	2,380	2,200	2,000	1,860	2,080	32,700	63,700	58,900	36,500	18,700
1971	8,270	5,750	3,380	2,470	2,070	1,760	1,740	16,700	70,700	57,400	44,500	16,900
1972	8,540	3,780	3,150	2,830	2,570	2,320	2,120	22,600	42,800	47,000	37,400	26,000
1973	12,800	6,640	3,750	2,600	2,010	1,740	2,080	17,900	42,500	38,700	27,700	17,300
1974	10,000	4,830	3,600	2,920	2,580	2,320	2,870	19,000	29,900	32,700	29,400	33,000
1975	10,300	5,470	3,210	2,890	2,670	2,540	2,530	20,900	54,800	57,100	35,600	27,900
1976	12,700	4,860	3,100	2,770	2,490	2,300	3,330	26,800	44,100	45,200	36,600	21,300
1977	14,500	7,630	6,740	6,160	4,460	3,150	3,050	24,300	89,000	67,300	55,700	31,900
1978	15,700	5,920	3,810	3,210	2,770	2,590	2,940	22,500	38,600	50,800	41,000	21,700
1979	14,000	5,140	4,130	3,470	3,120	2,880	4,080	33,500	46,800	53,300	50,600	25,700
1980	22,000	12,000	6,060	4,610	4,170	3,760	5,200	30,500	66,400	81,100	46,700	28,400
1981	18,500	8,370	4,370	3,710	3,740	2,750	5,480	45,600	55,100	64,400	58,900	25,900

WY	Yentna River near Susitna Station cont.											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1982	12,300	6,250	4,540	3,660	2,850	2,230	2,180	13,900	40,900	46,700	39,800	47,600
1983	12,500	5,660	4,120	3,340	3,240	3,090	4,420	25,900	48,800	44,600	47,100	15,800
1984	10,700	5,440	3,580	2,640	2,310	2,280	5,750	30,900	50,100	52,500	53,400	19,000
1985	13,700	4,370	3,010	2,960	2,850	2,620	2,500	19,300	48,500	58,800	46,200	29,800
1986	16,300	4,850	3,740	3,280	2,930	2,500	2,850	23,000	44,600	55,000	43,600	32,000
1987	38,400	6,760	3,830	3,240	3,140	3,080	4,000	27,000	46,900	61,500	52,600	30,700
1988	13,100	7,320	4,980	4,330	3,980	3,890	4,480	35,300	60,100	62,400	44,300	29,100
1989	16,100	5,430	2,940	2,650	2,650	2,940	3,640	29,000	50,200	55,800	69,500	50,400
1990	24,100	7,170	3,640	3,470	3,400	3,720	8,340	53,100	63,400	52,100	46,100	46,600
1991	13,000	4,570	3,140	3,140	3,130	2,770	3,540	23,300	59,300	54,400	45,900	29,600
1992	14,800	5,540	4,890	4,290	3,890	3,960	8,410	22,400	47,100	52,000	36,800	15,400
1993	7,210	5,410	4,530	3,870	3,210	2,950	4,700	41,300	48,000	40,800	39,100	42,600
1994	20,100	6,240	4,650	3,730	3,210	2,710	6,100	30,400	57,100	44,100	39,000	18,900
1995	8,690	5,150	3,810	3,340	3,080	3,040	5,300	36,100	48,200	51,200	38,000	40,200
1996	12,800	4,920	2,550	2,190	2,070	1,910	2,380	13,300	32,800	33,400	35,700	21,100
1997	7,520	4,090	3,490	3,050	2,760	2,550	3,150	21,400	40,900	50,400	50,900	29,800
1998	8,490	3,600	2,870	2,550	2,440	2,330	3,420	20,500	50,600	52,400	47,800	35,600
1999	17,000	6,470	4,430	3,330	2,570	2,180	2,660	20,900	47,800	48,200	51,800	25,300
2000	15,100	6,610	4,220	3,230	2,830	2,620	3,320	25,600	61,000	58,200	36,400	33,600
2001	17,900	6,530	4,410	3,580	2,970	2,700	3,080	19,300	57,700	45,400	44,200	21,000
2002	9,330	4,850	3,420	2,750	2,510	2,290	2,340	23,400	34,600	38,200	46,600	33,900
2003	22,300	10,500	4,780	2,960	4,110	2,690	4,030	16,100	49,300	55,300	42,900	27,600
2004	16,300	4,600	3,250	2,600	2,240	1,880	5,120	46,400	51,100	42,400	37,300	12,700
2005	6,200	3,110	2,870	2,540	2,170	1,810	4,960	52,100	61,300	52,700	45,700	46,400
2006	16,600	3,910	2,650	2,470	2,450	2,400	2,730	30,900	45,400	47,600	56,300	25,300
2007	21,000	5,870	4,240	3,670	3,440	3,130	4,170	35,500	41,200	45,300	40,400	27,900
2008	9,700	6,020	5,220	3,320	2,360	2,400	2,990	24,400	44,000	44,900	40,400	30,100
2009	10,800	2,760	2,280	2,440	2,280	2,360	8,920	45,600	46,900	40,600	38,500	25,600
2010	14,100	5,200	3,320	2,600	2,380	2,290	3,340	40,700	42,100	53,300	41,800	33,100
Average	13,400	5,350	3,640	3,020	2,650	2,400	3,480	26,900	50,600	49,900	43,100	27,900
Maximum	38,400	12,000	6,740	6,160	4,460	3,960	8,920	53,100	89,000	81,100	69,500	50,400
Minimum	5,480	1,940	1,790	1,650	1,340	1,230	1,490	4,650	29,900	32,700	21,000	10,700
Median	12,700	5,140	3,580	2,960	2,570	2,330	2,990	25,900	48,800	48,800	43,000	27,900

Table A-11 – Average Monthly Flow for Susitna River at Susitna Station for Pre-Project Conditions based on the USGS Extended Record

WY	Susitna River at Susitna Station											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1950	35,500	13,100	7,050	5,890	5,070	4,880	5,370	62,100	101,000	116,000	103,000	46,600
1951	21,800	6,690	6,120	5,680	5,210	4,930	8,680	75,300	105,000	116,000	102,000	107,000
1952	31,500	14,200	8,480	7,500	5,810	5,420	5,550	27,600	146,000	127,000	105,000	76,800
1953	46,000	19,400	7,750	6,120	5,210	5,210	8,790	99,500	131,000	105,000	107,000	81,700
1954	31,900	9,730	7,240	6,700	5,810	5,070	6,440	91,200	126,000	106,000	128,000	69,900
1955	31,200	14,100	9,410	8,270	6,970	6,120	6,410	51,100	137,000	132,000	122,000	76,600
1956	28,400	8,740	6,700	5,740	5,710	5,620	5,650	88,000	148,000	143,000	121,000	95,300
1957	33,500	16,200	10,000	7,750	7,240	6,410	6,410	70,500	138,000	118,000	107,000	103,000
1958	46,100	22,600	17,900	9,190	6,710	6,260	7,670	68,900	126,000	117,000	109,000	42,800
1959	27,600	10,400	7,340	7,100	6,710	5,740	6,530	78,900	118,000	124,000	139,000	85,400
1960	28,800	12,100	9,220	7,820	6,980	6,430	6,550	78,000	96,100	117,000	115,000	85,200
1961	33,500	12,100	11,100	10,000	7,670	7,970	11,100	87,900	132,000	122,000	109,000	79,800
1962	31,600	12,700	8,920	8,030	6,860	6,540	7,340	56,300	143,000	121,000	105,000	64,400
1963	26,800	10,900	8,160	7,240	6,770	5,860	5,490	71,300	117,000	141,000	103,000	58,700
1964	36,400	9,790	6,810	6,450	5,920	5,180	5,730	15,500	151,000	120,000	102,000	45,900
1965	33,600	14,300	10,700	7,930	7,130	6,560	6,840	37,400	122,000	130,000	110,000	103,000
1966	39,600	13,100	9,230	8,230	7,210	6,490	6,970	30,500	129,000	110,000	120,000	72,900
1967	35,600	9,770	8,060	7,050	6,380	5,960	6,020	28,600	109,000	121,000	124,000	77,500
1968	25,000	12,000	9,880	8,850	8,400	8,120	10,200	92,200	136,000	126,000	86,700	36,600
1969	15,900	7,990	6,370	5,780	5,460	5,400	8,180	66,500	104,000	96,600	52,100	25,000
1970	31,100	10,100	7,020	6,420	6,010	5,790	6,540	70,000	122,000	129,000	103,000	58,700
1971	25,300	15,400	10,500	7,590	6,060	5,490	6,030	35,600	147,000	130,000	126,000	56,400
1972	25,000	11,900	8,970	8,110	7,380	6,390	6,440	51,400	120,000	124,000	108,000	82,000
1973	37,500	15,100	9,570	8,060	7,090	6,430	6,720	47,800	115,000	105,000	90,200	45,800
1974	22,600	10,700	8,700	7,720	7,000	6,400	7,080	56,000	90,900	95,200	87,300	78,000
1975	19,500	10,400	9,420	8,600	7,800	7,050	6,870	47,500	129,000	136,000	91,400	77,700
1976	31,500	9,930	6,000	6,530	5,610	5,370	7,250	70,500	107,000	115,000	99,600	48,900
1977	30,100	18,300	13,100	10,100	8,910	6,770	6,230	56,200	166,000	144,000	125,000	83,800
1978	38,200	12,600	7,530	6,970	6,770	6,590	7,030	48,700	90,900	118,000	102,000	55,500
1979	36,800	15,000	9,310	8,820	7,950	7,030	8,680	81,300	120,000	142,000	128,000	74,300
1980	58,600	31,600	14,700	10,100	9,020	8,910	12,000	66,600	143,000	181,000	126,000	78,000
1981	35,000	16,200	8,520	7,770	7,590	6,180	10,400	83,600	109,000	153,000	160,000	67,200

WY	Susitna River at Susitna Station cont.											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1982	33,900	17,600	11,700	9,030	7,210	5,440	5,820	44,900	108,000	115,000	94,600	110,000
1983	34,000	15,200	9,890	8,370	8,420	7,120	7,680	62,100	104,000	103,000	108,000	54,900
1984	39,400	19,000	11,500	7,440	6,700	6,470	13,000	60,400	107,000	109,000	111,000	51,000
1985	30,800	11,000	8,230	7,970	6,950	6,500	6,820	45,700	113,000	135,000	109,000	84,100
1986	50,700	18,400	11,100	8,870	7,750	5,970	7,190	47,600	91,000	125,000	102,000	77,000
1987	88,500	17,500	9,350	7,790	7,500	7,350	9,860	65,400	109,000	139,000	120,000	73,500
1988	34,400	19,100	12,500	10,700	9,740	9,500	11,100	83,600	136,000	141,000	103,000	70,400
1989	41,400	13,800	7,000	6,240	6,230	7,000	8,900	70,300	115,000	127,000	155,000	116,000
1990	59,100	18,700	8,840	8,370	8,210	9,060	21,400	121,000	142,000	119,000	107,000	107,000
1991	33,700	11,400	7,500	7,500	7,480	6,560	8,620	56,500	134,000	124,000	106,000	71,700
1992	37,500	14,000	12,200	10,600	9,500	9,690	21,500	55,100	109,000	119,000	87,200	39,200
1993	18,800	13,700	11,300	9,470	7,700	7,030	12,500	105,000	123,000	108,000	101,000	116,000
1994	60,500	19,800	12,700	9,940	8,510	7,220	15,600	83,800	140,000	110,000	103,000	46,600
1995	25,300	13,700	9,980	8,370	7,590	7,520	12,100	89,400	120,000	124,000	96,700	98,500
1996	35,200	14,000	7,140	6,360	6,170	6,180	8,220	47,300	82,700	93,400	97,800	53,000
1997	18,900	10,800	9,340	8,250	7,300	6,410	8,150	50,100	97,400	122,000	123,000	69,500
1998	21,100	9,600	7,620	6,450	5,990	5,540	8,820	49,000	123,000	128,000	115,000	82,400
1999	40,500	16,500	11,700	8,910	6,510	5,020	6,600	48,400	116,000	115,000	123,000	58,600
2000	36,200	16,900	11,100	8,670	7,530	6,700	8,810	59,300	145,000	139,000	83,400	78,900
2001	42,300	16,700	11,600	9,540	8,000	7,040	8,210	47,000	139,000	107,000	108,000	56,000
2002	27,400	12,900	8,730	7,300	6,840	6,290	6,380	67,100	87,100	95,400	117,000	95,900
2003	66,800	31,500	13,300	7,070	9,340	6,680	12,800	50,700	121,000	134,000	106,000	66,200
2004	42,200	15,000	9,380	7,870	6,900	6,230	13,200	108,000	120,000	109,000	94,400	38,100
2005	26,300	11,600	8,780	7,980	7,060	7,250	19,000	134,000	151,000	129,000	113,000	119,000
2006	47,200	10,900	8,580	7,850	6,920	6,670	7,480	68,500	105,000	115,000	136,000	69,000
2007	65,300	18,000	10,100	8,120	7,050	6,230	10,400	69,400	89,300	111,000	104,000	79,100
2008	31,900	16,000	11,800	7,610	6,260	6,300	7,500	57,900	108,000	109,000	104,000	75,200
2009	31,800	9,320	7,830	7,730	6,970	6,860	18,300	107,000	113,000	102,000	93,000	64,300
2010	43,200	17,900	9,620	7,920	7,220	6,790	9,560	83,000	98,000	127,000	109,000	80,600
Average	36,000	14,400	9,510	7,910	7,080	6,510	8,990	66,100	120,000	122,000	109,000	72,800
Maximum	88,500	31,600	17,900	10,700	9,740	9,690	21,500	134,000	166,000	181,000	160,000	119,000
Minimum	15,900	6,690	6,000	5,680	5,070	4,880	5,370	15,500	82,700	93,400	52,100	25,000
Median	33,700	13,800	9,310	7,870	7,000	6,430	7,670	65,400	120,000	121,000	107,000	74,300

APPENDIX B. FLOW DURATION CURVES FOR PRE-PROJECT CONDITIONS

Susitna-Watana Hydroelectric Project (FERC No. 14241)

Stream Flow Assessment

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

Tetra Tech

February 2013

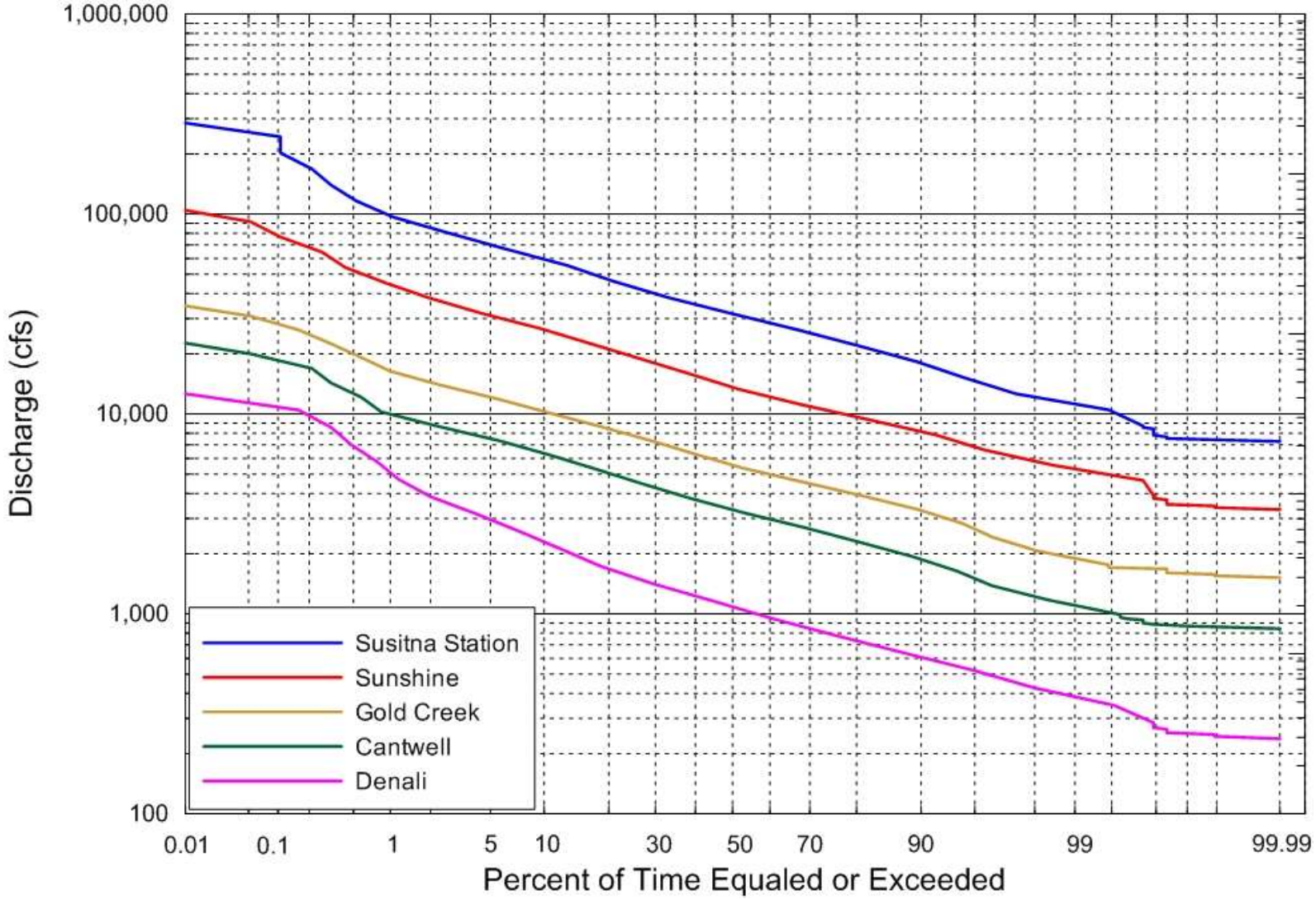

Figure B-1 – Monthly Flow-duration Curves for October for Mainstem Gages for Pre-Project Conditions based on the USGS Extended Record

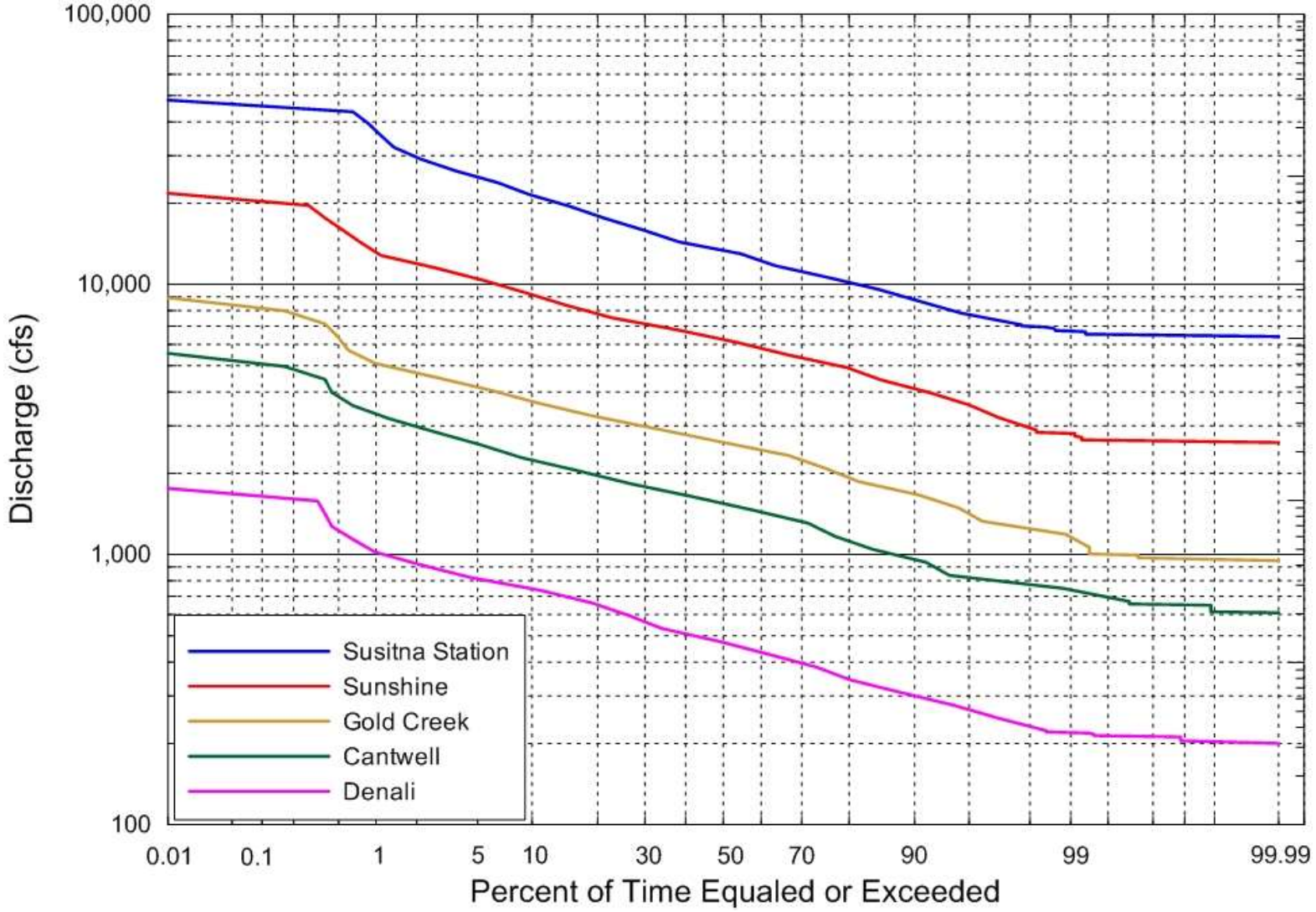

Figure B-2 – Monthly Flow-duration Curves for November for Mainstem Gages for Pre-Project Conditions based on the USGS Extended Record

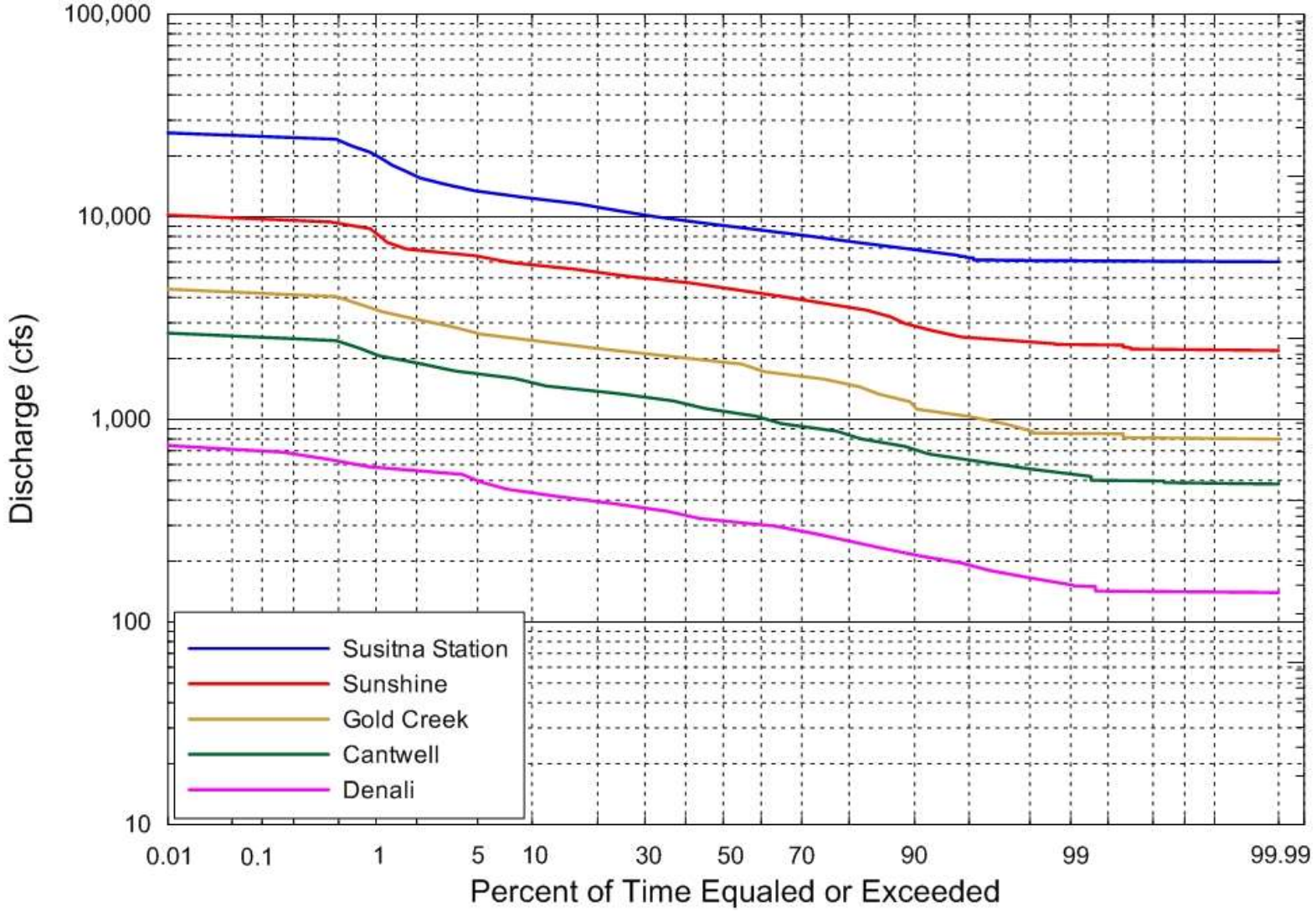

Figure B-3 – Monthly Flow-duration Curves for December for Mainstem Gages for Pre-Project Conditions based on the USGS Extended Record

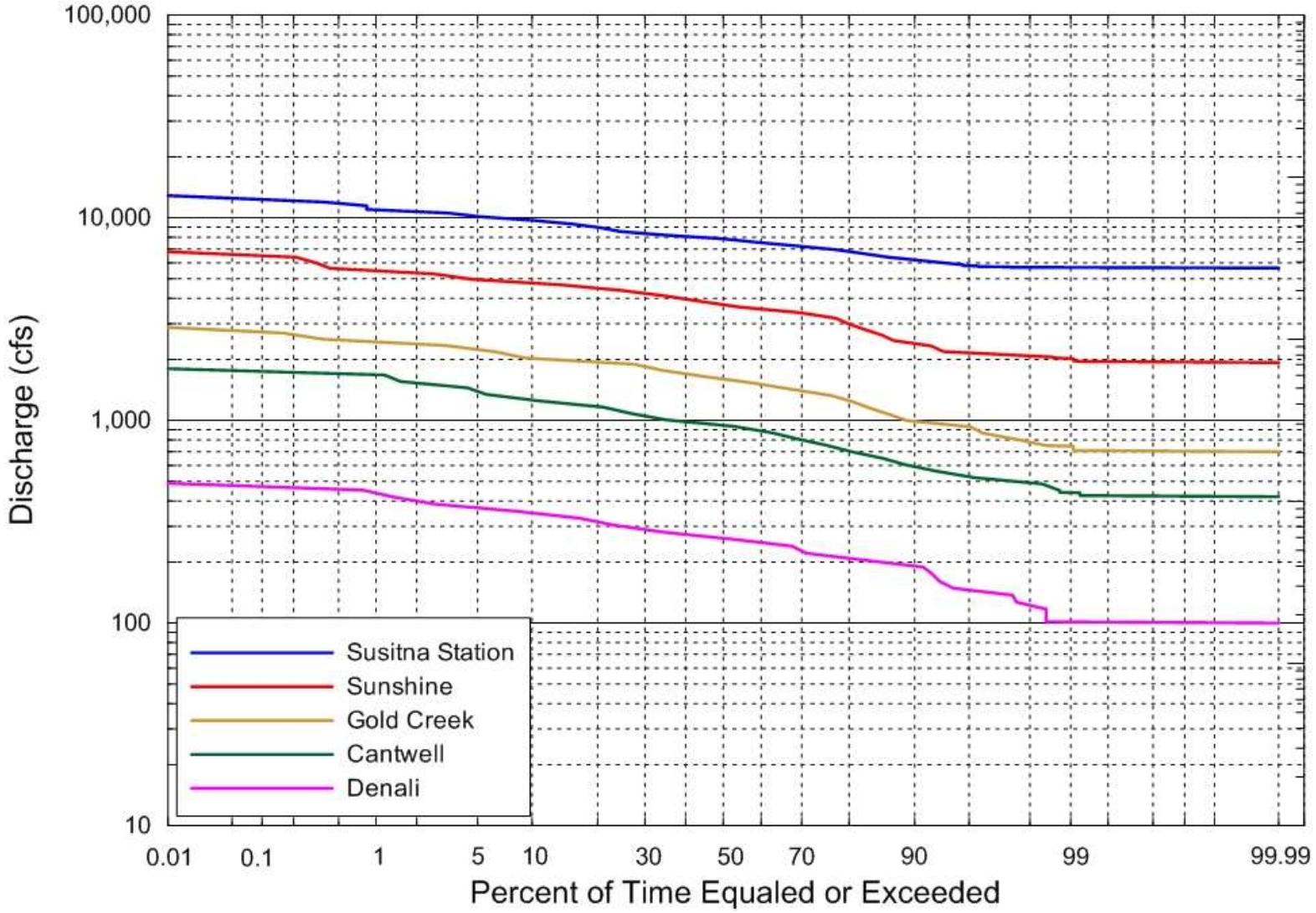

Figure B-4 – Monthly Flow-duration Curves for January for Mainstem Gages for Pre-Project Conditions based on the USGS Extended Record

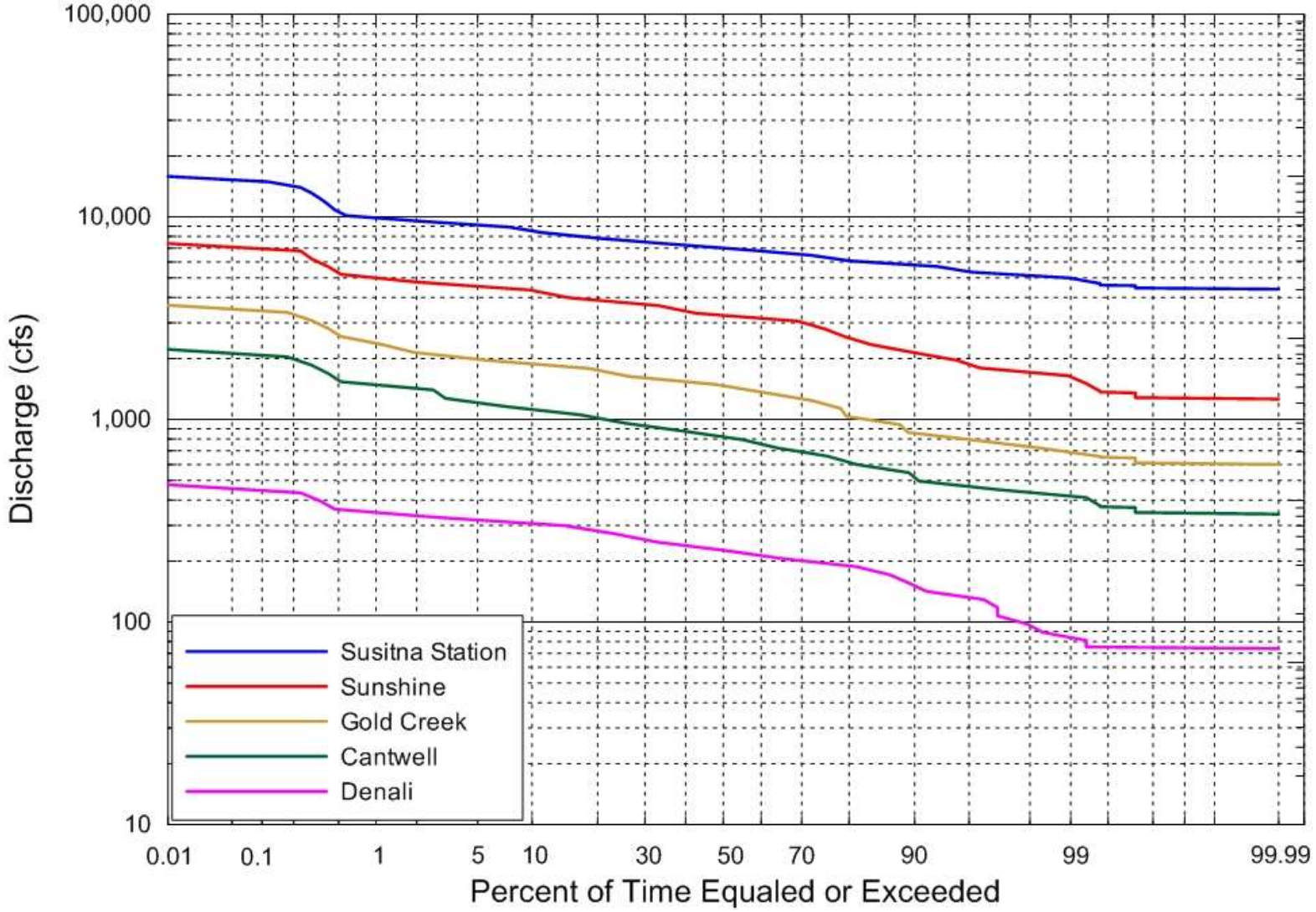

Figure B-5 – Monthly Flow-duration Curves for February for Mainstem Gages for Pre-Project Conditions based on the USGS Extended Record

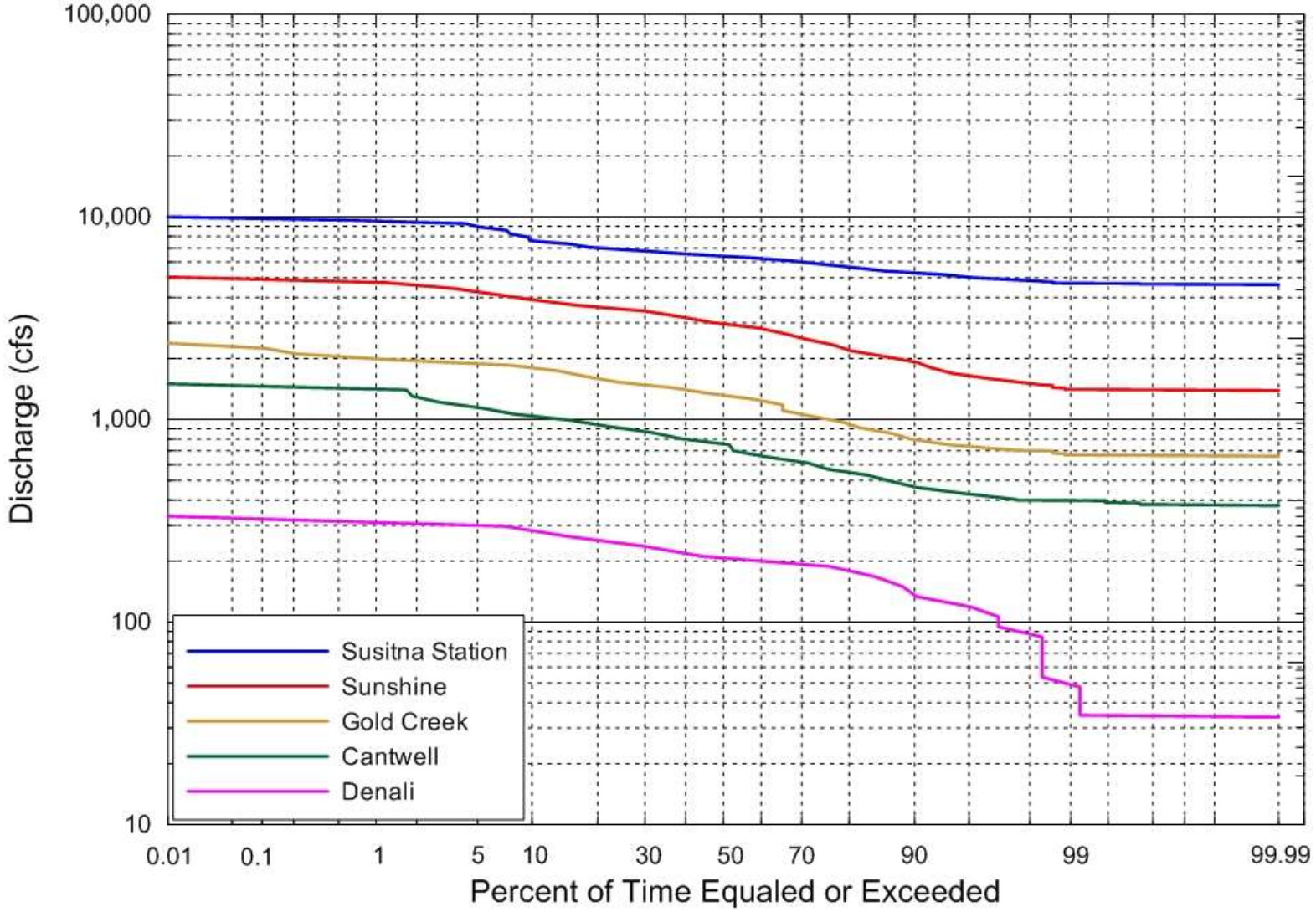

Figure B-6 – Monthly Flow-duration Curves for March for Mainstem Gages for Pre-Project Conditions based on the USGS Extended Record

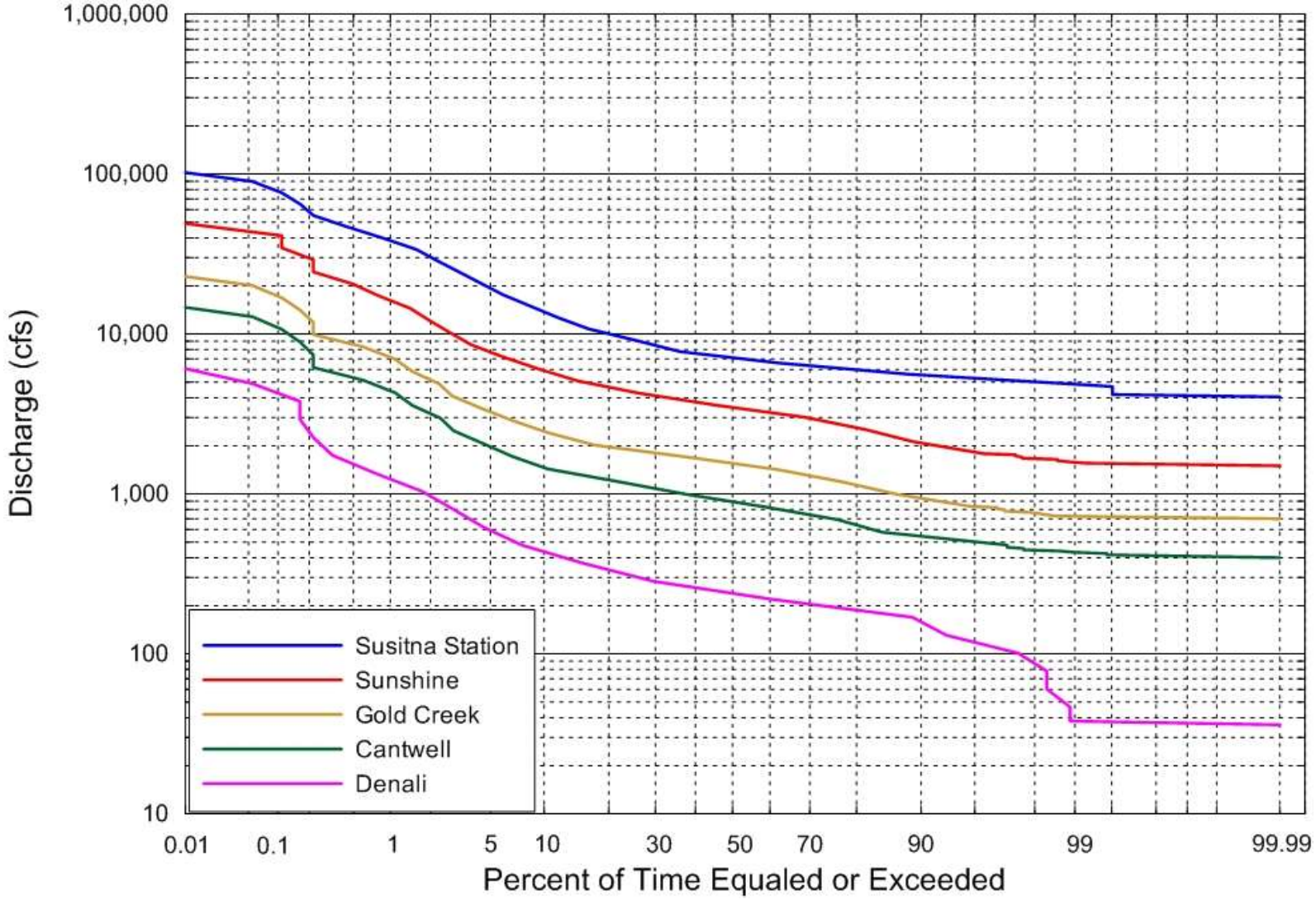

Figure B-7 – Monthly Flow-duration Curves for April for Mainstem Gages for Pre-Project Conditions based on the USGS Extended Record

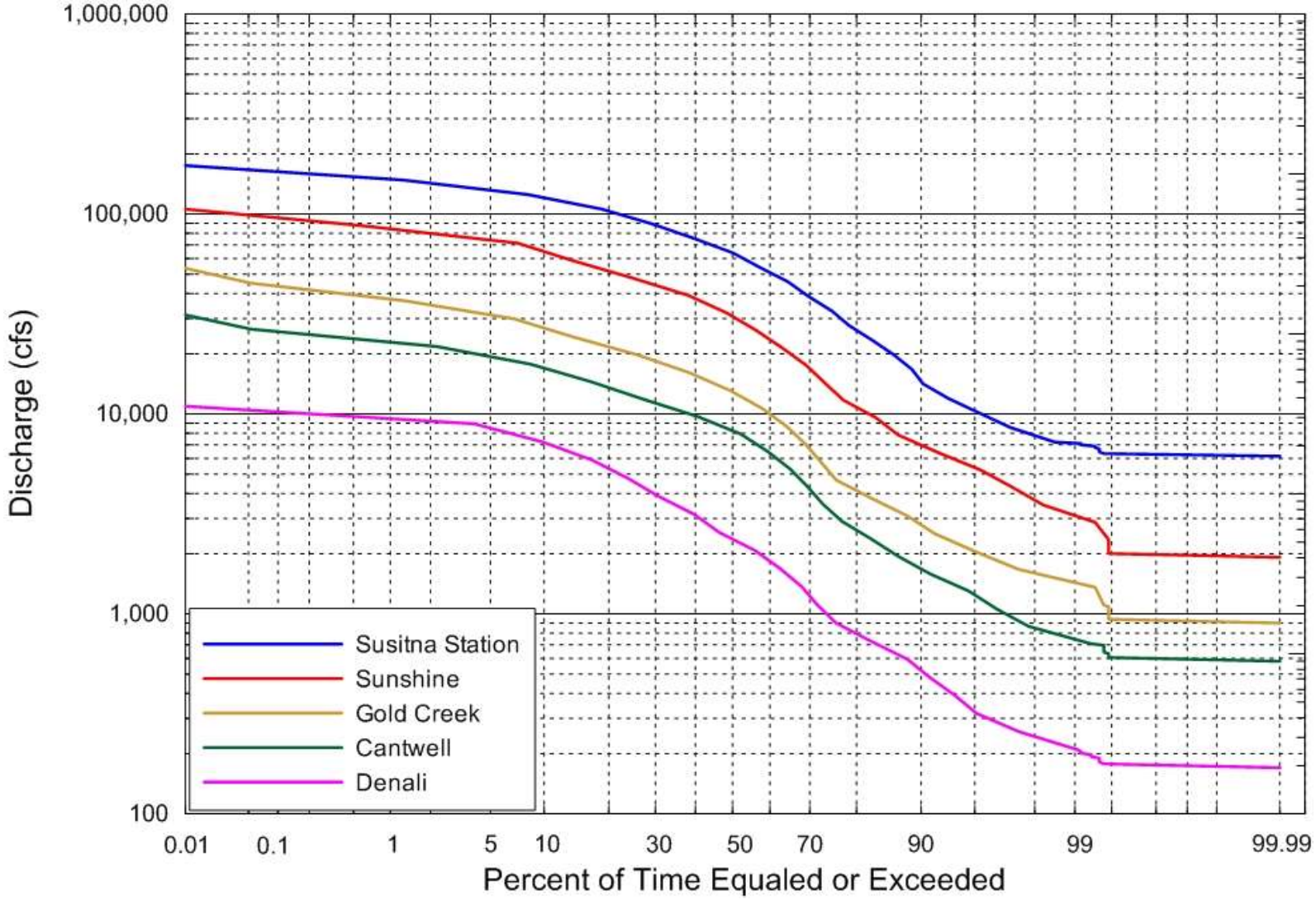

Figure B-8 – Monthly Flow-duration Curves for May for Mainstem Gages for Pre-Project Conditions based on the USGS Extended Record

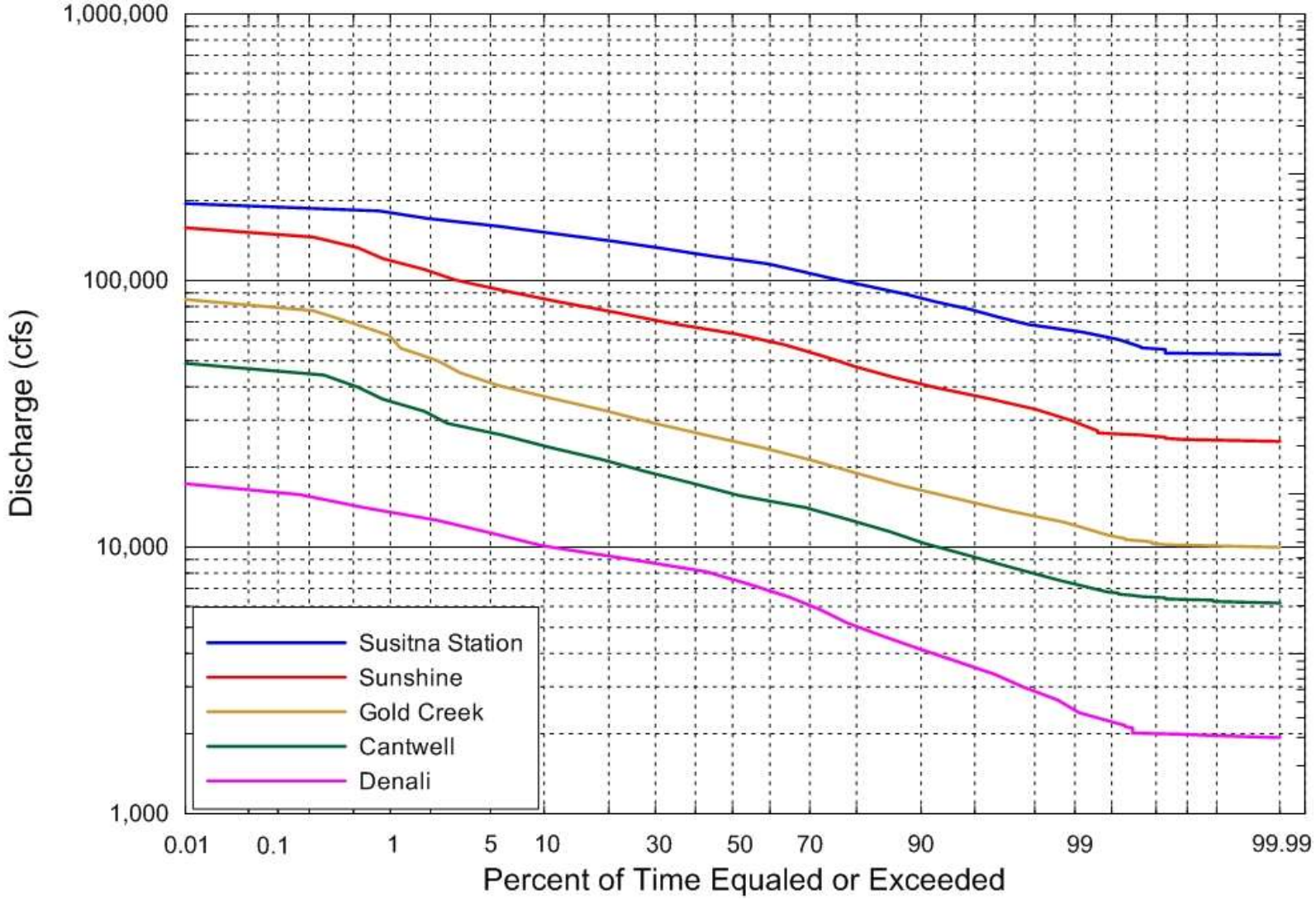

Figure B-9 – Monthly Flow-duration Curves for June for Mainstem Gages for Pre-Project Conditions based on the USGS Extended Record

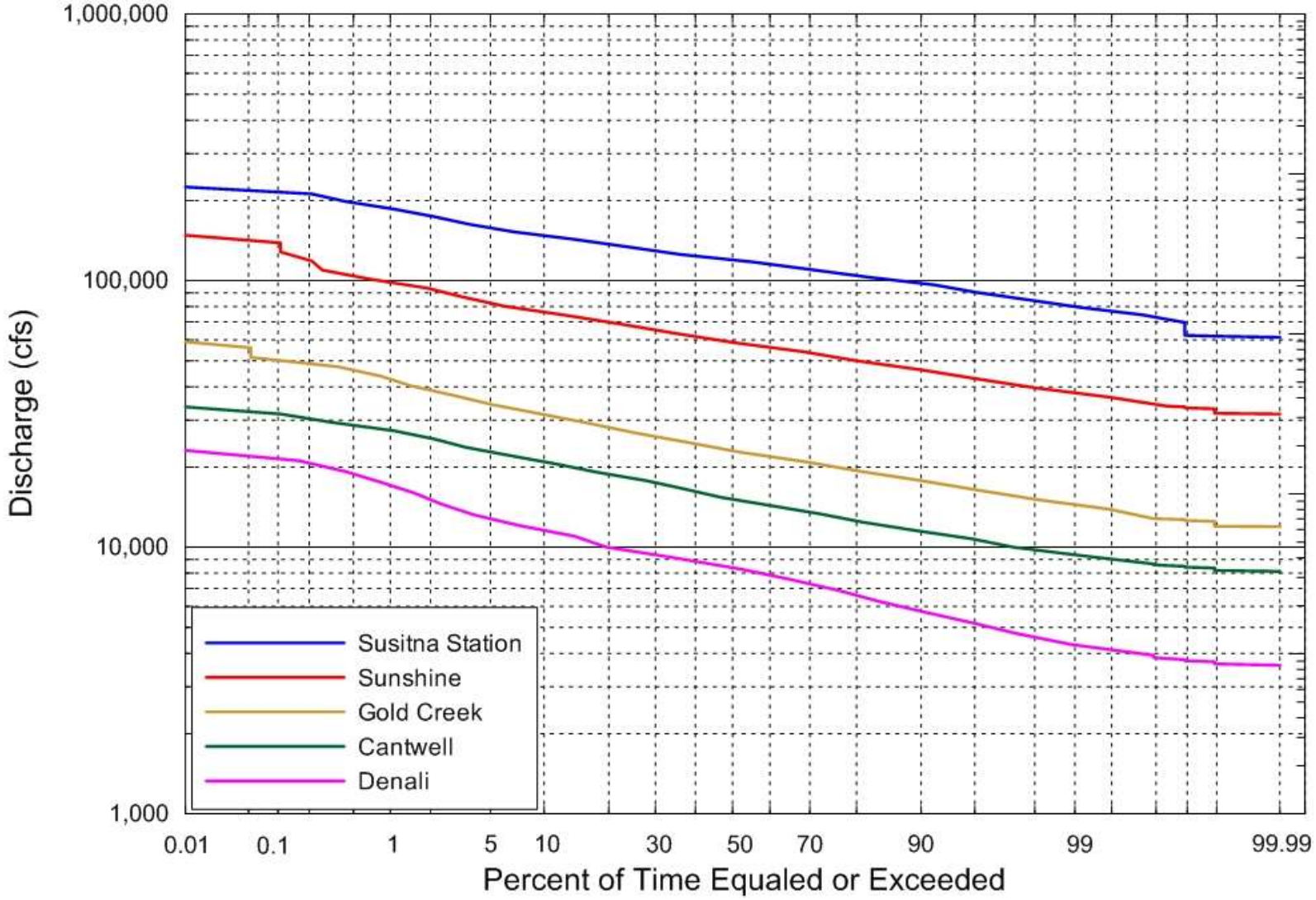

Figure B-10 – Monthly Flow-duration Curves for July for Mainstem Gages for Pre-Project Conditions based on the USGS Extended Record

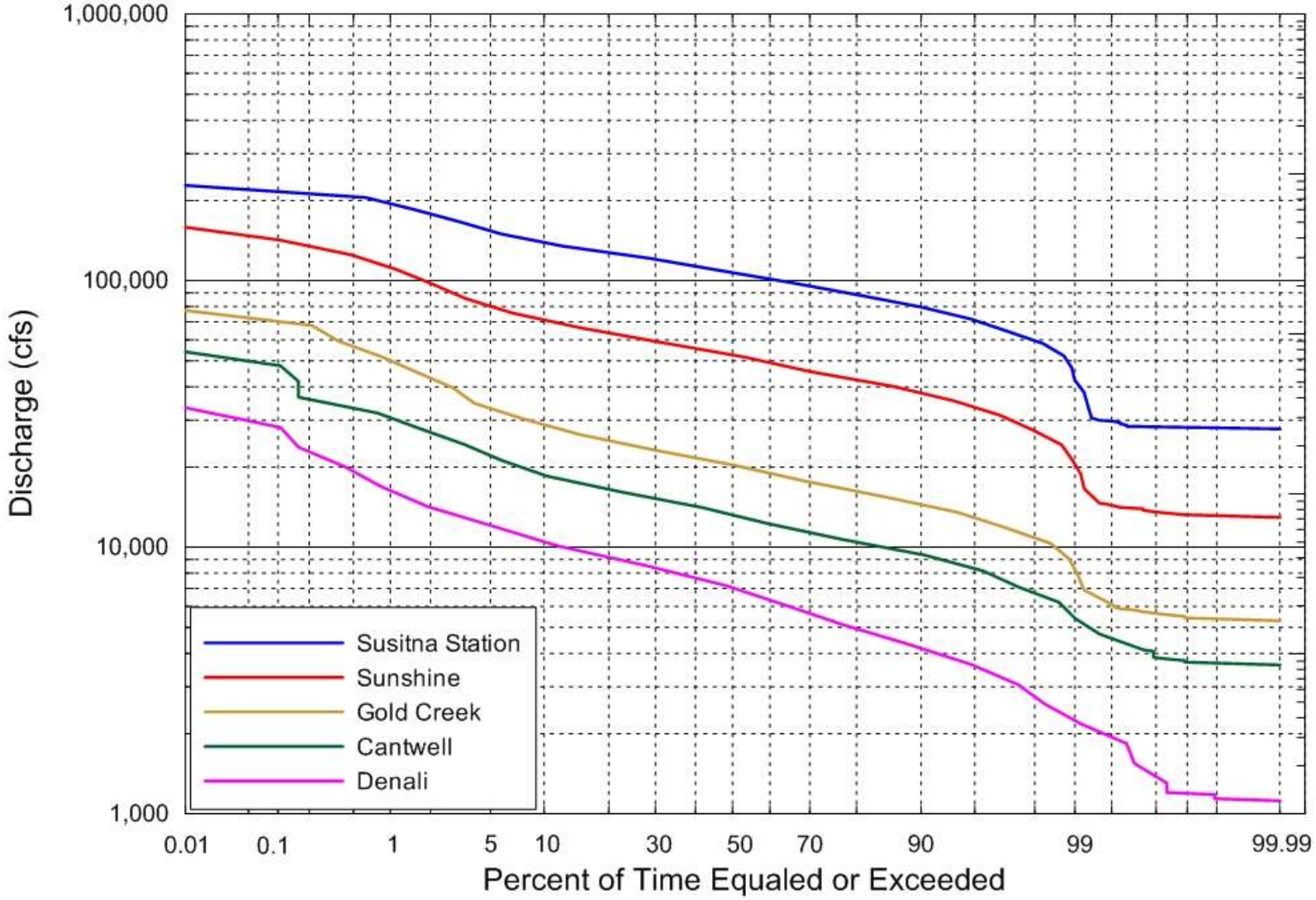

Figure B-11 – Monthly Flow-duration Curves for August for Mainstem Gages for Pre-Project Conditions based on the USGS Extended Record

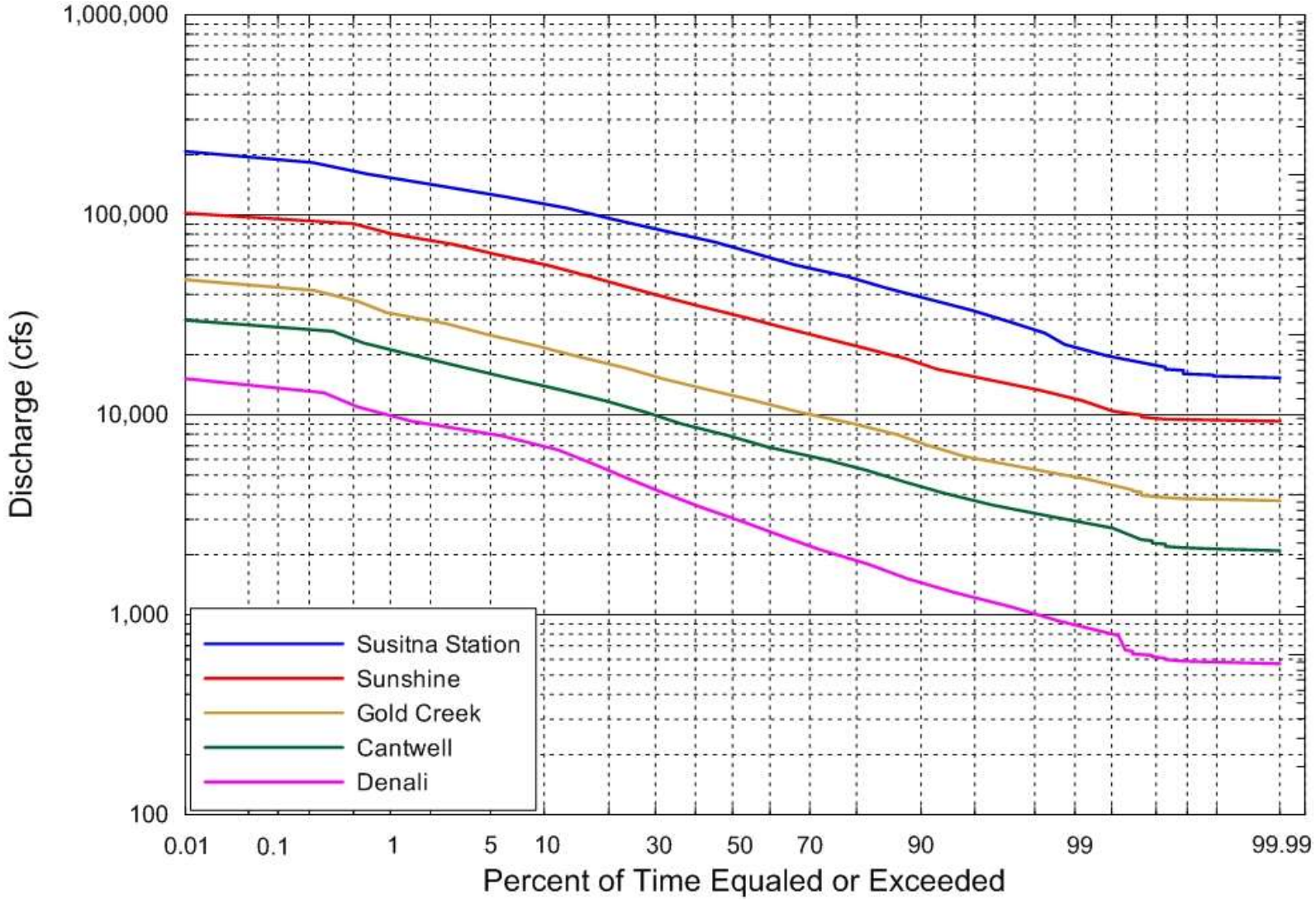

Figure B-12 – Monthly Flow-duration Curves for September for Mainstem Gages for Pre-Project Conditions based on the USGS Extended Record

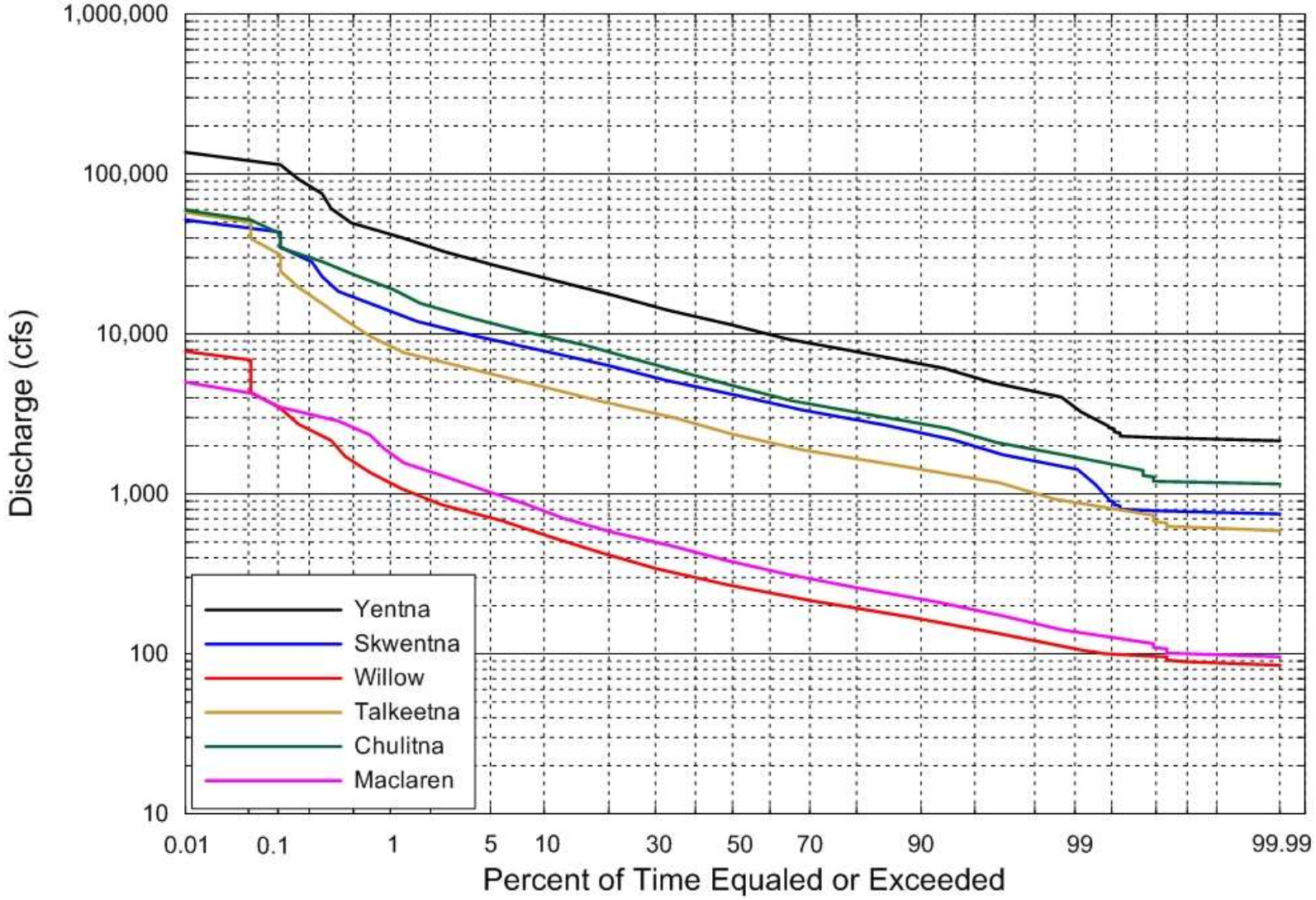

Figure B-13 – Monthly Flow-duration Curves for October for Tributary Gages for Pre-Project Conditions based on the USGS Extended Record

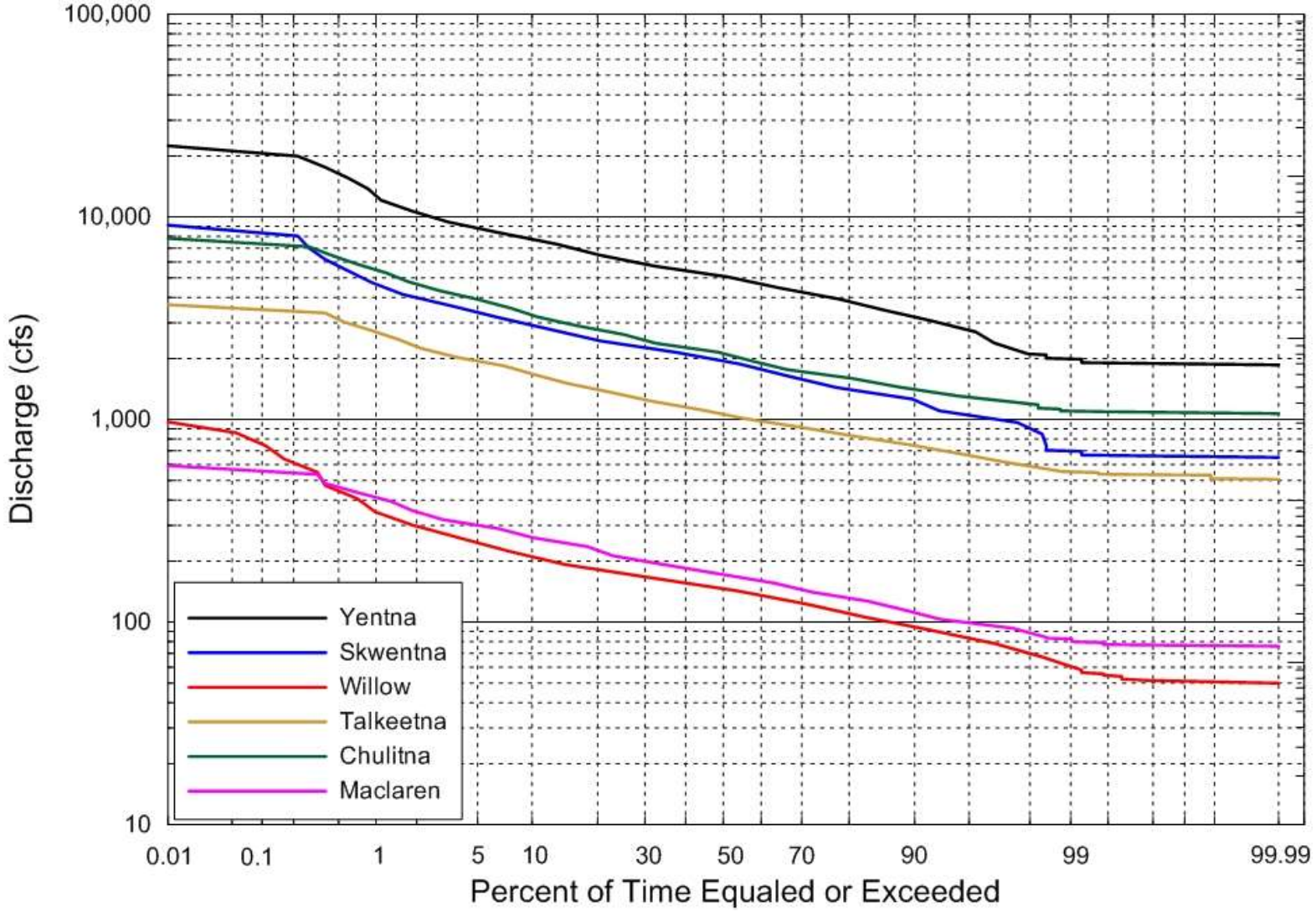

Figure B-14 – Monthly Flow-duration Curves for November for Tributary Gages for Pre-Project Conditions based on the USGS Extended Record

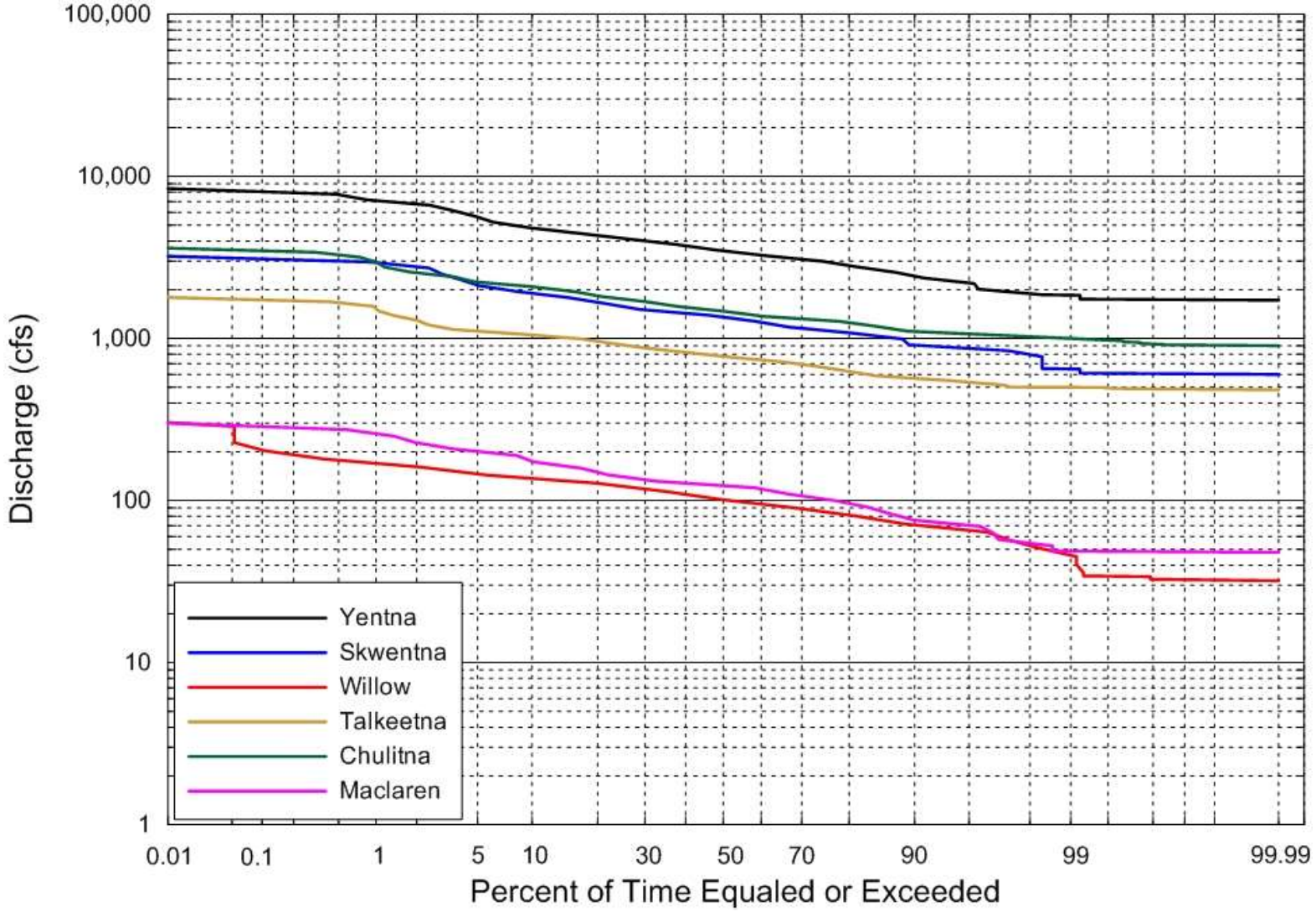

Figure B-15 – Monthly Flow-duration Curves for December for Tributary Gages for Pre-Project Conditions based on the USGS Extended Record

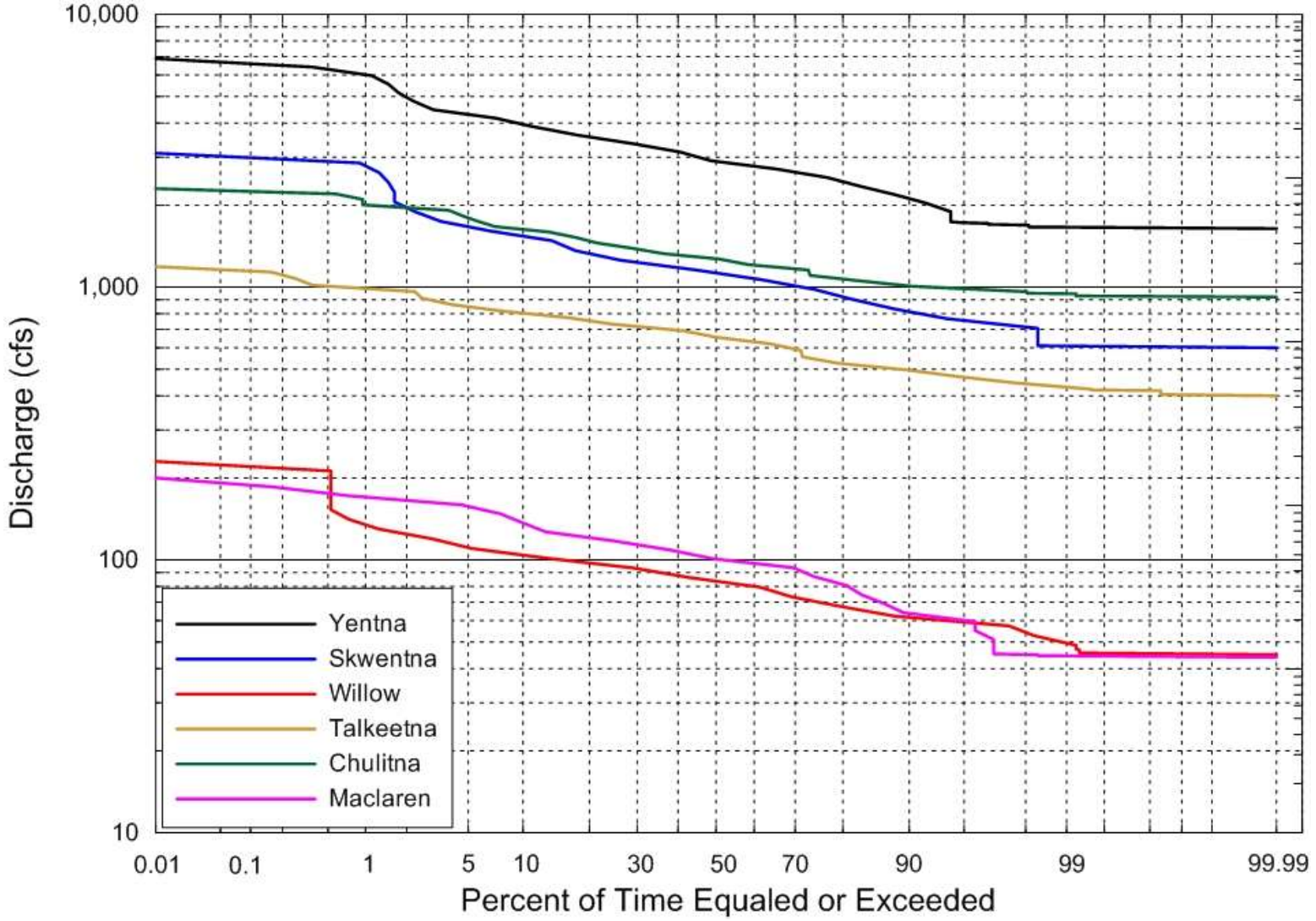

Figure B-16 – Monthly Flow-duration Curves for January for Tributary Gages for Pre-Project Conditions based on the USGS Extended Record

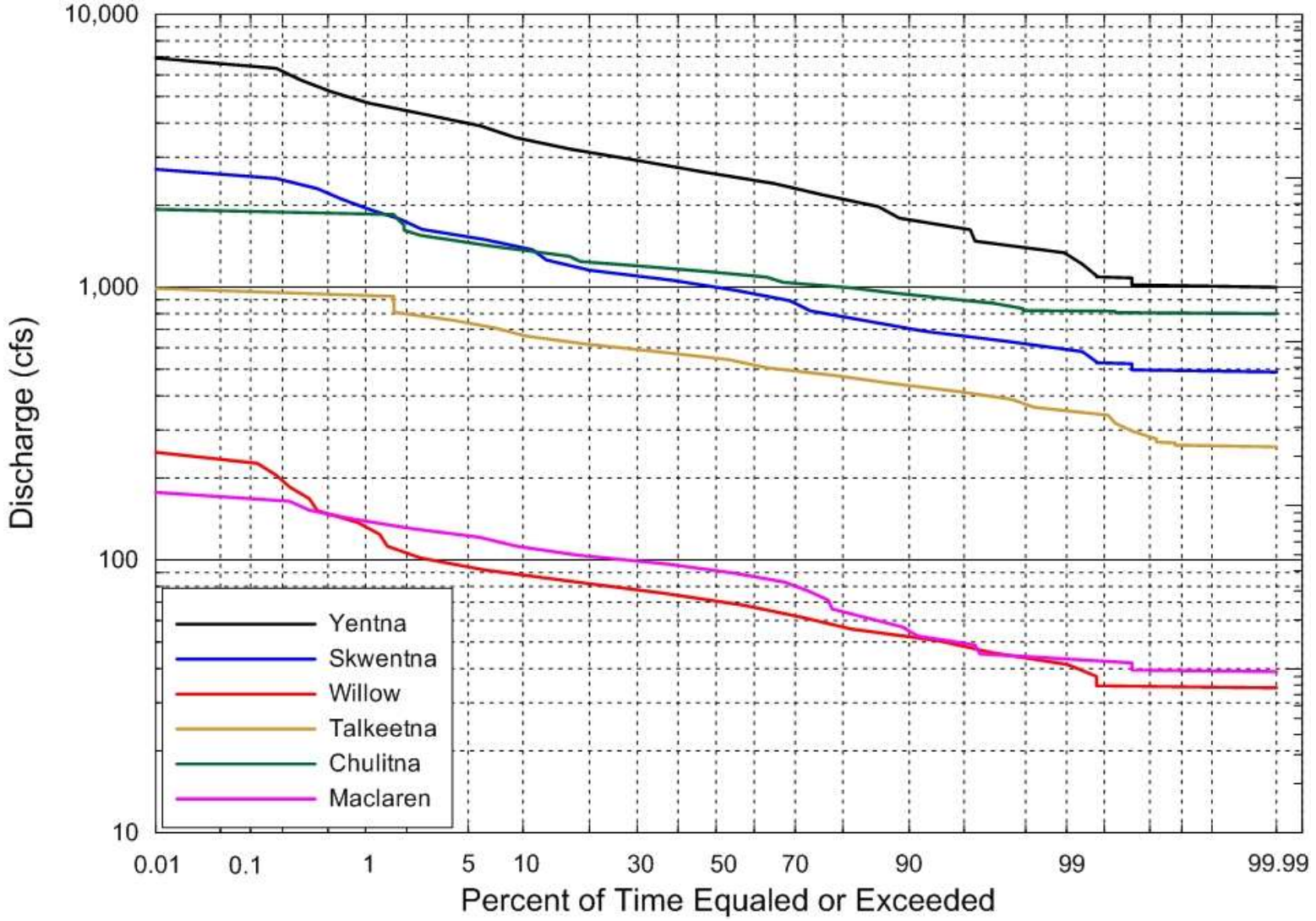

Figure B-17 – Monthly Flow-duration Curves for February for Tributary Gages for Pre-Project Conditions based on the USGS Extended Record

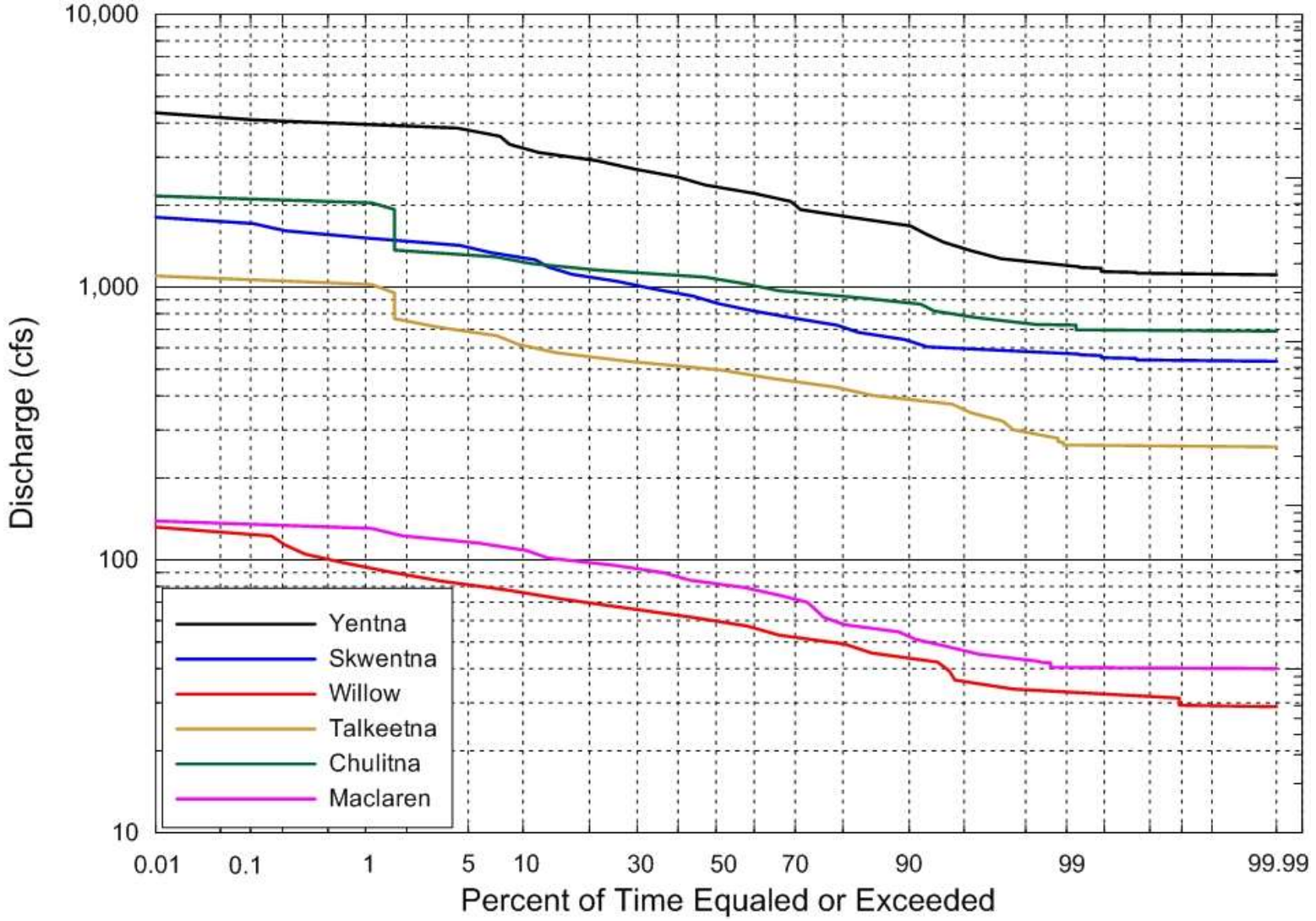

Figure B-18 – Monthly Flow-duration Curves for March for Tributary Gages for Pre-Project Conditions based on the USGS Extended Record

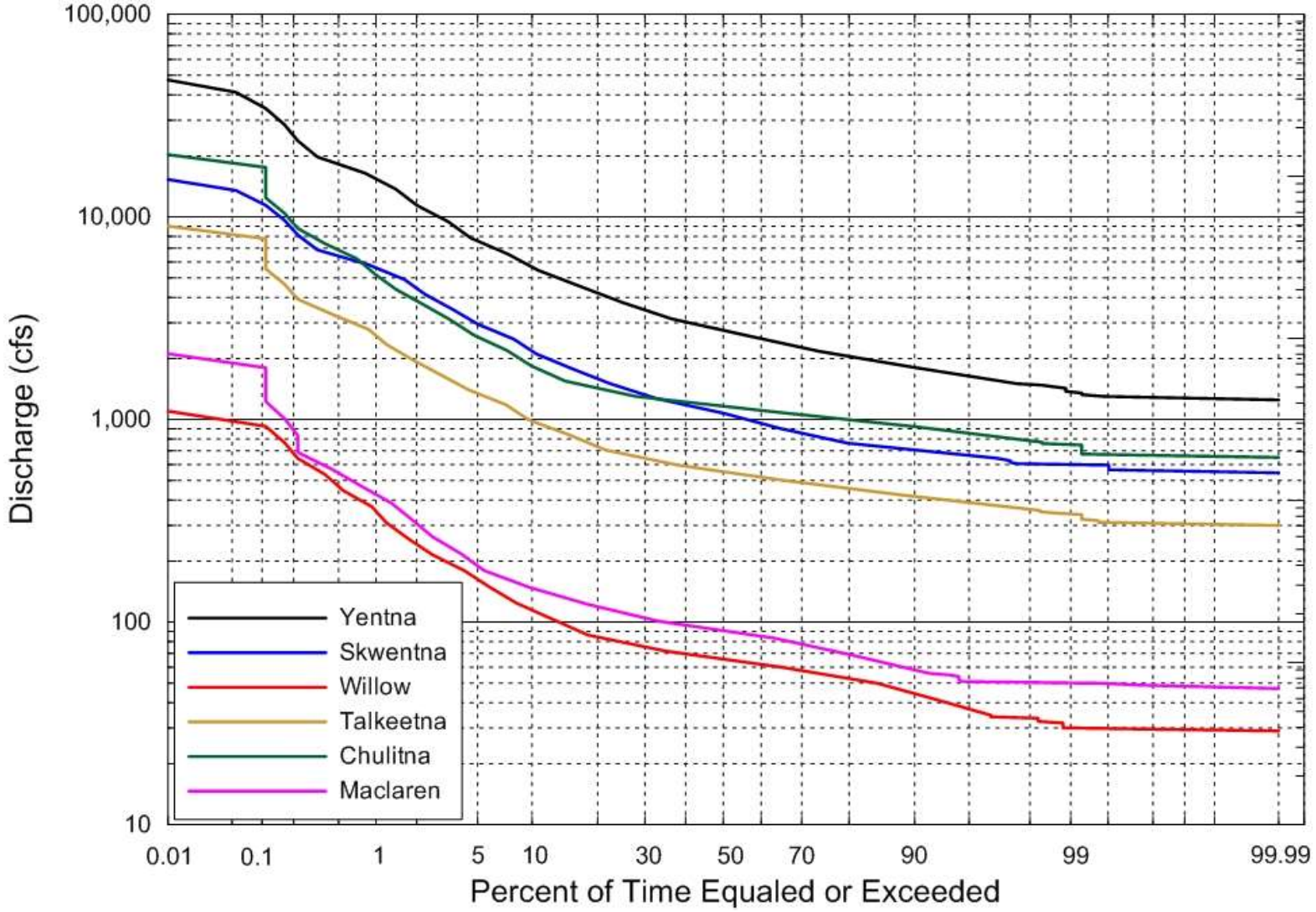

Figure B-19 – Monthly Flow-duration Curves for April for Tributary Gages for Pre-Project Conditions based on the USGS Extended Record

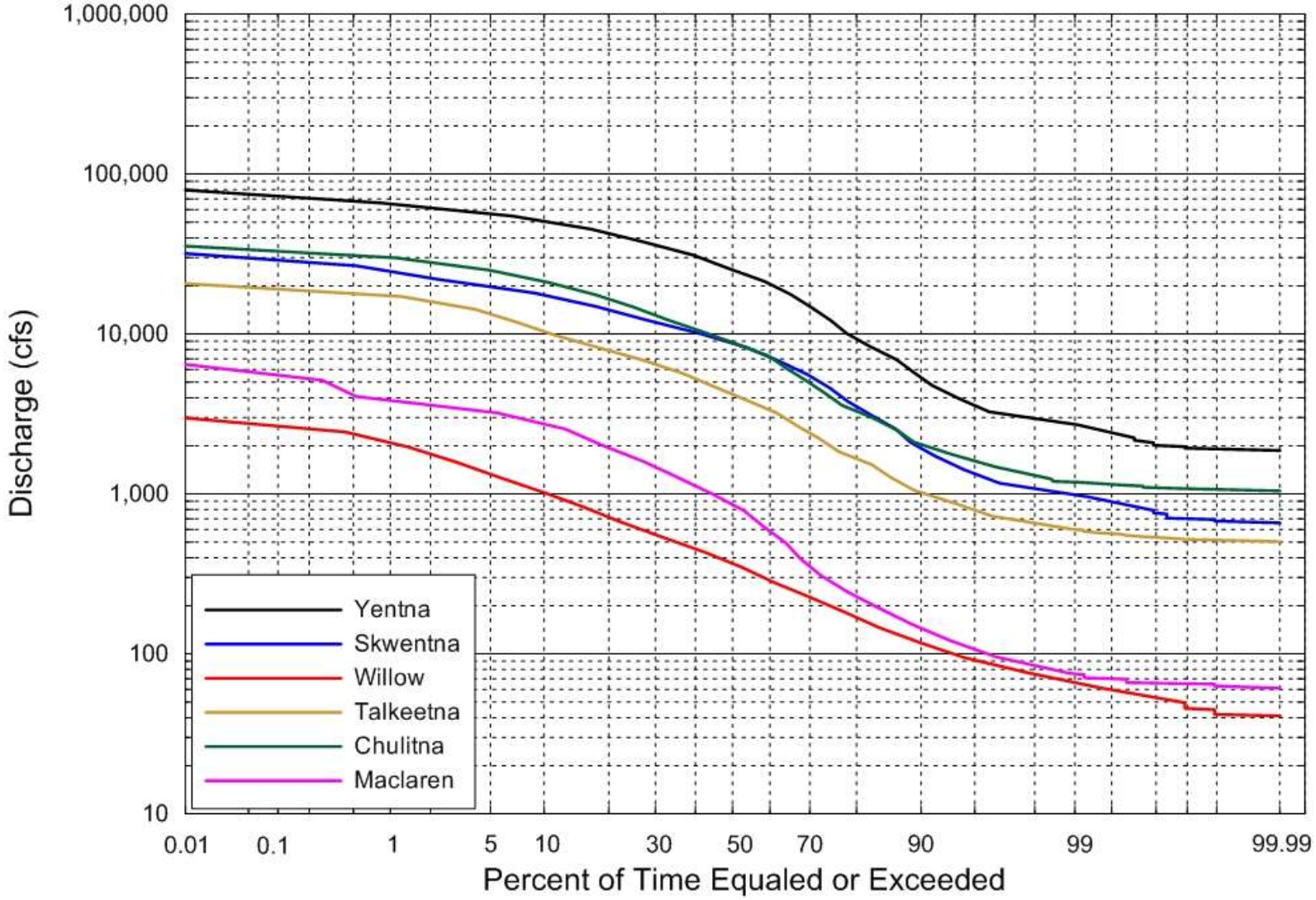

Figure B-20 – Monthly Flow-duration Curves for May for Tributary Gages for Pre-Project Conditions based on the USGS Extended Record

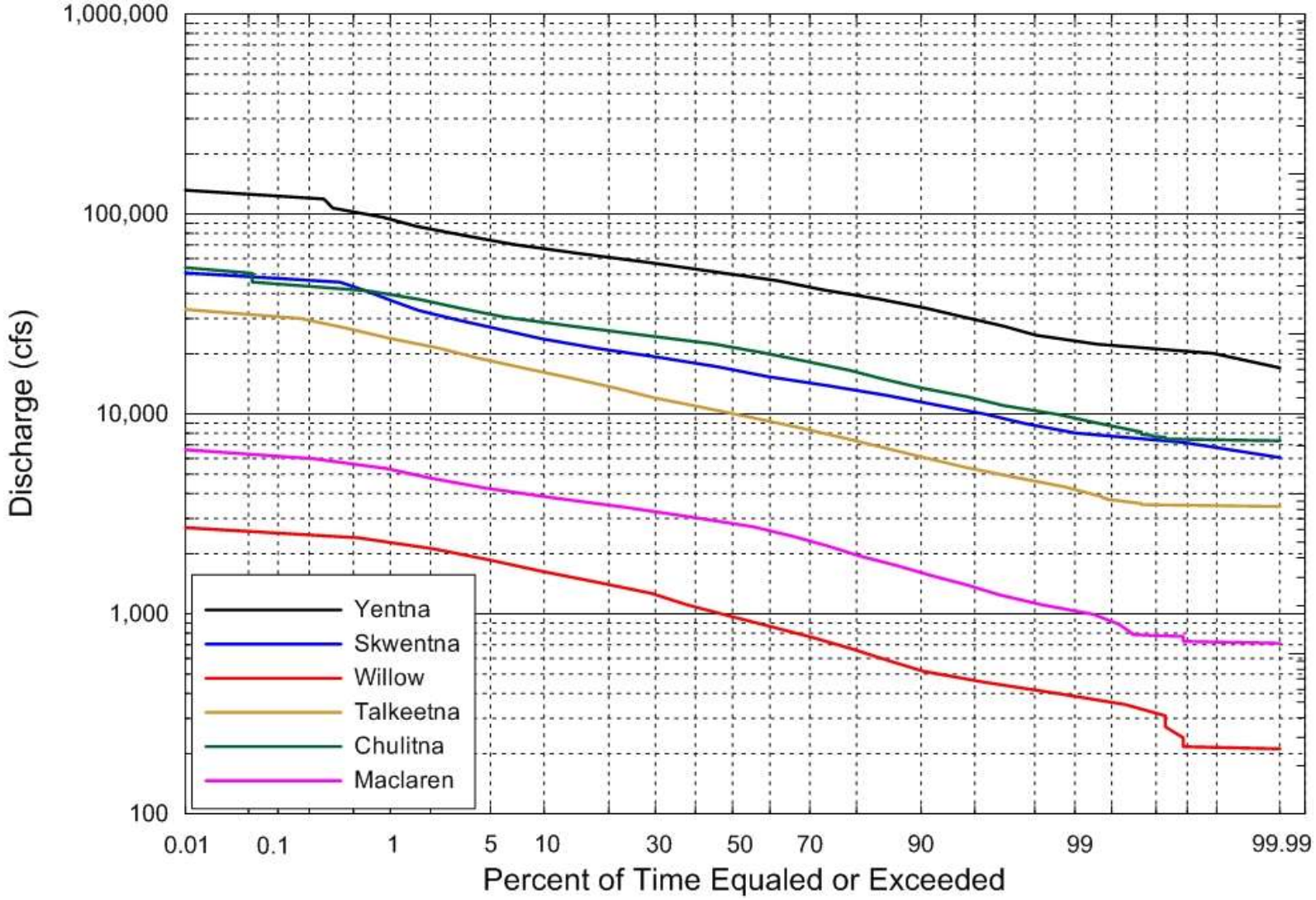

Figure B-21 – Monthly Flow-duration Curves for June for Tributary Gages for Pre-Project Conditions based on the USGS Extended Record

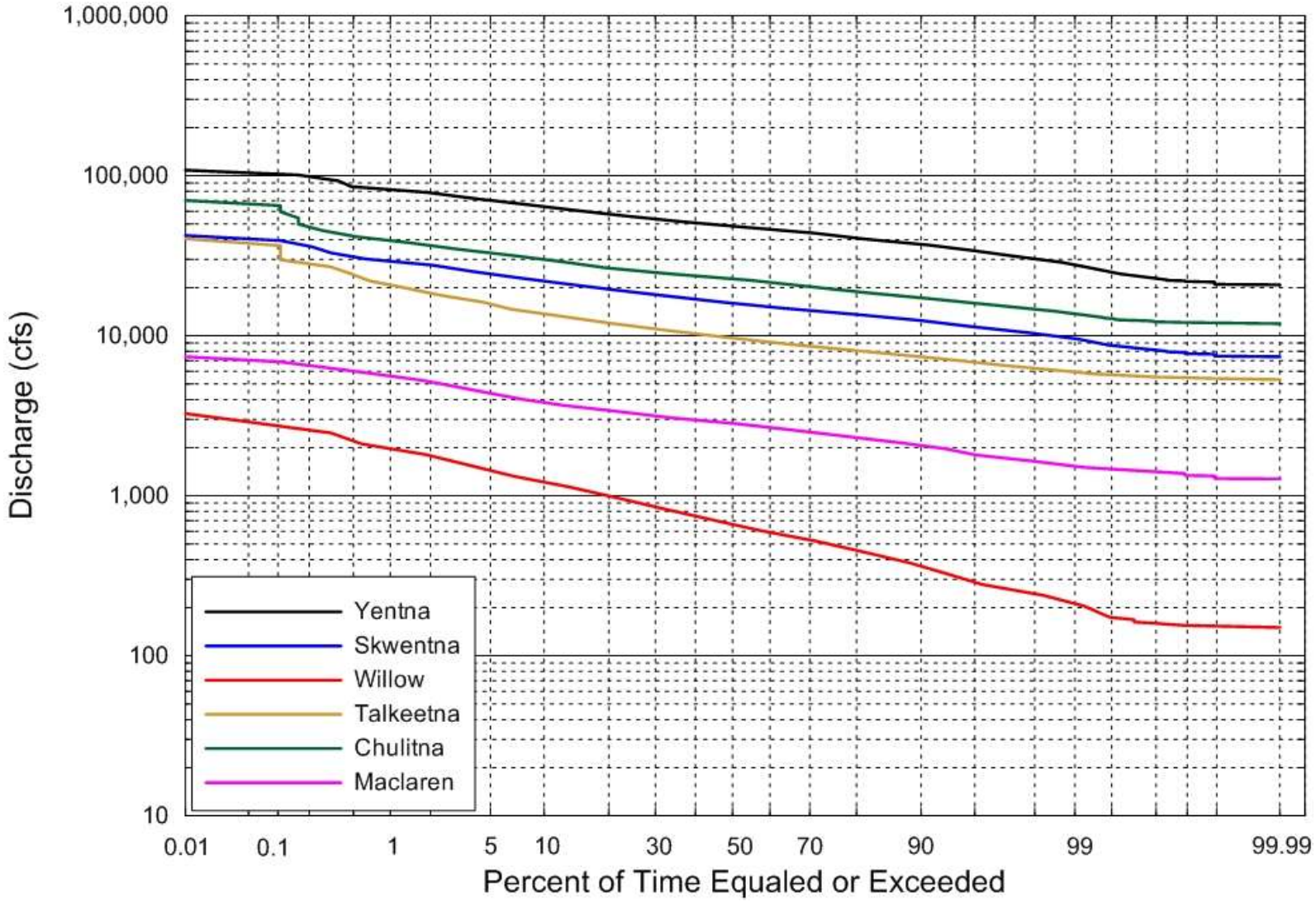

Figure B-22 – Monthly Flow-duration Curves for July for Tributary Gages for Pre-Project Conditions based on the USGS Extended Record

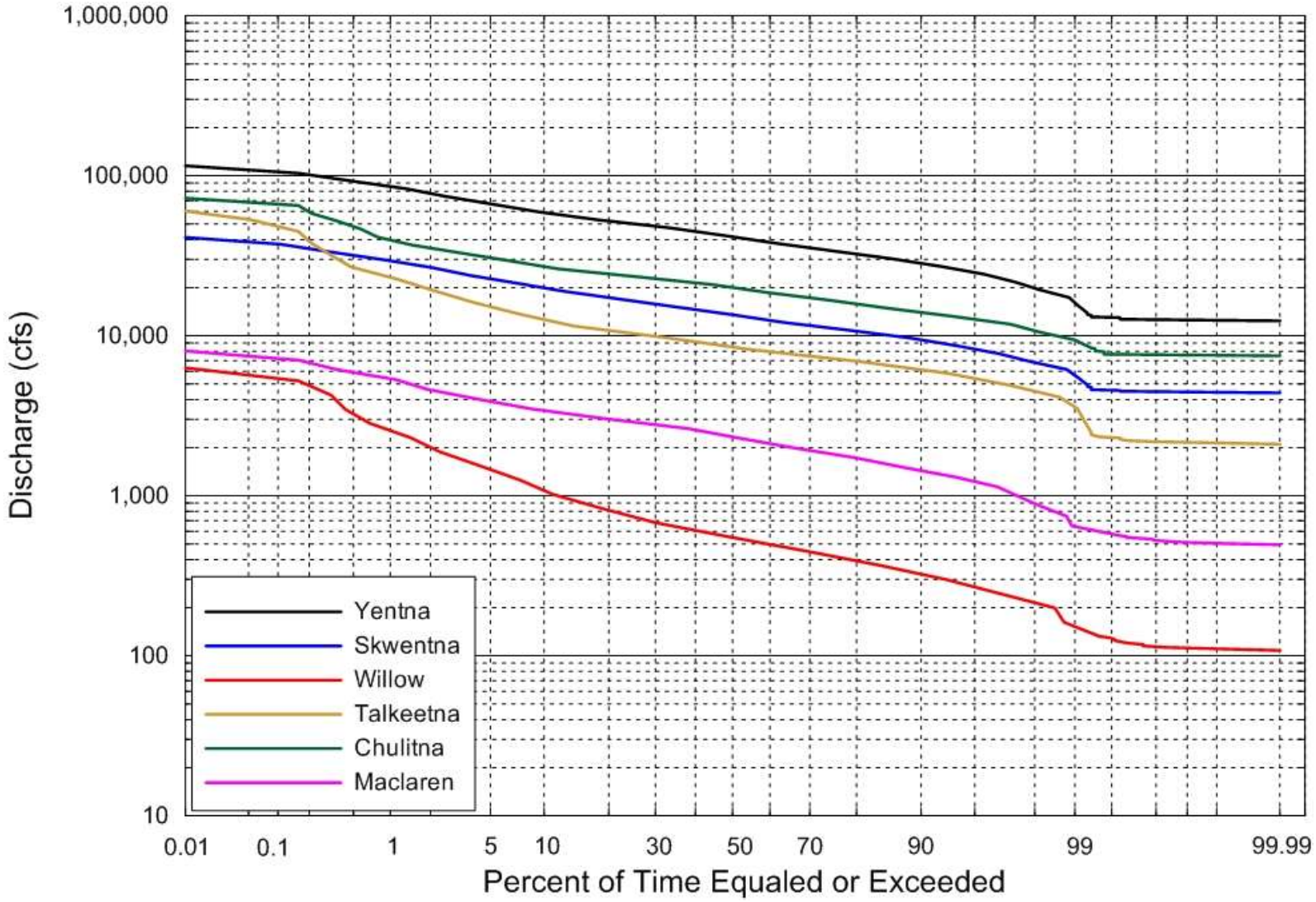

Figure B-23 – Monthly Flow-duration Curves for August for Tributary Gages for Pre-Project Conditions based on the USGS Extended Record

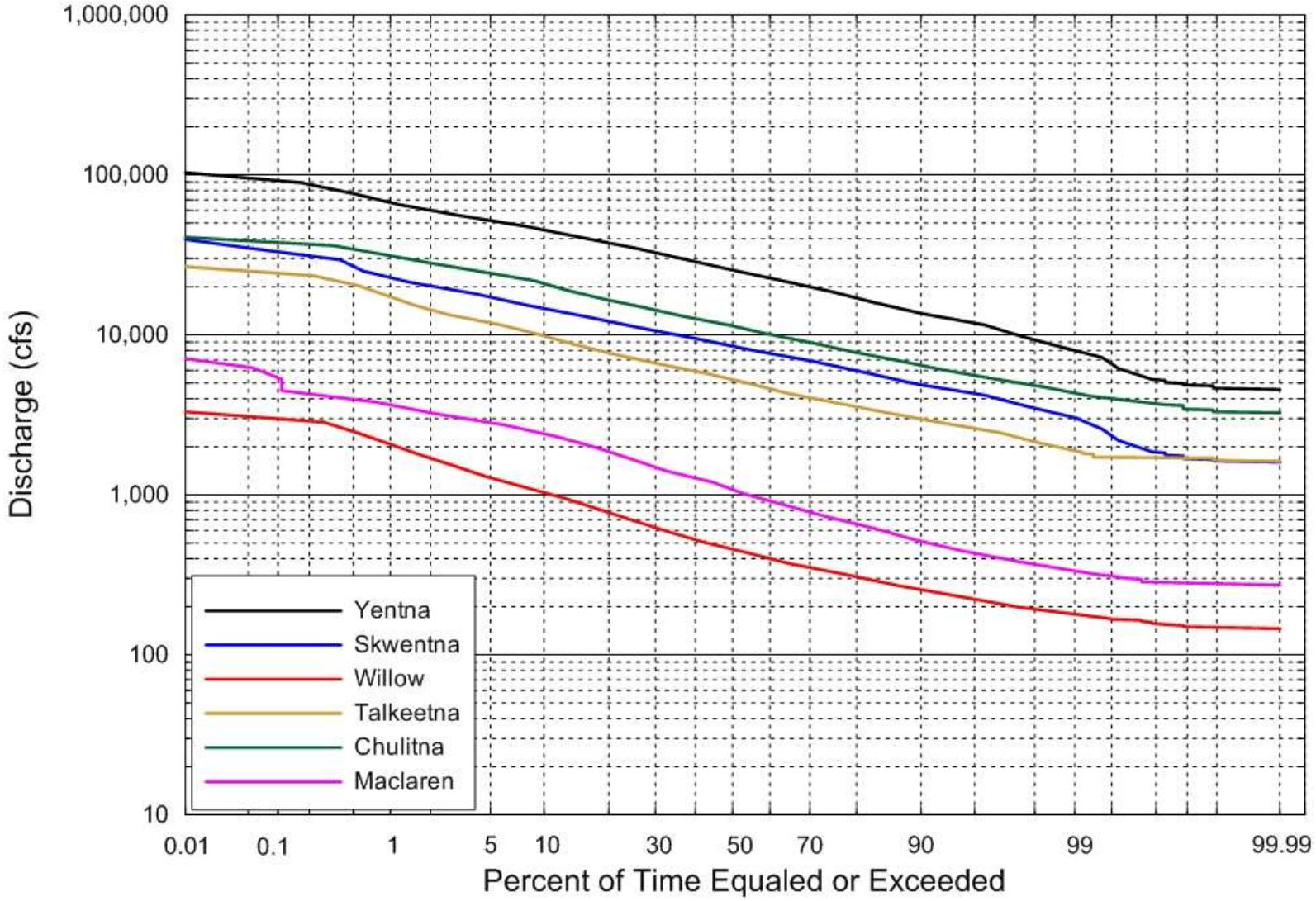

Figure B-24 – Monthly Flow-duration Curves for September for Tributary Gages for Pre-Project Conditions based on the USGS Extended Record

APPENDIX C. FLOW EXCEEDENCE SUMMARY DATA (CFS) FOR PRE-PROJECT CONDITIONS

Susitna-Watana Hydroelectric Project (FERC No. 14241)

Stream Flow Assessment

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

Tetra Tech

February 2013

Table C-1 – Annual and Monthly Flow Exceedence Ordinates (cfs) for Pre-Project Conditions for Susitna River near Denali based on the USGS Extended Record

Susitna River near Denali													
Percentile	**Annual**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
99%	110	391	219	160	100	87	50	36	218	2,400	4,310	2,260	900
95%	181	524	269	190	140	140	120	122	322	3,520	5,180	3,580	1,200
90%	200	600	300	215	190	150	140	150	520	4,090	5,750	4,200	1,440
75%	263	794	378	269	219	200	190	197	960	5,560	7,000	5,260	2,020
50%	650	1,100	471	310	260	227	207	243	2,380	7,630	8,400	7,040	3,070
25%	5,070	1,500	600	380	300	264	242	300	4,610	8,990	9,600	8,690	4,690
10%	8,500	2,350	740	440	340	300	290	438	7,210	10,100	11,500	10,500	6,990
5%	9,570	2,960	809	500	361	320	311	588	8,720	11,300	12,800	12,100	8,070
1%	12,700	5,200	1,000	580	440	340	323	1,240	9,550	14,000	17,100	15,800	9,850

Table C-2 - Annual and Monthly Flow Exceedence Ordinates (cfs) for Pre-Project Conditions for Maclaren River near Paxson based on the USGS Extended Record

Maclaren River near Paxson													
Percentile	**Annual**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
99%	47	137	83	48	44	42	40	50	75	1,010	1,540	613	331
95%	60	194	98	70	60	50	47	50	110	1,370	1,810	1,240	428
90%	76	220	110	75	64	55	52	59	147	1,600	2,050	1,450	515
75%	100	280	139	100	85	76	64	72	280	2,160	2,410	1,820	715
50%	220	380	170	122	101	90	83	93	890	2,850	2,830	2,340	1,070
25%	1,820	531	210	140	117	100	96	110	1,700	3,380	3,290	2,900	1,640
10%	2,950	798	262	180	135	110	110	148	2,780	3,870	3,830	3,400	2,400
5%	3,400	1,010	300	198	150	126	120	190	3,260	4,200	4,350	3,890	2,870
1%	4,400	1,800	400	260	170	140	133	418	3,800	5,070	5,610	5,390	3,640

Table C-3 - Annual and Monthly Flow Exceedence Ordinates (cfs) for Pre-Project Conditions for Susitna River near Cantwell based on the USGS Extended Record

Susitna River near Cantwell													
Percentile	**Annual**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
99%	440	1,100	700	548	440	414	400	431	750	7,130	9,440	5,760	2,980
95%	560	1,550	800	638	548	471	430	491	1,210	9,160	10,700	8,400	3,680
90%	694	1,900	950	720	578	500	465	530	1,650	10,400	11,500	9,370	4,320
75%	940	2,490	1,200	879	758	670	578	698	3,180	13,200	13,100	10,900	5,890
50%	2,050	3,300	1,550	1,120	940	819	758	879	8,190	15,900	15,200	13,300	7,770
25%	11,400	4,670	1,900	1,310	1,120	970	879	1,130	12,400	19,900	18,000	16,000	10,800
10%	16,500	6,310	2,200	1,500	1,300	1,060	1,060	1,490	17,000	24,000	20,800	18,800	14,000
5%	19,400	7,410	2,600	1,610	1,430	1,200	1,200	2,000	19,700	27,000	22,900	21,700	16,100
1%	25,700	10,100	3,230	2,090	1,700	1,500	1,500	4,320	23,700	34,400	27,500	30,000	20,800

Table C-4 - Annual and Monthly Flow Exceedence Ordinates (cfs) for Pre-Project Conditions for Susitna River at Gold Creek based on the USGS Extended Record

Susitna River at Gold Creek													
Percentile	**Annual**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
99%	750	1,900	1,100	850	750	700	660	710	1,400	12,100	14,600	8,240	4,910
95%	960	2,710	1,400	1,100	950	800	750	830	2,100	14,900	16,400	12,900	6,000
90%	1,200	3,300	1,700	1,200	980	860	800	930	2,800	16,400	17,800	14,500	7,340
75%	1,600	4,200	2,100	1,600	1,400	1,200	1,000	1,200	5,000	20,000	20,000	17,000	9,560
50%	3,400	5,500	2,600	1,900	1,600	1,400	1,300	1,520	13,000	25,100	23,000	20,400	12,500
25%	17,800	7,790	3,100	2,200	1,900	1,690	1,500	1,820	20,000	30,500	26,900	24,000	16,800
10%	25,300	10,300	3,690	2,500	2,000	1,850	1,800	2,500	27,100	36,700	31,300	28,500	21,800
5%	29,800	12,000	4,200	2,700	2,200	2,000	1,900	3,300	31,000	41,100	34,500	32,700	25,000
1%	39,300	16,100	5,100	3,460	2,500	2,400	2,100	7,000	37,800	58,800	42,600	51,100	32,000

Table C-5 - Annual and Monthly Flow Exceedence Ordinates (cfs) for Pre-Project Conditions for Chulitna River near Talkeetna based on the USGS Extended Record

Chulitna River near Talkeetna													
Percentile	**Annual**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
99%	820	1,700	1,100	1,000	950	820	730	750	1,200	9,600	13,800	9,410	4,310
95%	965	2,370	1,300	1,080	995	900	800	884	1,540	11,900	16,100	12,700	5,540
90%	1,040	2,790	1,440	1,100	1,010	942	877	933	2,100	13,500	17,300	14,000	6,460
75%	1,230	3,440	1,620	1,300	1,100	1,010	950	1,000	4,000	17,100	19,600	16,600	8,400
50%	2,840	4,780	2,110	1,500	1,280	1,130	1,070	1,170	8,940	21,800	22,700	20,000	11,500
25%	16,100	6,990	2,640	1,740	1,420	1,210	1,130	1,350	14,800	25,100	25,600	23,400	15,100
10%	23,400	9,820	3,230	2,100	1,600	1,400	1,230	1,810	21,400	28,600	30,000	26,900	20,900
5%	26,200	12,000	3,890	2,200	1,800	1,440	1,300	2,580	25,000	31,200	33,400	30,700	24,200
1%	33,700	19,100	5,400	2,920	2,000	1,930	2,060	5,190	30,600	39,000	39,100	40,000	31,400

Table C-6 - Annual and Monthly Flow Exceedence Ordinates (cfs) for Pre-Project Conditions for Talkeetna River near Talkeetna based on the USGS Extended Record

Talkeetna River near Talkeetna													
Percentile	**Annual**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
99%	380	900	550	500	440	350	260	340	600	4,170	5,890	3,670	1,900
95%	450	1,200	661	520	460	400	350	390	800	5,310	6,830	5,600	2,600
90%	500	1,400	746	550	495	440	390	420	1,000	6,120	7,400	6,240	3,000
75%	621	1,770	900	661	550	480	440	488	2,000	7,940	8,280	7,250	3,800
50%	1,430	2,360	1,100	791	660	550	500	550	4,160	9,990	9,680	8,460	5,220
25%	7,240	3,400	1,310	900	720	600	540	682	7,200	12,800	11,400	10,200	7,110
10%	10,500	4,690	1,700	1,040	800	680	600	965	10,200	16,000	13,700	12,600	9,890
5%	12,800	5,640	2,000	1,100	855	750	700	1,350	13,200	18,600	15,900	15,000	12,000
1%	18,100	8,530	2,630	1,520	1,000	990	1,050	2,510	17,600	23,800	20,600	23,400	17,100

Table C-7 - Annual and Monthly Flow Exceedence Ordinates (cfs) for Pre-Project Conditions for Susitna River at Sunshine based on the USGS Extended Record

Susitna River at Sunshine													
Percentile	**Annual**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
99%	1,740	5,280	2,820	2,340	2,030	1,570	1,390	1,560	3,060	29,700	38,000	21,000	12,000
95%	2,310	6,880	3,590	2,500	2,110	1,900	1,650	1,850	5,340	37,000	43,000	33,900	15,300
90%	2,830	8,120	4,100	2,830	2,370	2,120	1,920	2,030	6,990	40,800	46,400	38,000	18,000
75%	3,750	10,400	5,140	3,750	3,260	2,830	2,370	2,660	13,100	50,600	52,000	44,500	23,800
50%	8,220	13,600	6,100	4,520	3,700	3,280	2,930	3,520	31,100	63,500	58,600	52,900	32,000
25%	45,000	19,500	7,470	5,190	4,350	3,760	3,490	4,330	47,800	73,900	67,600	61,200	42,600
10%	64,000	26,300	9,150	5,840	4,780	4,330	3,920	5,900	65,800	85,100	76,800	71,400	56,200
5%	72,800	31,300	10,400	6,370	4,940	4,510	4,390	7,760	75,100	93,400	82,500	80,000	64,200
1%	91,200	45,000	13,000	8,490	5,620	4,990	4,790	15,700	85,100	119,000	97,600	111,000	80,300

Table C-8 - Annual and Monthly Flow Exceedence Ordinates (cfs) for Pre-Project Conditions for Willow Creek near Willow based on the USGS Extended Record

Willow Creek near Willow													
Percentile	**Annual**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
99%	38	108	58	47	51	42	32	29	68	391	209	159	177
95%	51	141	80	65	60	49	34	38	92	461	288	266	223
90%	60	163	97	70	61	51	43	44	117	521	367	325	253
75%	80	203	119	88	71	60	50	55	195	711	491	421	328
50%	171	268	149	101	85	71	61	65	374	968	666	548	455
25%	526	373	171	121	94	80	68	78	624	1,320	912	737	693
10%	930	559	211	140	106	90	76	115	1,010	1,630	1,230	1,090	1,040
5%	1,240	708	249	150	112	96	80	161	1,310	1,850	1,400	1,480	1,290
1%	1,870	1,140	349	170	130	130	93	353	2,160	2,330	2,030	2,610	2,050

Table C-9 - Annual and Monthly Flow Exceedence Ordinates (cfs) for Pre-Project Conditions for Skwentna River near Skwentna based on the USGS Extended Record

Skwentna River near Skwentna													
Percentile	**Annual**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
99%	600	1,460	700	650	600	585	596	600	970	8,080	9,610	5,730	3,030
95%	750	2,000	1,090	867	762	651	600	650	1,290	10,200	11,400	8,360	4,320
90%	850	2,400	1,240	900	800	700	636	700	1,960	11,500	12,400	9,520	4,860
75%	1,140	3,080	1,500	1,100	976	810	747	800	4,500	13,700	14,000	11,100	6,460
50%	2,660	4,200	1,950	1,350	1,100	1,000	873	1,090	8,880	16,600	16,000	13,500	8,520
25%	12,000	5,800	2,330	1,570	1,270	1,140	1,050	1,460	12,900	20,100	18,800	16,300	11,400
10%	17,200	7,800	2,900	1,880	1,530	1,380	1,300	2,200	17,800	23,600	22,000	19,900	14,700
5%	19,900	9,050	3,300	2,130	1,710	1,500	1,400	2,970	19,600	27,400	24,200	22,700	17,000
1%	26,400	13,400	4,460	2,900	2,800	1,950	1,470	5,630	24,600	37,000	29,600	29,400	22,200

Table C-10 - Annual and Monthly Flow Exceedence Ordinates (cfs) for Pre-Project Conditions for Yentna River near Susitna Station based on the USGS Extended Record

Yentna River near Susitna Station													
Percentile	**Annual**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
99%	1,460	3,600	2,000	1,860	1,650	1,260	1,250	1,360	2,770	22,800	27,300	16,200	7,840
95%	1,910	5,380	2,850	2,280	1,720	1,670	1,400	1,600	3,420	29,800	33,900	24,900	11,900
90%	2,280	6,530	3,140	2,400	2,100	1,730	1,690	1,850	5,120	34,100	37,500	28,500	13,700
75%	2,970	8,300	3,990	2,970	2,570	2,280	1,910	2,150	12,100	40,800	42,800	34,200	18,600
50%	6,950	11,300	5,120	3,440	2,860	2,570	2,290	2,720	25,400	50,000	48,500	41,900	25,400
25%	36,500	16,300	6,230	4,200	3,420	3,050	2,800	3,800	39,000	58,700	55,400	49,700	35,200
10%	51,300	22,600	7,750	4,810	4,000	3,430	3,140	5,680	51,200	66,500	64,100	59,000	45,800
5%	58,700	27,300	8,770	5,590	4,380	3,960	3,810	7,590	56,700	73,600	70,100	67,100	51,100
1%	73,700	41,900	12,900	6,990	6,010	4,710	3,890	15,200	64,700	95,300	81,700	84,600	67,000

Table C-11 - Annual and Monthly Flow Exceedence Ordinates (cfs) for Pre-Project Conditions for Susitna River at Susitna Station based on the USGS Extended Record

Susitna River at Susitna Station													
Percentile	**Annual**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
99%	5,210	11,000	6,700	6,000	5,670	4,930	4,700	5,000	7,160	65,500	80,200	44,100	21,600
95%	5,840	15,000	7,750	6,280	5,810	5,340	5,070	5,400	10,400	77,000	90,800	70,900	33,100
90%	6,400	18,000	8,720	6,850	6,190	5,810	5,280	5,550	14,700	86,200	98,300	79,700	38,800
75%	7,710	23,500	10,700	7,840	7,000	6,380	5,800	6,120	32,800	102,000	108,000	92,400	50,800
50%	19,000	31,700	13,000	9,000	7,880	6,990	6,440	7,000	64,000	121,000	120,000	107,000	68,600
25%	94,000	42,900	16,700	10,700	8,570	7,530	7,000	9,210	95,200	136,000	133,000	123,000	90,300
10%	124,000	60,000	21,300	12,000	9,720	8,500	7,520	13,500	122,000	152,000	147,000	138,000	114,000
5%	138,000	70,000	25,000	13,300	10,300	9,200	9,000	19,000	135,000	161,000	157,000	153,000	125,000
1%	164,000	97,500	36,500	19,900	11,000	10,000	9,500	37,100	150,000	182,000	186,000	195,000	154,000

APPENDIX D. FLOOD FREQUENCY REGRESSION PLOTS

Susitna-Watana Hydroelectric Project (FERC No. 14241)

Stream Flow Assessment

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

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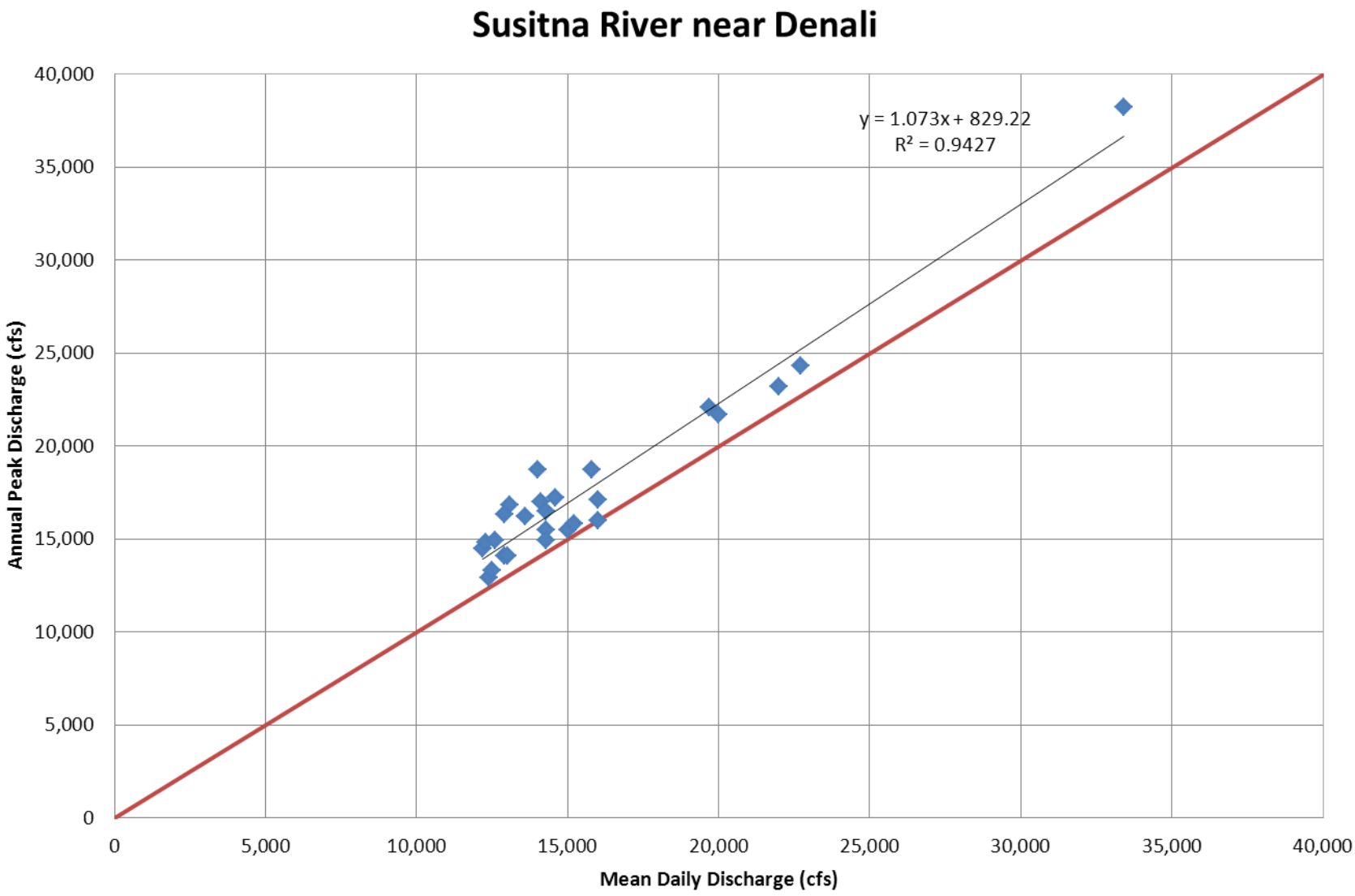

Figure D-1 – Susitna River near Denali regression to extend the Pre-Project USGS available record annual peak data.

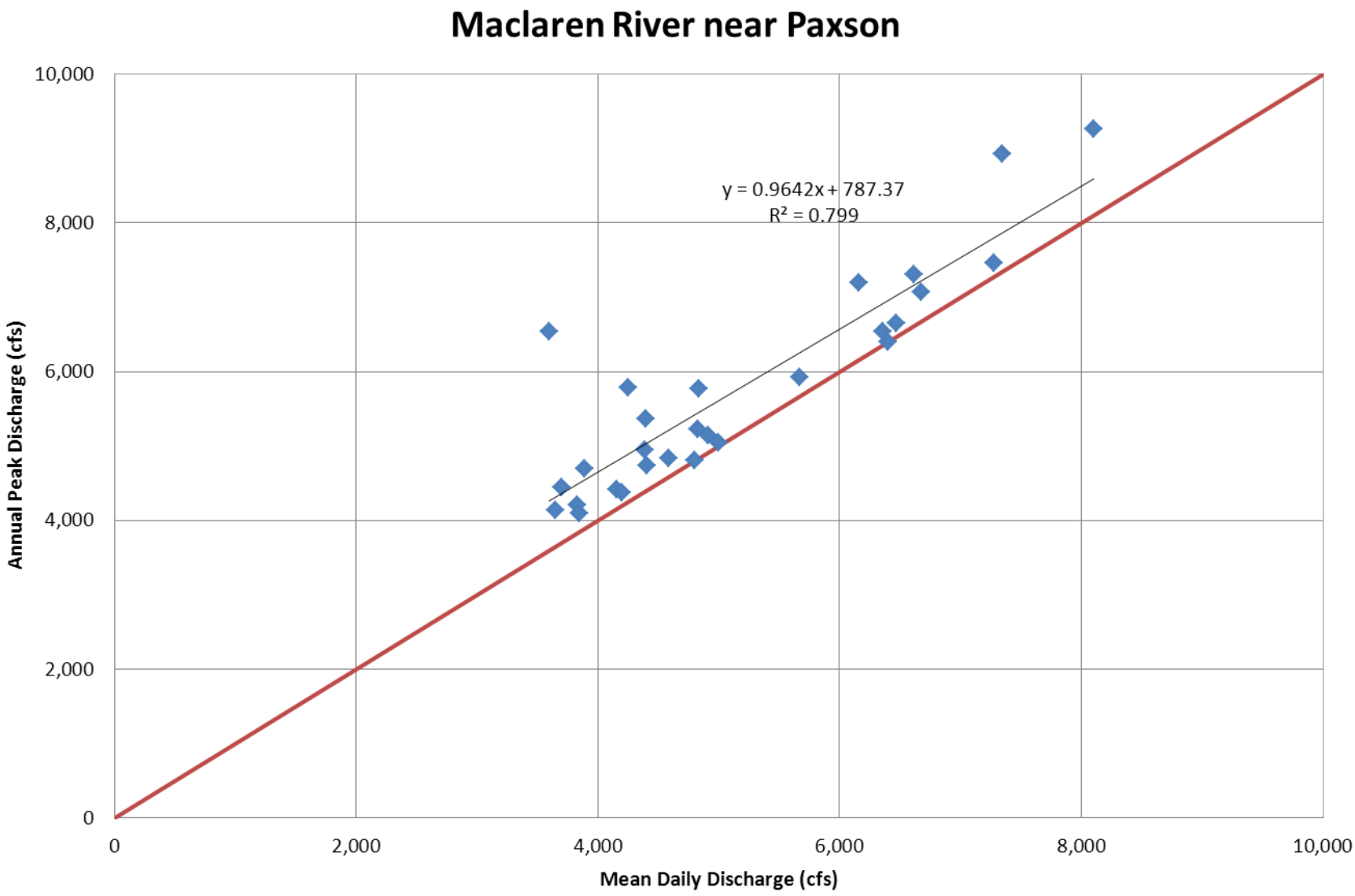

Figure D-2 – Maclaren River near Paxson regression to extend the Pre-Project USGS available record annual peak data.

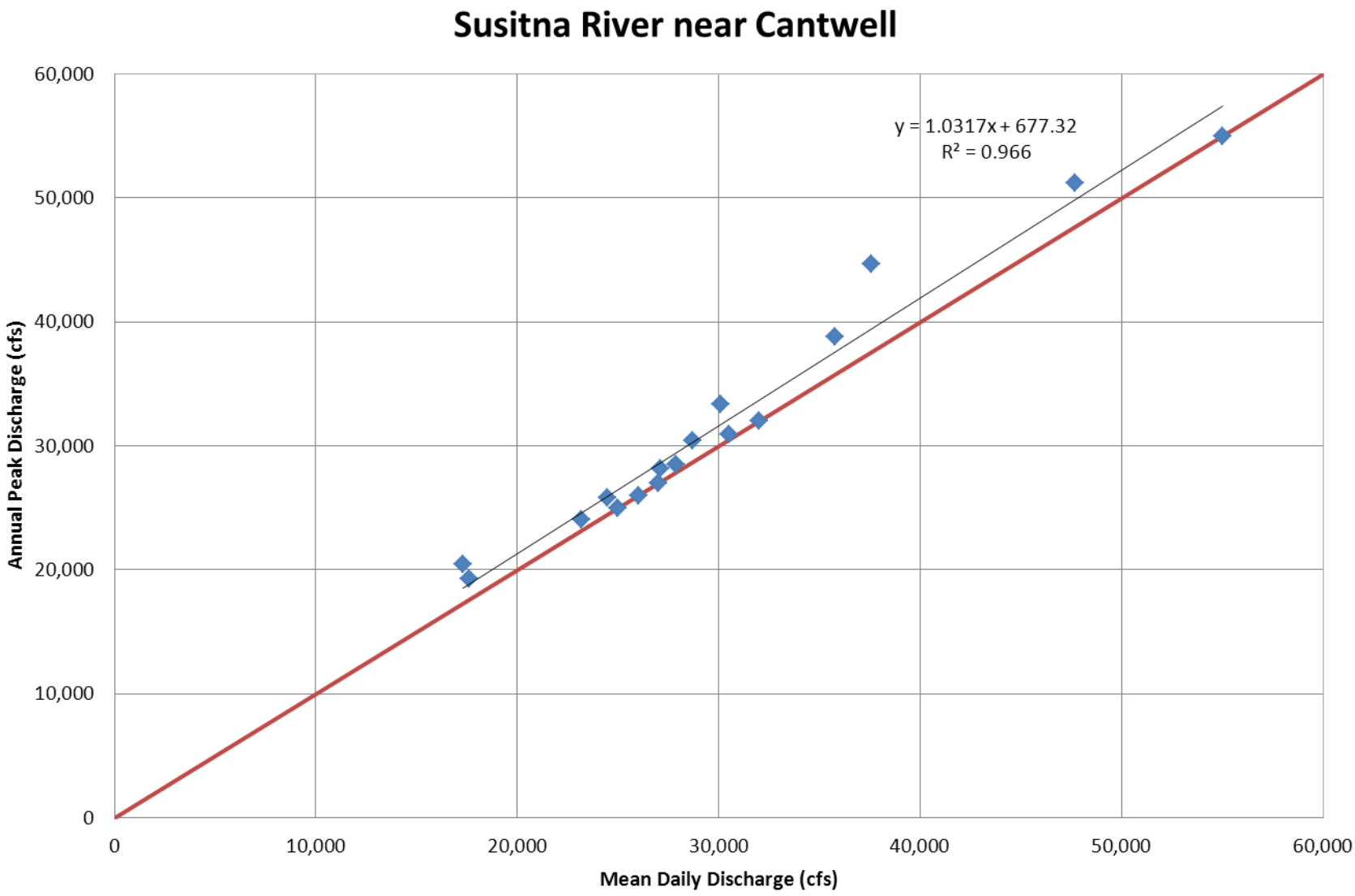

Figure D-3 – Susitna River near Cantwell regression to extend the Pre-Project USGS available record annual peak data.

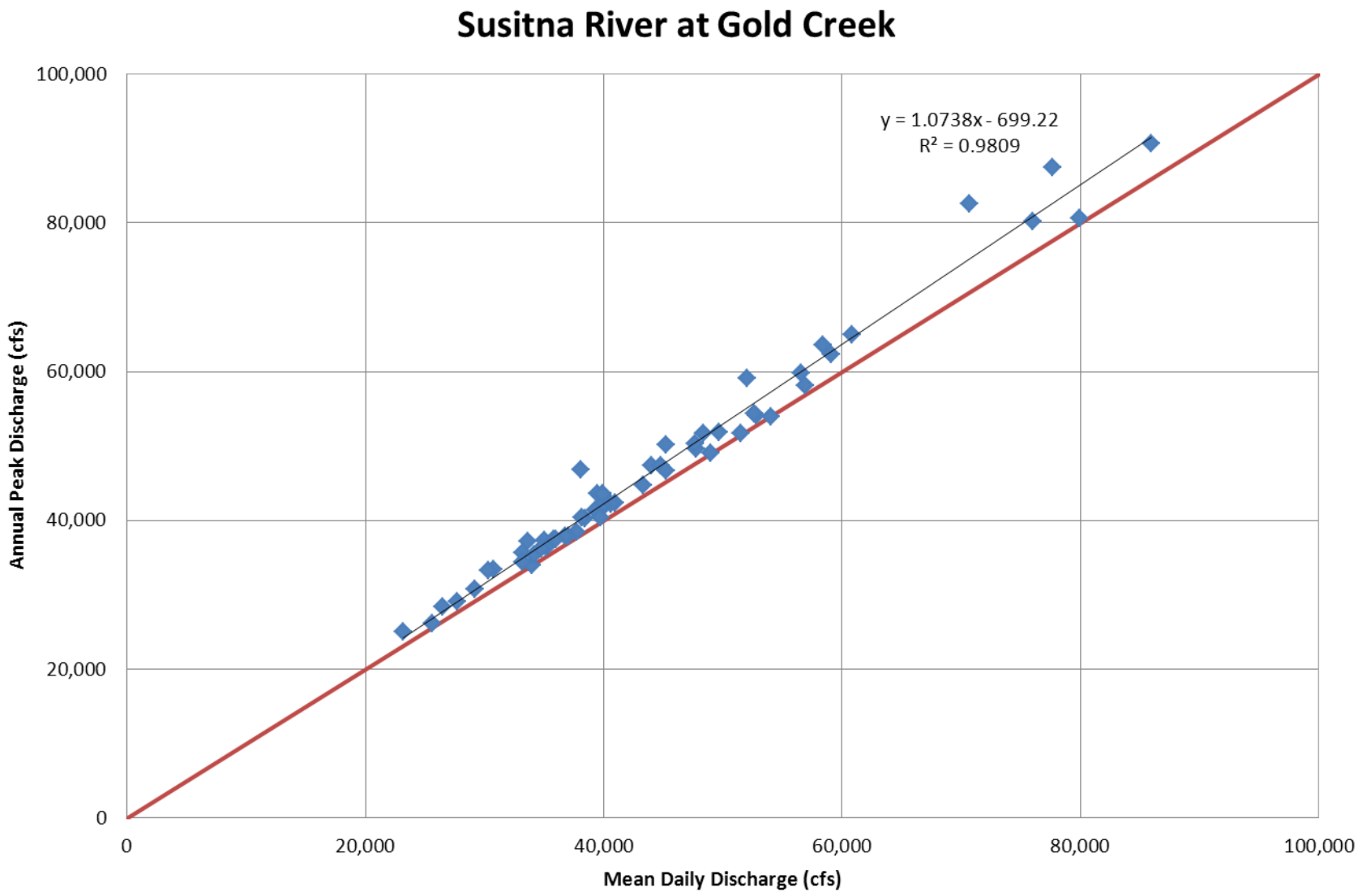

Figure D-4 – Susitna River at Gold Creek regression to extend the Pre-Project USGS available record annual peak data.

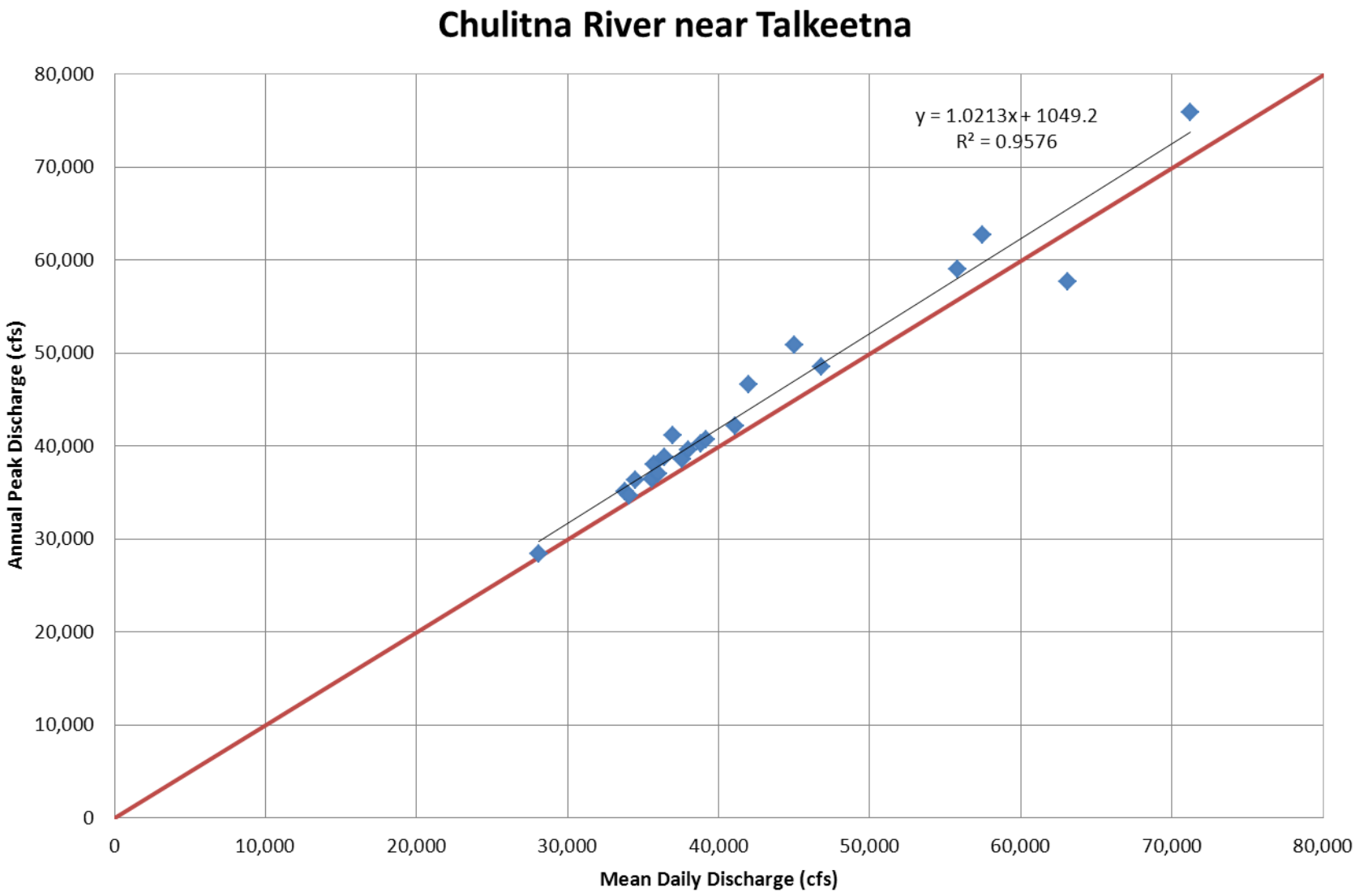

Figure D-5 – Chulitna River near Talkeetna regression to extend the Pre-Project USGS available record annual peak data.

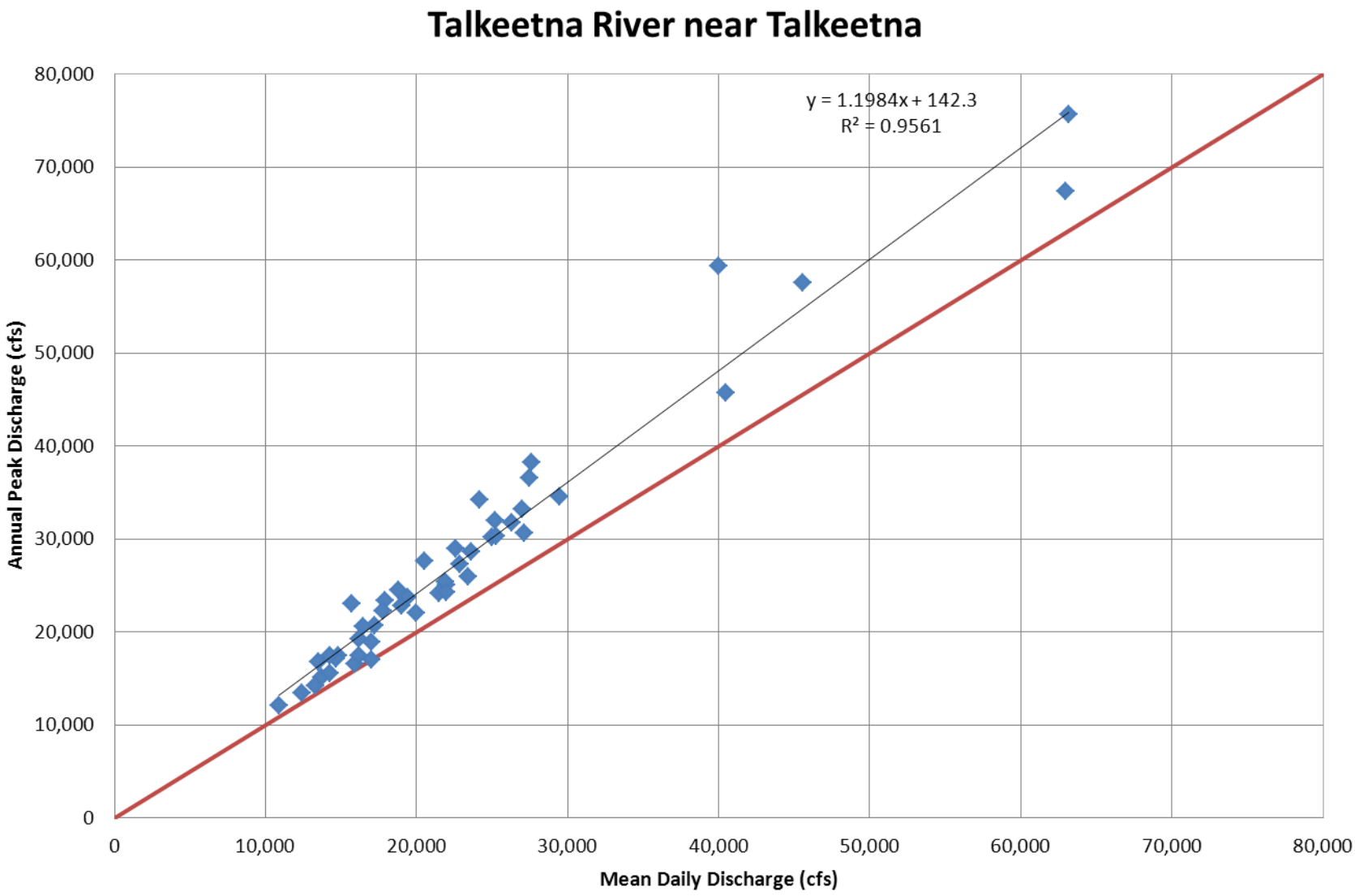

Figure D-6 – Talkeetna River near Talkeetna regression to extend the Pre-Project USGS available record annual peak data.

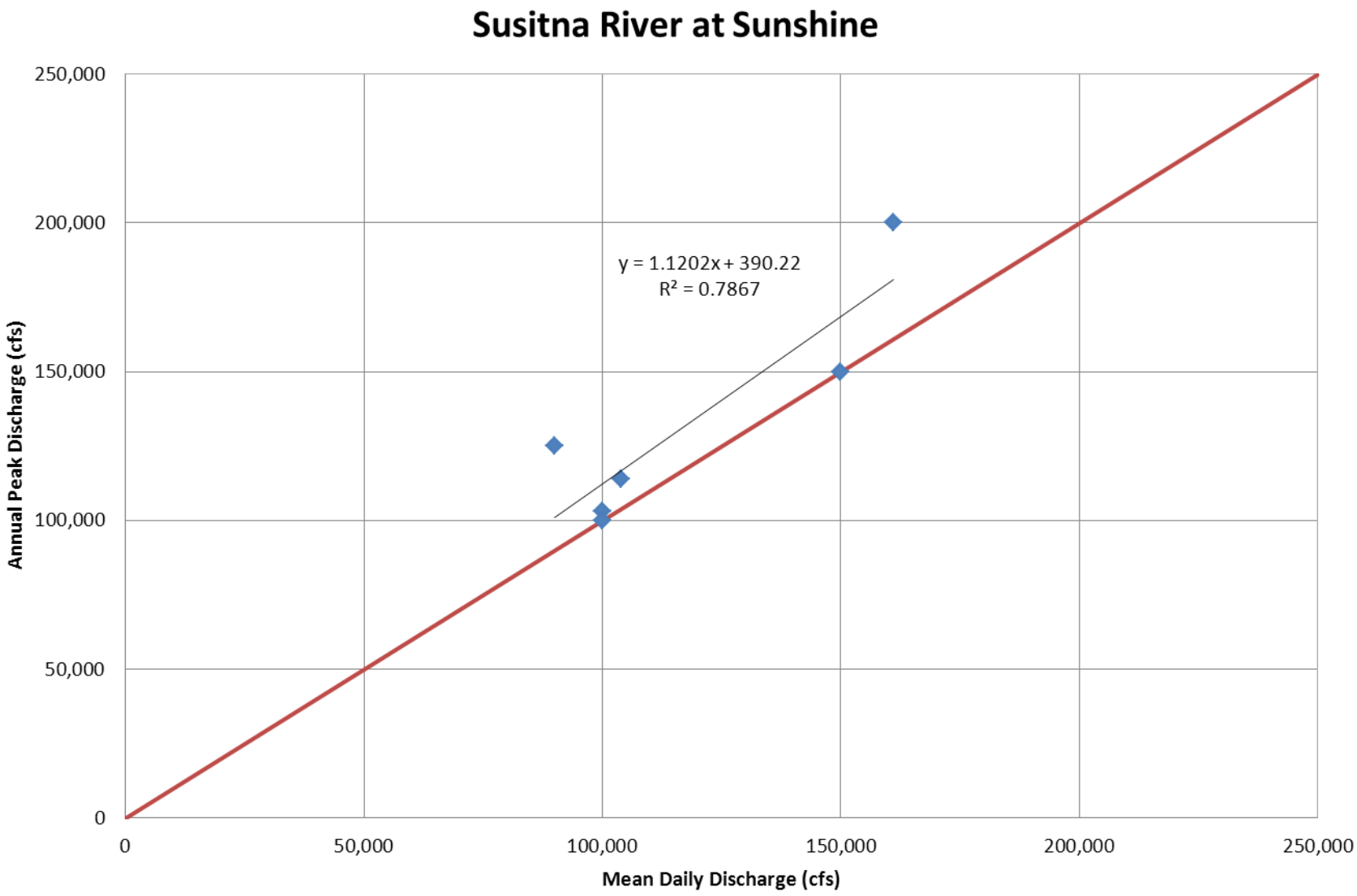

Figure D-7 – Susitna River at Sunshine regression to extend the Pre-Project USGS available record annual peak data.

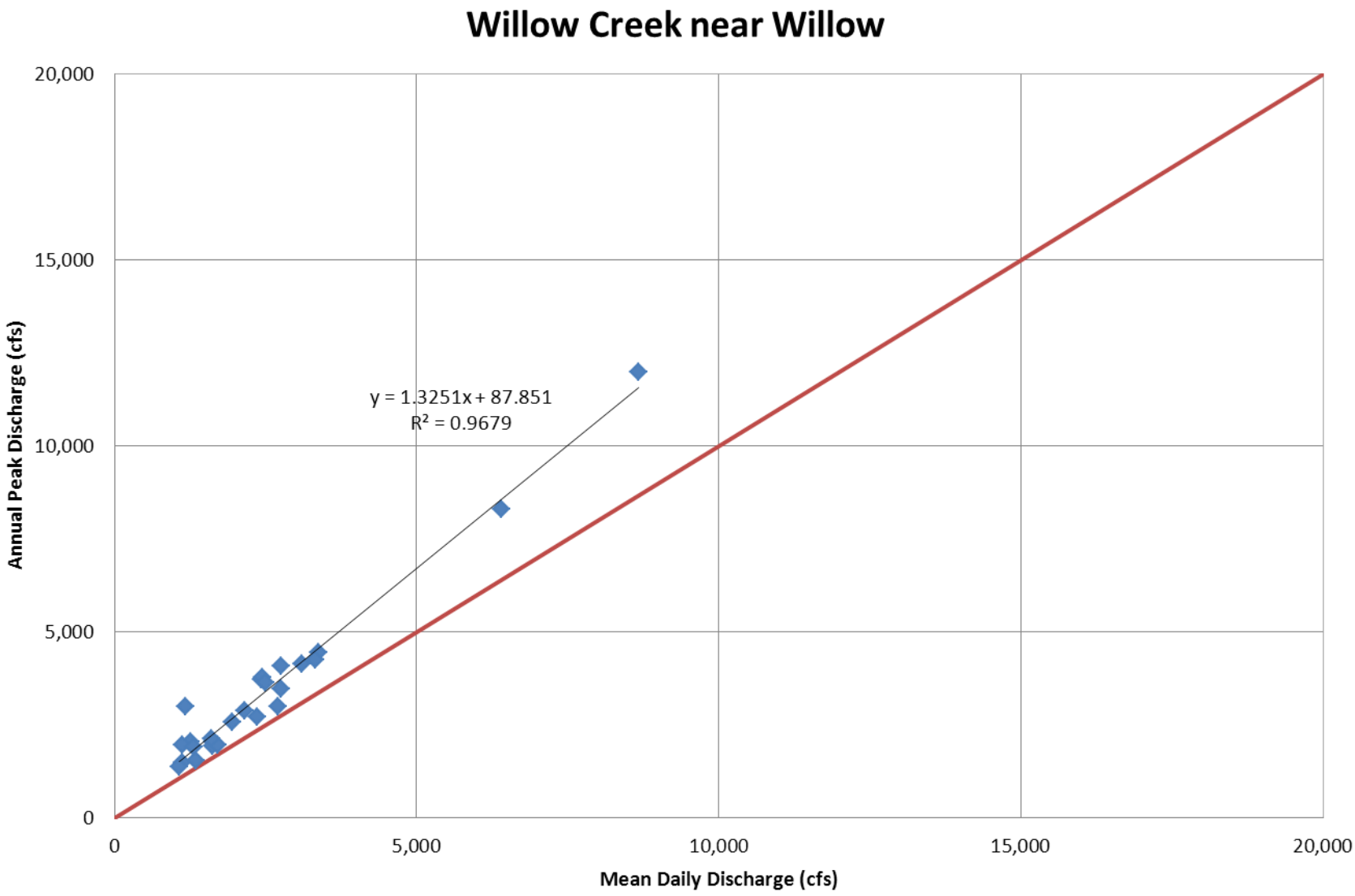

Figure D-8 – Willow Creek near Willow regression to extend the Pre-Project USGS available record annual peak data.

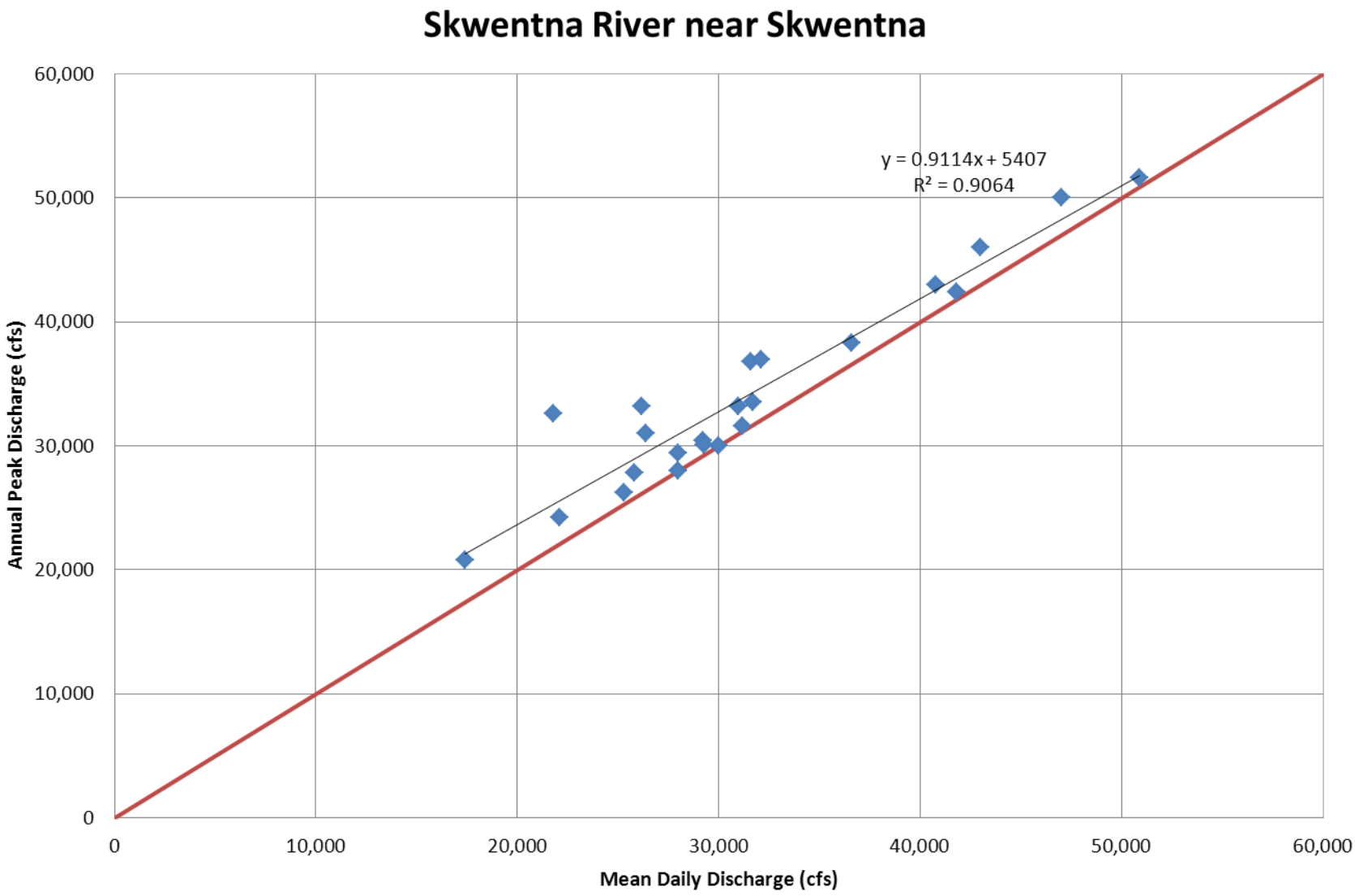

Figure D-9 – Skwentna River near Skwentna regression to extend the Pre-Project USGS available record annual peak data.

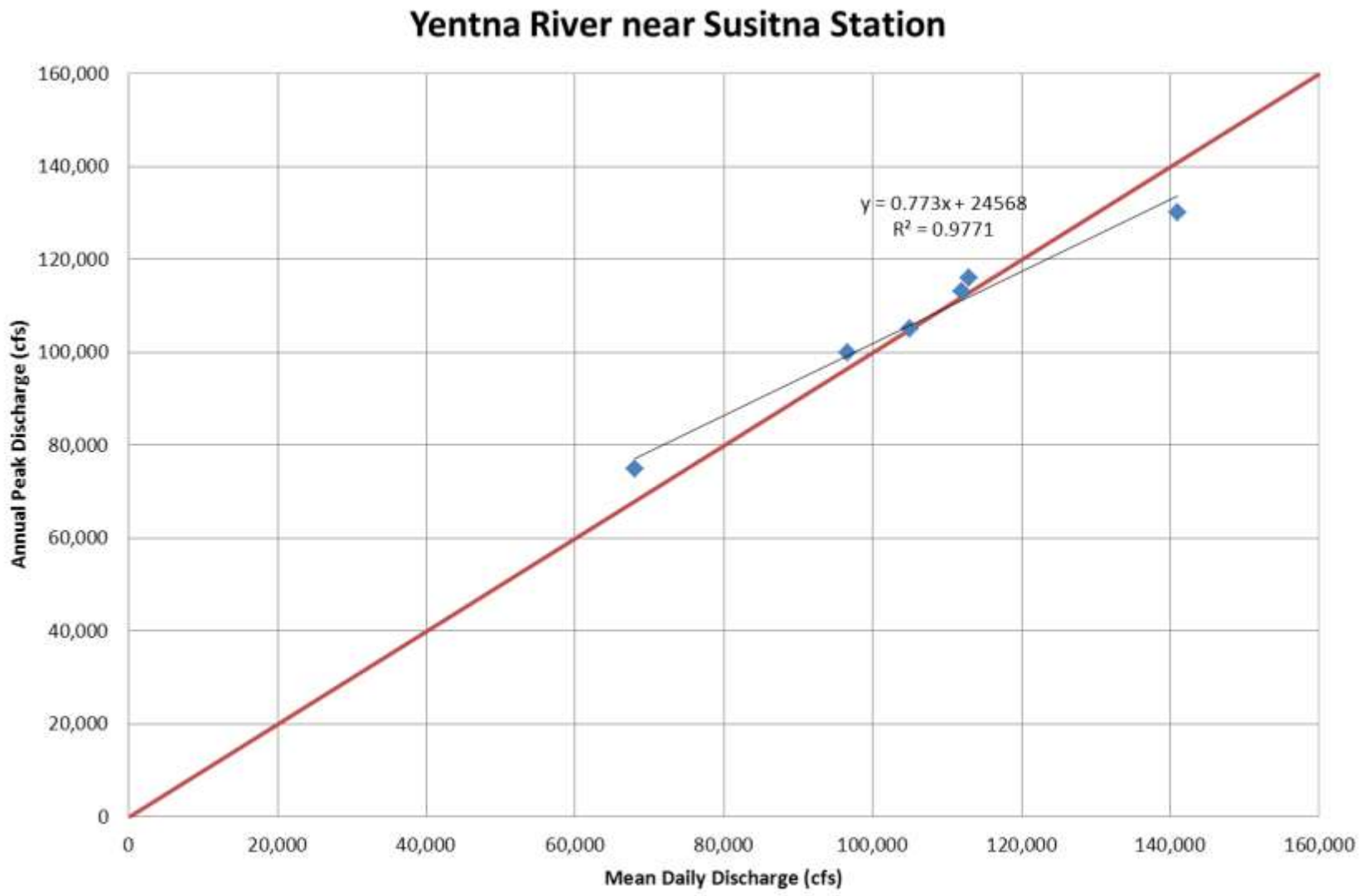

Figure D-10 – Yentna River near Susitna Station regression to extend the Pre-Project USGS available record annual peak data.

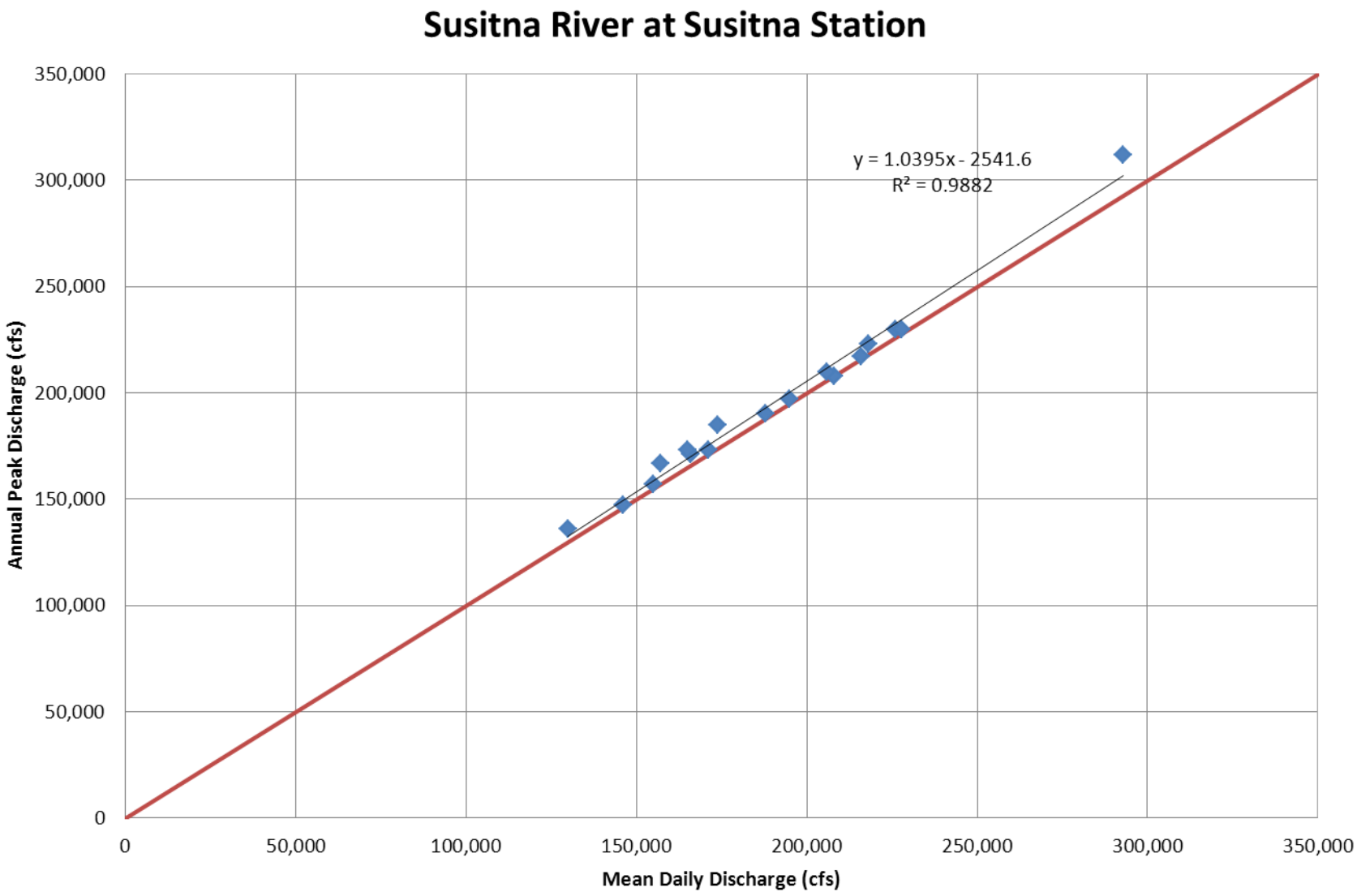

Figure D-11 – Susitna River at Susitna Station regression to extend the Pre-Project USGS available record annual peak data.

APPENDIX E. FLOOD FREQUENCY CURVES FOR PRE-PROJECT CONDITIONS

Susitna-Watana Hydroelectric Project (FERC No. 14241)

Stream Flow Assessment

Prepared for

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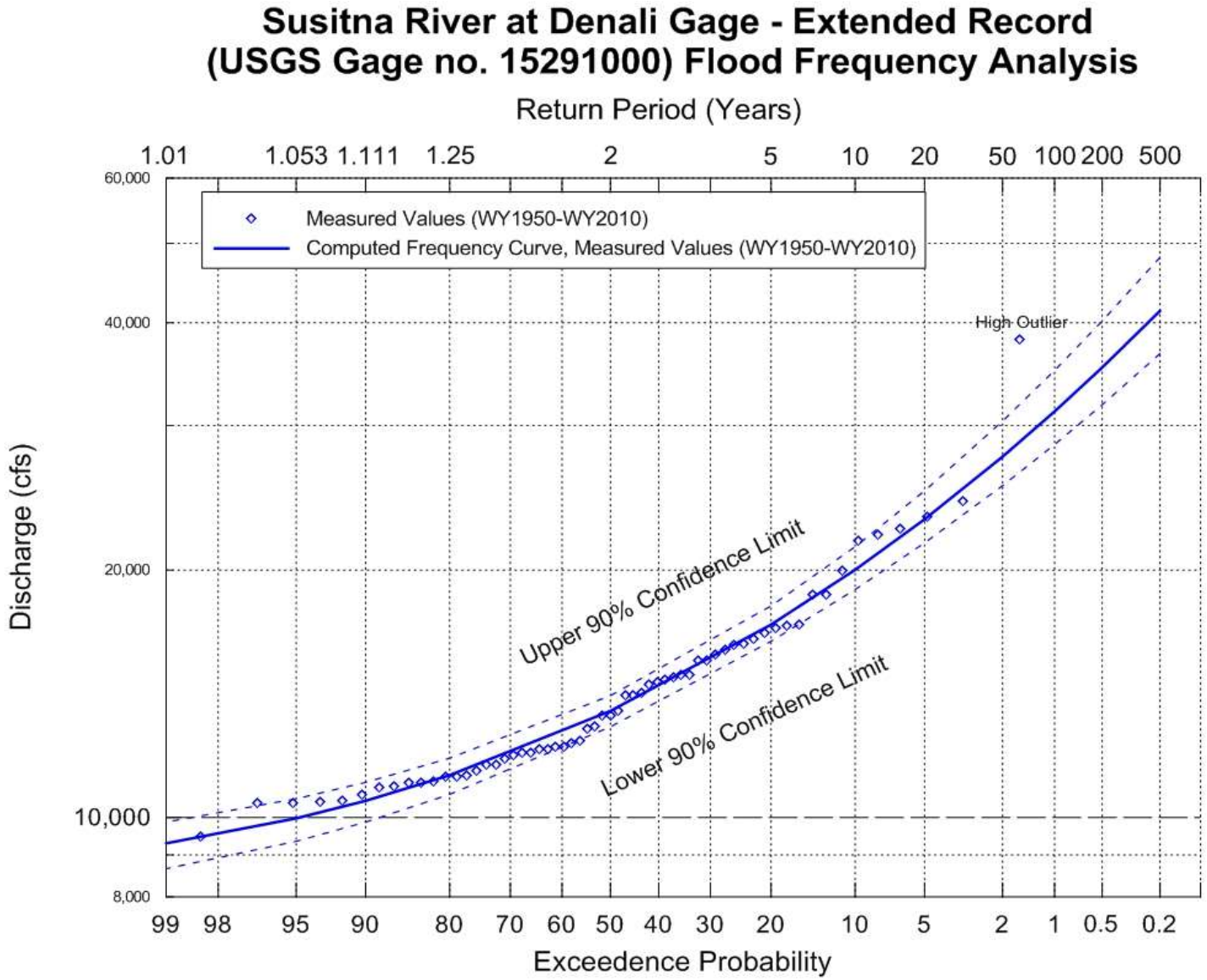

Figure E-1 – Flood Frequency Curve for Susitna River near Denali for Pre-Project Conditions based on the USGS Extended Record

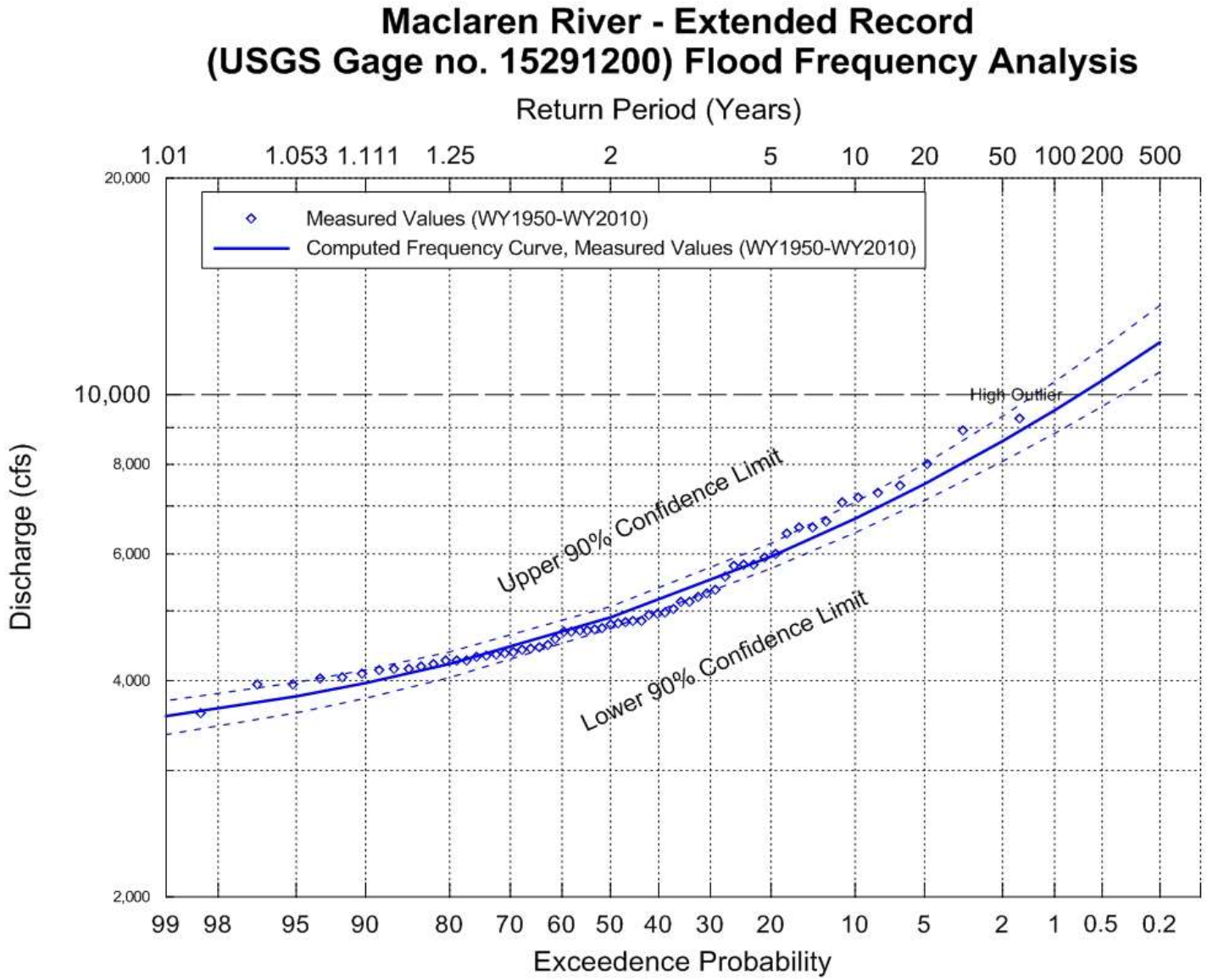

Figure E-2 – Flood Frequency Curve for Maclaren River near Paxson for Pre-Project Conditions based on the USGS Extended Record

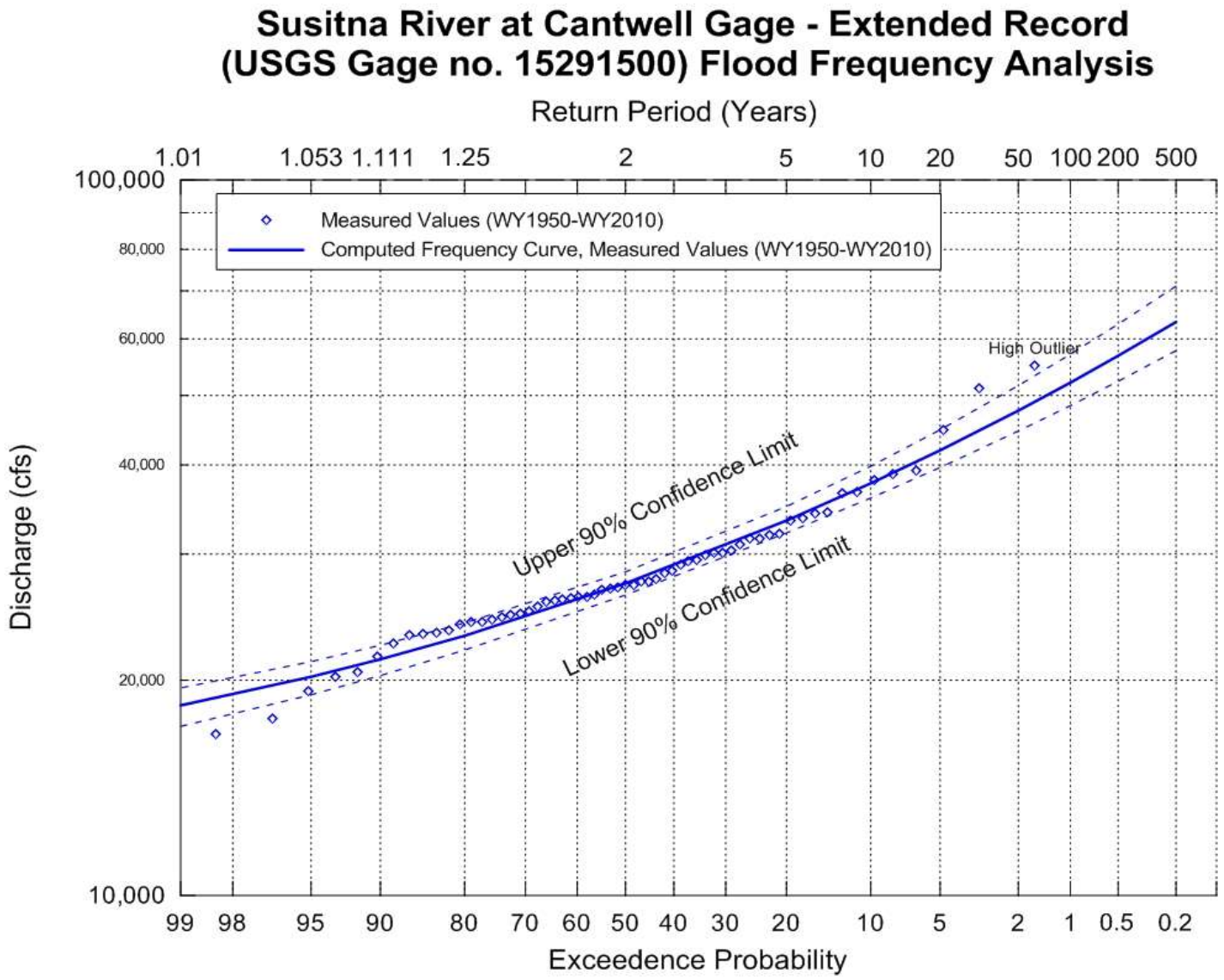

Figure E-3 – Flood Frequency Curve for Susitna River near Cantwell for Pre-Project Conditions based on the USGS Extended Record

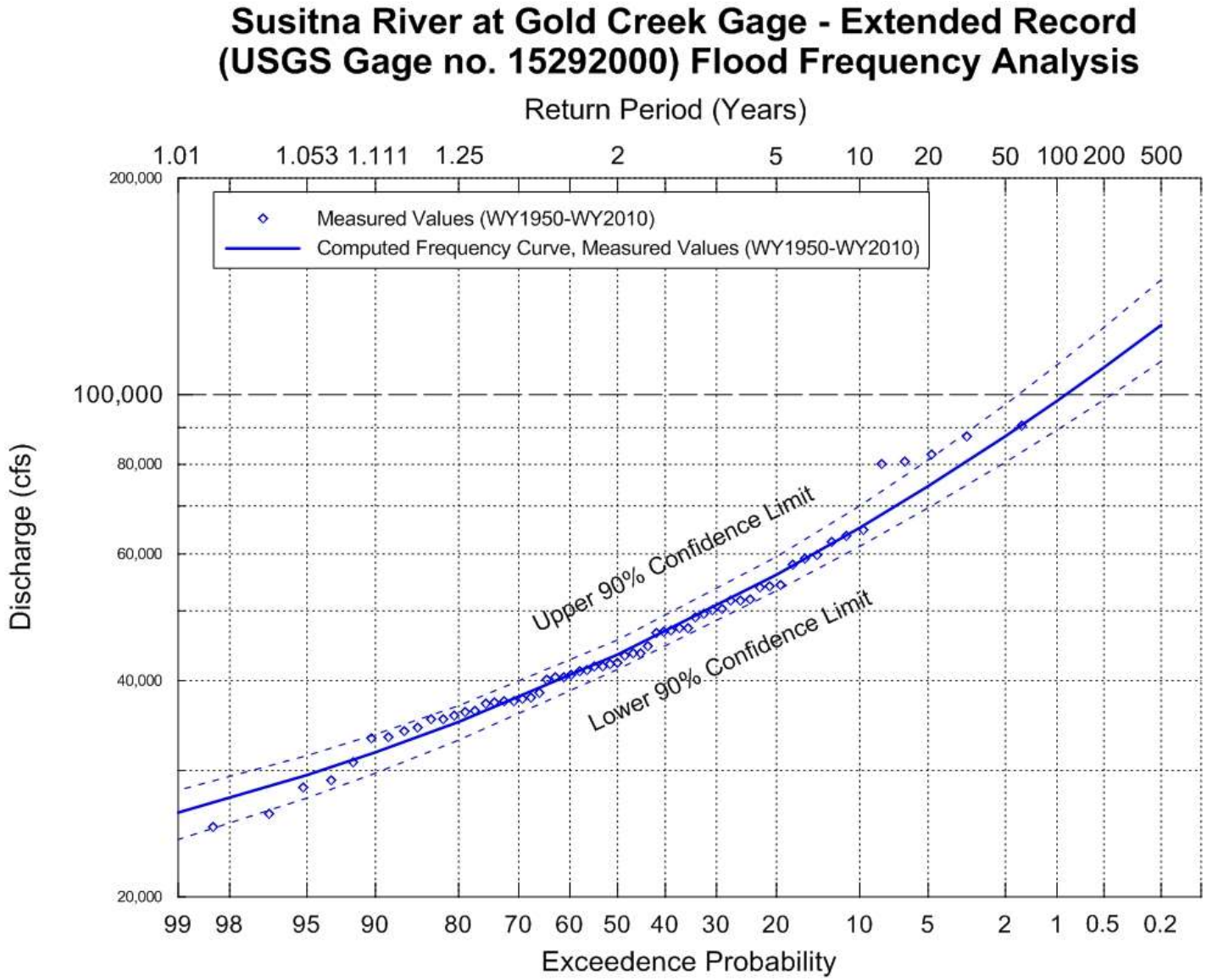

Figure E-4 – Flood Frequency Curve for Susitna River at Gold Creek for Pre-Project Conditions based on the USGS Extended Record

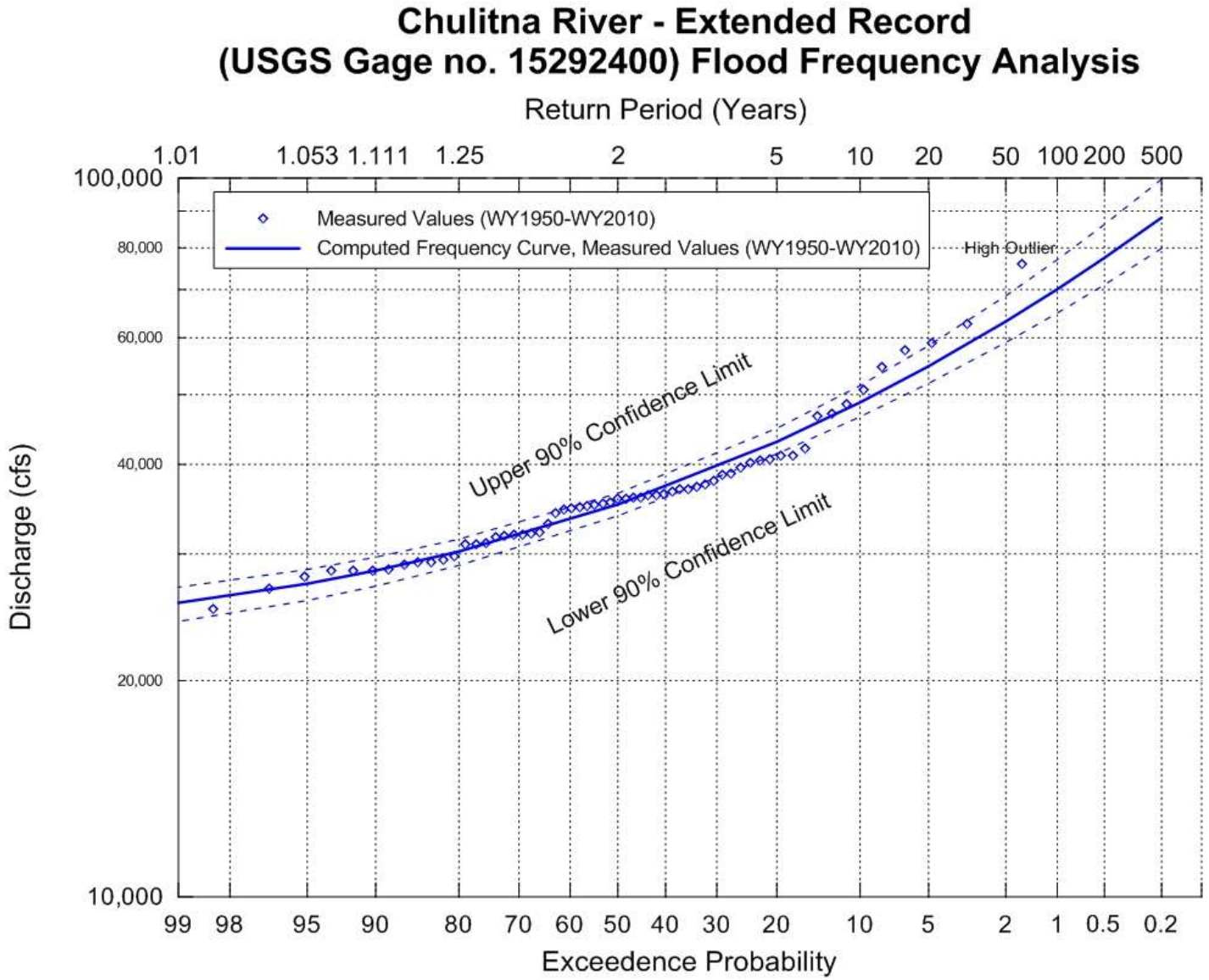

Figure E-5 – Flood Frequency Curve for Chulitna River near Talkeetna for Pre-Project Conditions based on the USGS Extended Record

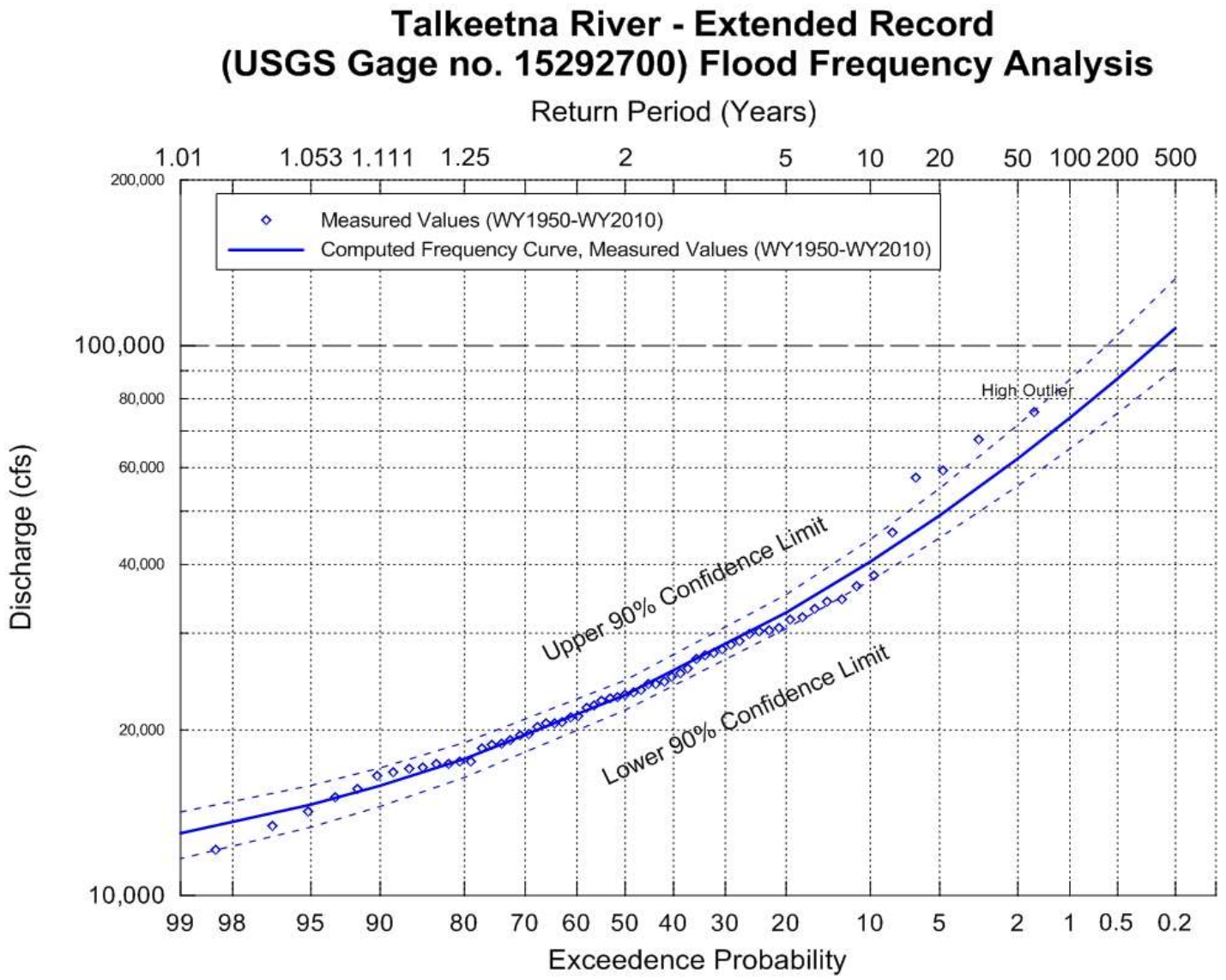

Figure E-6 – Flood Frequency Curve for Talkeetna River near Talkeetna for Pre-Project Conditions based on the USGS Extended Record

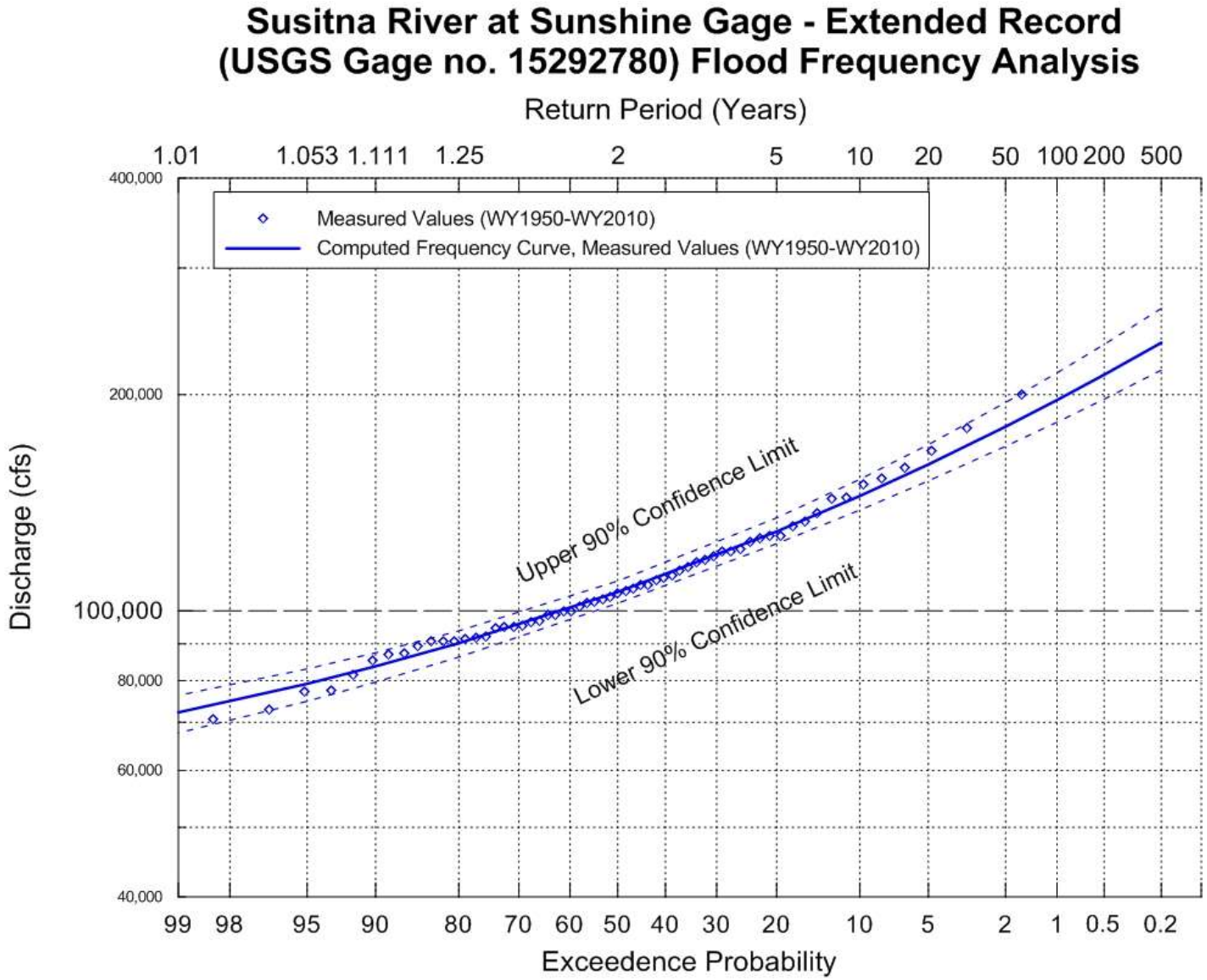

Figure E-7 – Flood Frequency Curve for Susitna River at Sunshine for Pre-Project Conditions based on the USGS Extended Record

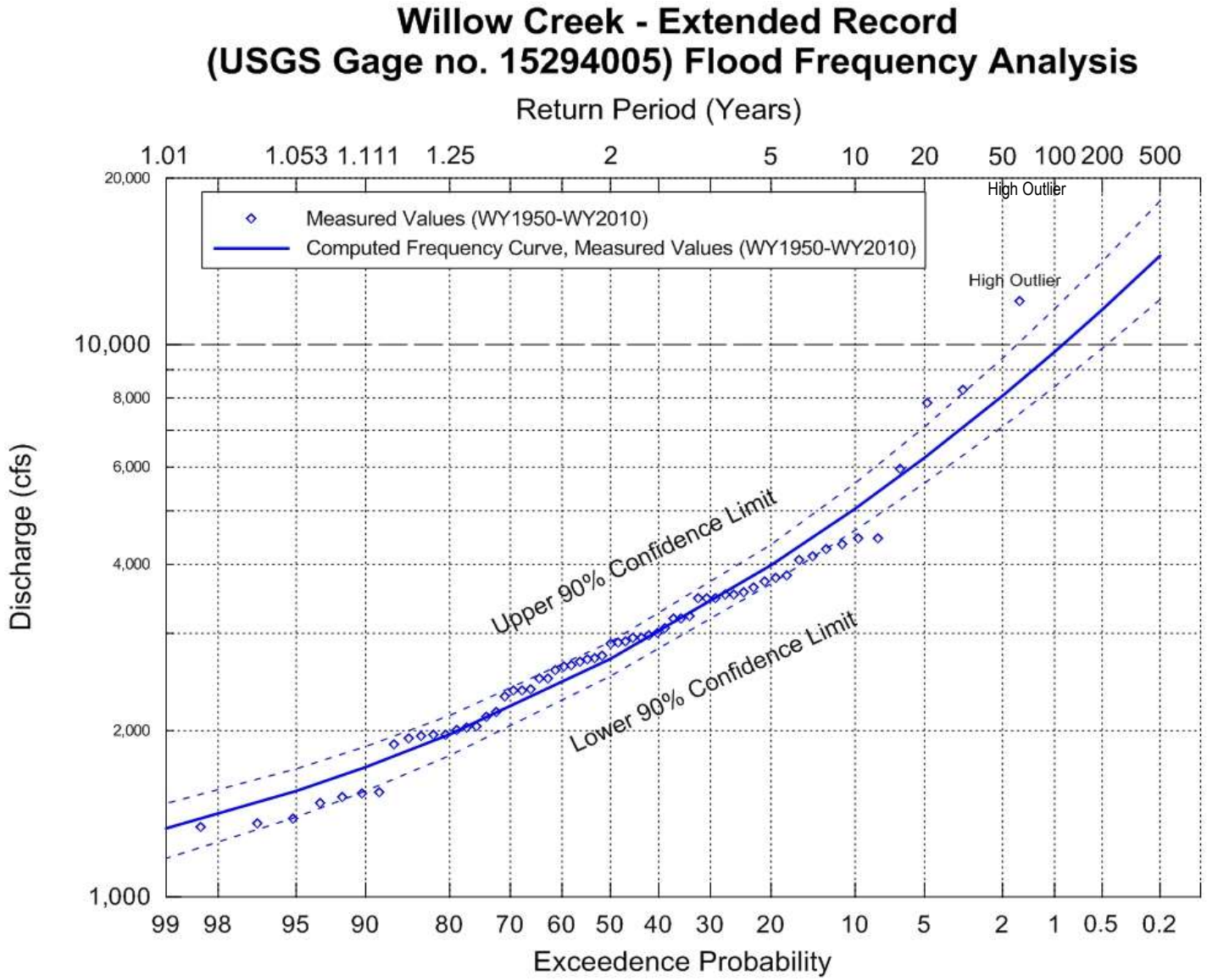

Figure E-8 – Flood Frequency Curve for Willow Creek near Willow for Pre-Project Conditions based on the USGS Extended Record

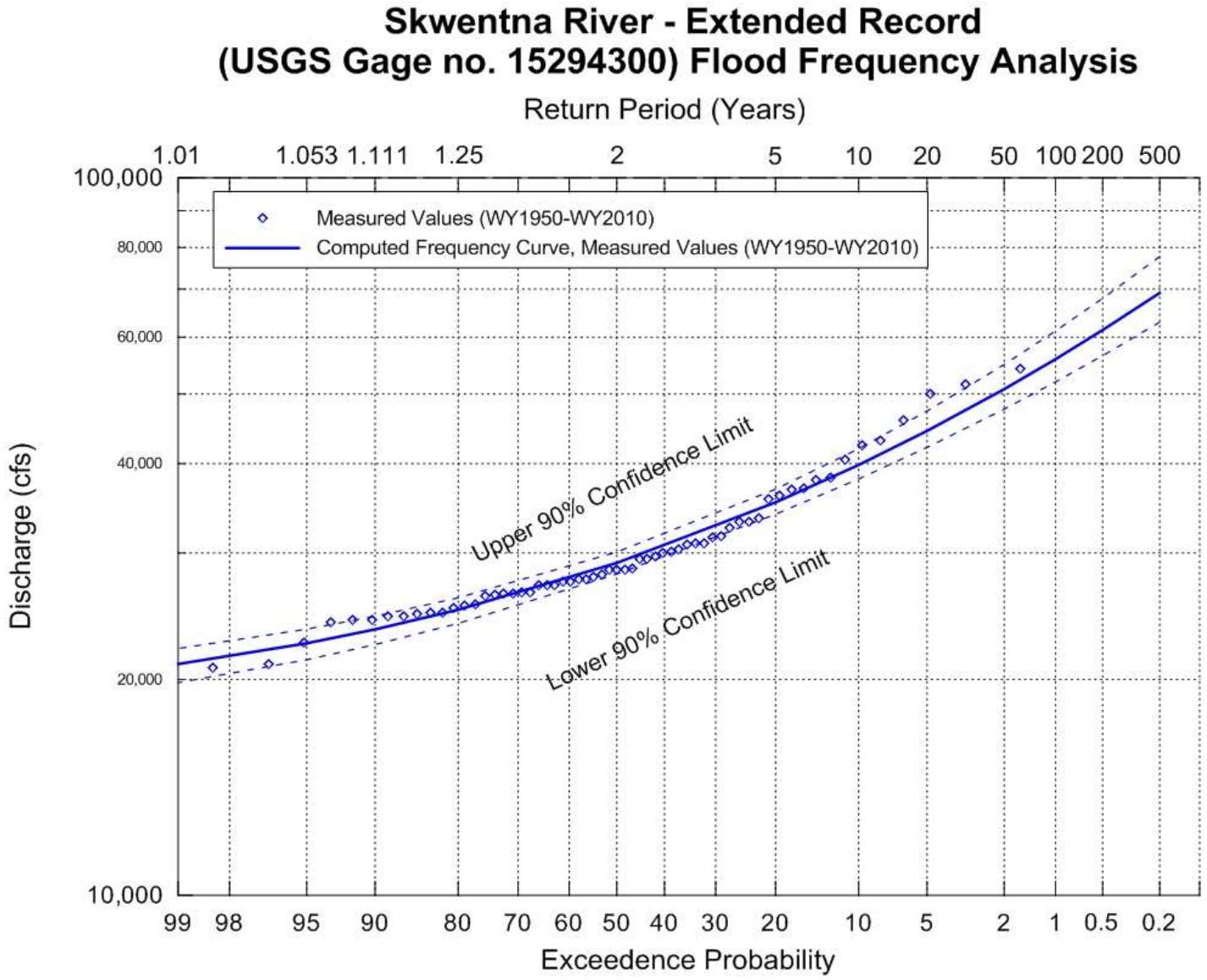

Figure E-9 – Flood Frequency Curve for Skwentna River near Skwentna for Pre-Project Conditions based on the USGS Extended Record

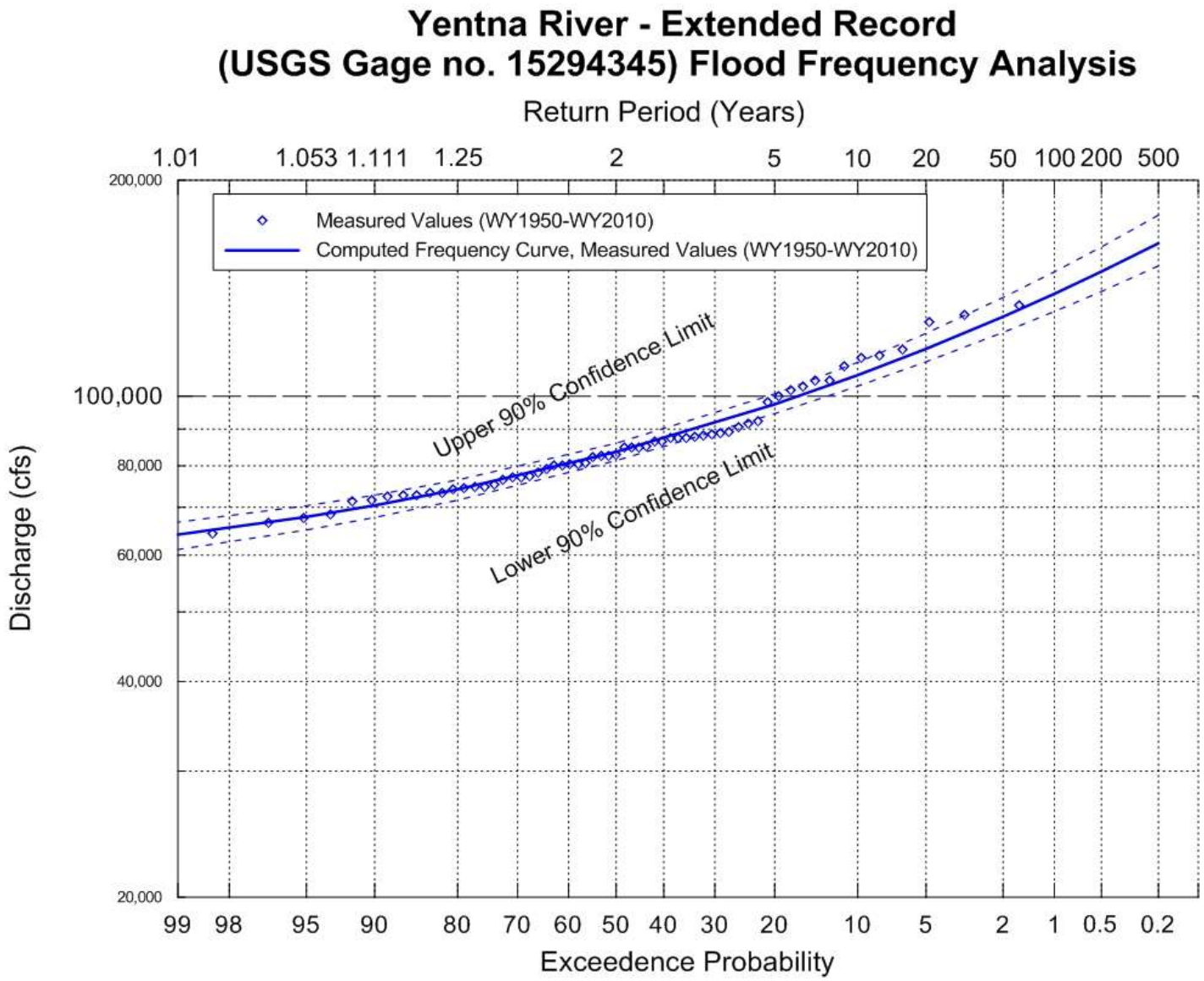

Figure E-10 – Flood Frequency Curve for Yentna River near Susitna Station for Pre-Project Conditions based on the USGS Extended Record

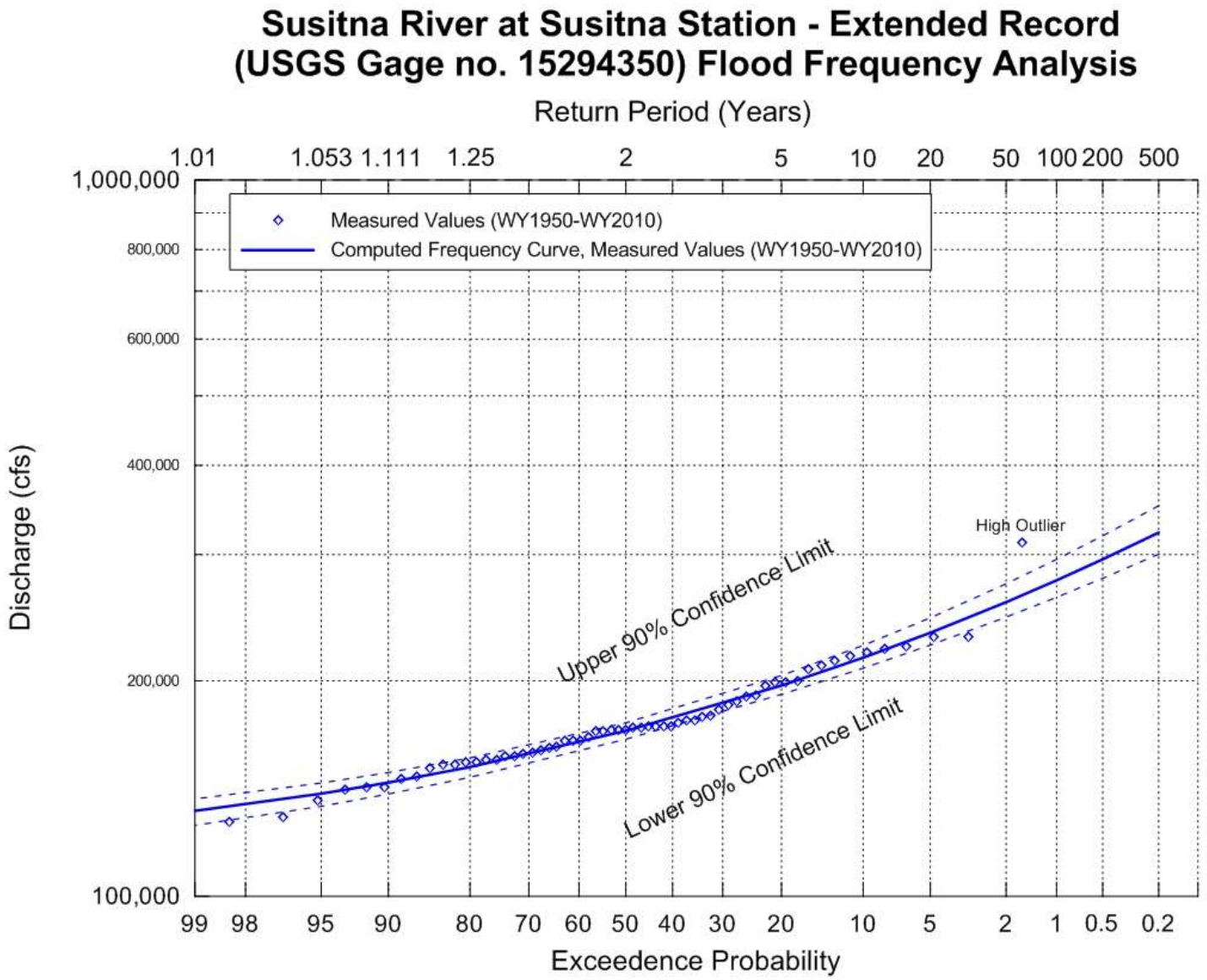

Figure E-11 – Flood Frequency Curve for Susitna River at Susitna Station for Pre-Project Conditions based on the USGS Extended Record.

APPENDIX F. AVERAGE MONTHLY FLOW (CFS) BY WATER YEAR FOR POST-PROJECT CONDITIONS

Susitna-Watana Hydroelectric Project (FERC No. 14241)

Stream Flow Assessment

Prepared for

Alaska Energy Authority

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February 2013

Table F-1 – Average Monthly Flow for Susitna River at Gold Creek for Max LF OS-1 Conditions based on the HEC-ResSim model

WY	Susitna River at Gold Creek											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1950	7,580	7,900	8,570	9,030	9,760	7,810	7,390	8,320	9,370	9,610	9,200	7,210
1951	7,310	7,950	8,930	9,570	10,500	8,590	8,420	9,530	9,950	9,890	9,450	9,340
1952	7,610	8,170	8,970	9,510	10,200	8,350	7,940	7,990	11,700	10,200	9,430	8,020
1953	7,850	8,020	8,540	8,940	9,590	7,710	7,380	9,320	9,980	9,030	16,700	15,600
1954	7,630	7,780	8,570	9,060	9,710	7,800	7,410	9,140	9,740	9,160	16,200	13,500
1955	7,360	7,900	8,630	9,100	9,730	7,760	7,280	7,860	10,600	9,990	20,200	14,800
1956	7,440	7,760	8,550	9,060	9,810	7,900	7,450	9,340	11,100	14,800	24,900	18,500
1957	7,690	7,940	8,630	9,050	9,740	7,740	7,230	8,460	10,500	9,360	17,800	19,900
1958	9,010	8,050	8,750	8,950	9,490	7,560	7,110	8,130	9,750	9,320	19,300	7,770
1959	7,270	7,810	8,590	9,120	9,810	7,850	7,430	9,000	9,590	9,670	19,800	17,500
1960	8,500	7,910	8,640	9,100	9,690	7,770	7,270	8,810	8,830	9,610	9,890	19,700
1961	9,330	7,910	8,700	9,150	9,650	7,760	7,340	9,510	11,800	12,200	22,400	13,400
1962	8,350	7,810	8,580	9,050	9,700	7,750	7,240	7,350	12,300	20,100	23,600	16,300
1963	8,020	7,630	8,470	8,980	9,670	7,590	7,020	9,670	10,500	18,000	23,900	12,500
1964	8,100	7,800	8,540	8,980	9,670	7,770	7,300	7,190	13,000	12,100	16,600	9,820
1965	7,990	7,780	8,370	8,850	9,560	7,680	7,220	8,160	10,000	9,860	16,600	19,000
1966	9,860	7,930	8,720	9,170	9,850	7,960	7,590	8,800	12,500	9,330	9,890	11,500
1967	7,280	7,810	8,710	9,290	9,990	8,030	7,570	9,190	10,200	10,100	25,600	17,200
1968	7,340	7,790	8,590	9,140	9,790	7,870	7,340	9,390	11,000	12,200	17,400	9,310
1969	7,070	7,710	8,480	9,040	9,830	7,970	7,620	8,210	8,460	8,340	8,230	7,250
1970	8,290	9,340	10,900	5,270	771	772	1,030	6,960	10,600	10,400	9,780	7,910
1971	8,660	9,360	10,300	10,900	10,800	953	1,060	3,390	11,600	9,120	10,100	12,900
1972	7,450	7,850	8,750	9,260	9,870	7,900	7,310	11,600	12,200	15,500	19,500	12,700
1973	7,270	7,830	8,570	9,080	9,830	7,860	7,400	7,840	10,500	9,070	9,330	7,240
1974	7,240	7,930	8,820	9,450	10,300	8,430	8,140	9,780	9,500	9,480	9,140	8,130
1975	7,780	8,700	9,900	10,800	12,200	1,660	1,550	8,280	11,400	10,200	8,960	10,800
1976	9,050	7,730	8,450	8,980	9,710	7,820	7,410	8,450	9,830	9,100	9,130	6,960
1977	7,250	8,110	8,980	9,460	10,200	8,240	7,810	8,770	12,100	9,420	13,000	12,500
1978	8,580	7,990	8,660	9,030	9,600	7,710	7,180	8,040	9,080	9,250	8,790	7,170
1979	7,370	7,980	8,750	9,250	9,960	8,060	7,650	8,810	9,960	10,300	11,200	11,000
1980	8,340	8,100	8,610	8,980	9,560	7,690	7,190	8,090	10,800	14,700	21,600	13,400
1981	8,510	7,820	8,270	8,760	9,640	7,670	7,190	7,910	8,580	15,800	34,500	14,300

WY	Susitna River at Gold Creek											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1982	8,160	8,110	8,450	8,970	9,750	7,820	7,500	8,470	9,960	9,200	11,300	17,900
1983	8,740	7,840	8,660	9,190	9,770	7,710	7,240	9,120	9,490	8,500	18,300	14,000
1984	9,180	7,810	8,490	8,900	9,490	7,560	7,000	8,030	9,410	8,950	19,900	9,680
1985	7,740	8,070	8,830	9,200	9,790	7,920	7,440	8,780	10,500	8,980	14,900	15,700
1986	8,810	7,990	8,740	9,210	9,900	7,890	7,450	8,460	8,590	8,200	8,880	8,520
1987	11,400	7,970	8,530	8,970	9,610	7,720	7,260	8,190	9,460	10,100	21,500	13,600
1988	7,450	7,840	8,550	9,080	9,740	7,850	7,350	9,010	10,300	11,100	19,500	14,300
1989	8,910	7,920	8,590	9,100	9,720	7,800	7,310	8,300	9,940	9,390	19,700	15,600
1990	9,320	7,910	8,570	9,050	9,720	7,830	7,670	10,100	11,200	23,700	23,700	25,600
1991	8,920	7,820	8,660	9,130	9,780	7,810	7,300	7,290	9,980	9,330	8,990	7,890
1992	7,510	7,860	8,690	9,170	9,790	7,910	7,430	7,320	9,740	9,840	9,220	8,980
1993	7,190	7,930	8,680	9,180	9,840	7,880	7,520	9,580	9,480	8,980	12,700	21,500
1994	10,800	7,960	8,650	9,030	9,630	7,690	7,410	8,410	10,500	10,700	18,700	9,870
1995	7,220	7,940	8,680	9,150	9,850	7,890	7,570	9,040	9,700	9,610	16,700	19,300
1996	8,350	7,870	8,530	9,020	9,730	7,820	7,370	7,500	9,090	9,110	9,220	7,800
1997	7,720	8,730	9,880	10,800	12,100	2,600	1,570	7,240	9,970	10,400	10,200	8,200
1998	7,580	8,350	9,450	10,200	11,300	9,480	2,450	6,360	10,600	10,400	9,680	8,480
1999	7,970	8,130	8,850	9,340	10,100	8,140	7,700	8,230	9,920	9,720	10,000	7,530
2000	7,680	7,960	8,620	9,060	9,770	7,850	7,390	8,160	10,800	11,500	16,500	15,400
2001	9,550	7,950	8,610	9,050	9,750	7,790	7,280	7,700	10,600	9,280	16,100	10,700
2002	7,270	7,890	8,630	9,090	9,780	7,840	7,360	8,250	9,020	9,150	9,820	8,310
2003	9,830	8,280	8,570	8,860	9,580	7,550	7,120	7,310	9,610	10,200	20,700	13,800
2004	9,760	7,820	8,590	9,040	9,710	7,790	7,550	9,960	9,570	9,000	16,800	7,510
2005	7,040	7,820	8,710	9,230	9,930	8,010	7,780	10,700	10,900	19,500	22,100	22,700
2006	9,860	7,760	8,530	9,040	9,750	7,810	7,350	8,850	9,700	9,460	20,800	12,600
2007	11,100	7,940	8,620	9,080	9,730	7,760	7,300	8,850	9,080	9,210	12,500	13,700
2008	7,430	7,990	8,780	9,090	9,630	7,790	7,320	8,190	9,380	9,450	9,140	12,200
2009	7,690	7,680	8,540	9,120	9,840	7,910	7,900	9,880	9,370	8,970	13,700	12,900
2010	8,130	7,860	8,560	9,010	9,690	7,750	7,330	9,310	9,080	9,960	18,100	16,500
Average	8,240	7,990	8,750	9,140	9,750	7,460	6,950	8,490	10,200	10,800	15,400	12,700
Maximum	11,400	9,360	10,900	10,900	12,200	9,480	8,420	11,600	13,000	23,700	34,500	25,600
Minimum	7,040	7,630	8,270	5,270	771	772	1,030	3,390	8,460	8,200	8,230	6,960
Median	7,970	7,910	8,630	9,080	9,750	7,810	7,350	8,450	9,960	9,610	16,200	12,600

Table F-2 – Average Monthly Flow for Susitna River at Sunshine for Max LF OS-1 Conditions based on the HEC-ResSim model

WY	Susitna River at Sunshine											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1950	16,700	11,200	10,200	10,200	10,700	8,680	8,360	24,400	38,200	43,200	39,200	18,800
1951	12,400	9,520	10,100	10,700	11,400	9,470	10,300	29,800	40,400	43,700	38,600	40,900
1952	15,300	11,700	11,200	11,400	11,400	9,410	8,980	14,900	56,500	48,500	40,400	29,100
1953	19,400	12,600	10,500	10,200	10,500	8,690	9,260	37,300	49,500	39,100	47,300	38,500
1954	15,300	10,400	10,300	10,600	10,900	8,730	8,820	34,200	47,400	39,700	54,100	32,900
1955	14,600	11,400	11,100	11,300	11,400	9,100	8,660	20,700	51,800	50,200	55,900	36,300
1956	14,200	10,100	10,000	10,200	10,900	9,030	8,510	34,200	56,500	58,400	61,700	45,900
1957	15,800	11,900	11,200	11,100	11,500	9,210	8,620	27,500	53,100	44,100	48,000	49,800
1958	20,900	13,300	12,900	11,400	11,000	8,960	8,890	26,300	47,900	43,200	51,600	18,400
1959	13,700	10,500	10,300	10,900	11,400	9,040	8,860	31,400	44,400	46,800	61,300	42,600
1960	17,700	11,600	11,300	11,400	11,400	9,230	8,780	30,900	31,600	42,600	45,300	49,600
1961	20,600	11,800	12,000	12,200	11,800	10,000	10,600	34,700	52,500	49,100	56,000	32,800
1962	16,600	11,300	11,100	11,400	11,500	9,480	9,280	24,500	66,200	58,600	59,100	39,900
1963	17,400	11,200	10,900	10,900	11,500	8,820	7,950	34,800	50,100	64,600	59,300	30,500
1964	17,100	10,600	10,300	10,200	10,800	8,630	8,120	12,100	65,800	47,600	45,200	24,300
1965	18,300	12,500	11,000	10,700	11,200	9,250	9,070	23,100	48,600	51,100	51,300	51,100
1966	24,100	12,000	11,200	11,300	11,600	9,570	9,470	20,200	55,700	41,800	45,500	30,800
1967	14,700	10,400	10,900	11,300	11,900	9,700	9,060	28,300	49,500	49,800	69,000	43,100
1968	14,600	11,600	11,600	11,900	12,400	10,400	10,200	34,500	55,600	51,800	45,500	23,900
1969	12,700	10,200	9,920	10,300	11,000	9,240	9,450	23,500	30,400	34,200	22,300	14,600
1970	13,000	11,500	12,400	7,050	2,080	2,040	2,610	22,700	38,900	46,600	41,700	25,700
1971	17,600	14,700	13,600	13,000	12,700	2,290	2,600	9,450	57,400	47,100	54,300	35,400
1972	16,600	12,300	11,800	12,000	12,300	10,000	9,290	33,700	56,100	53,100	52,000	37,400
1973	17,500	11,800	11,000	11,100	11,700	9,550	9,030	20,900	50,100	38,000	42,000	21,600
1974	13,100	10,600	10,700	11,100	11,800	9,810	9,660	30,900	38,900	39,100	35,900	26,700
1975	14,000	11,600	12,100	13,000	14,100	3,750	3,440	26,700	55,500	51,500	39,100	37,600
1976	20,500	10,500	10,000	10,500	11,200	9,290	9,290	24,300	46,700	40,500	39,800	17,900
1977	13,300	11,800	12,400	11,900	12,200	10,200	9,820	25,500	62,200	44,600	43,400	33,300
1978	20,500	12,400	11,800	11,600	11,700	9,660	9,180	22,500	38,000	44,400	35,100	20,300
1979	13,800	11,700	11,400	11,500	11,900	9,880	9,750	31,300	49,000	53,500	42,500	26,900
1980	20,000	14,200	11,700	11,500	11,800	9,840	9,990	25,500	51,200	59,000	52,600	33,200
1981	19,200	12,300	10,700	11,200	11,900	9,700	9,640	27,200	39,800	67,100	81,800	33,700

WY	Susitna River at Sunshine cont.											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1982	17,200	12,000	10,500	10,800	11,500	9,410	9,480	21,300	46,500	47,800	41,800	49,100
1983	18,400	11,600	11,800	12,200	12,500	9,570	9,470	25,100	43,000	42,900	54,000	30,900
1984	22,500	13,000	11,700	11,800	12,100	10,200	9,720	20,700	41,600	44,400	58,500	24,600
1985	14,500	11,300	11,200	11,800	12,000	10,000	9,530	22,600	45,100	50,700	50,100	40,900
1986	18,900	11,500	11,000	11,300	11,700	9,440	8,940	18,000	35,400	42,300	37,600	30,900
1987	35,500	14,000	11,700	11,400	11,900	9,860	10,100	27,400	44,500	51,000	55,700	34,200
1988	14,900	11,500	11,200	11,500	11,900	9,910	9,380	32,200	50,500	48,800	50,000	35,200
1989	19,200	12,000	11,500	11,600	11,900	9,980	9,680	24,800	49,300	44,100	57,300	43,300
1990	23,200	12,800	11,500	11,900	12,500	10,900	13,900	46,700	55,700	58,300	58,200	62,700
1991	18,400	10,900	11,200	11,400	11,700	9,550	9,550	22,000	50,200	43,600	35,900	25,000
1992	15,300	10,600	11,000	11,300	11,800	10,100	9,950	16,300	46,400	48,800	41,600	24,400
1993	13,100	11,900	11,600	11,600	12,000	9,890	10,700	41,300	47,400	41,100	42,600	57,300
1994	28,200	13,300	11,900	11,700	12,000	9,650	11,300	32,500	53,700	43,300	49,500	23,000
1995	13,600	11,500	11,300	11,400	11,900	10,000	10,500	35,100	45,800	47,800	45,300	48,600
1996	17,900	11,600	10,300	10,600	11,300	9,410	9,480	20,700	33,000	36,400	38,300	22,600
1997	13,800	12,100	12,600	13,300	14,300	4,890	3,980	22,800	41,400	49,700	50,300	31,100
1998	14,400	11,300	11,700	12,200	13,100	11,200	5,300	21,300	50,600	51,700	47,100	35,100
1999	21,300	13,400	12,400	12,100	12,100	9,760	9,660	23,700	47,000	46,700	50,900	26,700
2000	19,400	13,400	12,000	11,700	12,100	9,970	10,000	26,900	58,800	57,600	43,900	40,900
2001	23,700	13,300	12,200	12,000	12,200	10,000	9,750	21,700	53,500	41,200	48,800	26,700
2002	14,400	11,300	10,900	11,000	11,600	9,510	8,970	28,100	34,600	37,200	45,300	36,600
2003	29,100	16,600	12,100	10,800	12,000	9,360	10,300	21,200	46,600	51,300	52,600	33,100
2004	21,400	12,000	11,100	11,100	11,500	9,390	10,700	42,000	46,000	41,700	44,600	18,000
2005	14,400	11,100	11,000	11,300	11,700	9,860	12,600	52,300	58,500	58,800	56,200	59,000
2006	23,500	10,700	10,700	11,100	11,600	9,580	9,310	28,700	41,200	44,500	62,300	32,800
2007	30,300	12,800	11,200	11,300	11,700	9,530	9,970	28,300	35,300	42,200	43,700	36,800
2008	16,000	12,100	11,700	11,200	11,200	9,470	9,290	24,100	41,700	41,800	40,700	33,800
2009	16,300	10,200	10,500	11,100	11,600	9,740	12,200	41,900	44,000	39,300	40,800	31,600
2010	19,900	12,800	11,100	11,100	11,600	9,550	9,750	33,200	37,900	48,700	50,200	40,700
Average	18,000	11,900	11,300	11,300	11,600	9,190	9,160	27,400	47,600	47,200	48,400	34,100
Maximum	35,500	16,600	13,600	13,300	14,300	11,200	13,900	52,300	66,200	67,100	81,800	62,700
Minimum	12,400	9,520	9,920	7,050	2,080	2,040	2,600	9,450	30,400	34,200	22,300	14,600
Median	17,200	11,700	11,200	11,300	11,700	9,550	9,470	26,300	47,400	46,700	47,300	33,200

Table F-3 – Average Monthly Flow for Susitna River at Susitna Station for Max LF OS-1 Conditions based on the HEC-ResSim model

WY	Susitna River at Susitna Station											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1950	37,200	18,500	14,100	13,900	14,100	12,000	11,900	58,400	90,800	102,000	92,900	45,600
1951	25,300	13,400	13,900	14,300	14,900	12,800	15,400	70,400	94,400	103,000	92,100	95,700
1952	33,800	19,600	15,500	15,400	15,100	13,000	12,600	29,500	125,000	111,000	94,100	70,500
1953	45,800	24,000	14,500	14,000	14,000	12,200	14,500	89,200	113,000	94,200	103,000	82,500
1954	34,100	15,500	14,200	14,500	14,500	12,200	12,600	82,500	110,000	94,700	118,000	71,300
1955	33,200	19,300	15,900	15,600	15,300	12,800	12,500	49,300	117,000	115,000	116,000	77,900
1956	31,100	14,600	13,900	13,800	14,600	12,600	12,100	79,200	125,000	126,000	122,000	95,600
1957	35,700	21,200	16,500	15,100	15,500	13,000	12,400	64,500	119,000	104,000	104,000	104,000
1958	47,400	26,700	23,400	16,200	14,900	12,700	13,200	63,600	110,000	103,000	106,000	43,200
1959	30,100	16,100	14,300	14,800	15,200	12,700	12,700	71,300	104,000	109,000	127,000	87,100
1960	31,000	17,200	15,600	15,100	15,200	13,100	12,500	70,500	89,500	104,000	102,000	84,400
1961	35,500	17,100	17,000	16,700	15,600	14,000	15,700	79,600	114,000	109,000	110,000	80,000
1962	34,300	17,900	15,300	15,200	15,100	13,000	12,900	50,300	112,000	115,000	106,000	65,300
1963	28,200	15,800	14,600	14,600	15,000	12,500	11,700	61,000	102,000	124,000	103,000	59,200
1964	38,200	15,400	13,800	14,400	14,600	12,300	12,300	17,500	114,000	109,000	102,000	46,400
1965	35,400	19,400	17,800	15,800	15,900	13,400	12,700	31,700	106,000	112,000	105,000	102,000
1966	42,900	19,000	16,200	16,000	15,800	13,200	12,800	29,100	108,000	99,100	108,000	72,900
1967	38,900	16,000	15,200	14,800	15,000	12,900	12,400	21,700	90,100	104,000	117,000	78,400
1968	27,600	17,500	16,400	16,000	16,300	14,200	15,600	84,700	116,000	111,000	87,400	37,500
1969	19,200	14,100	13,900	14,100	14,600	12,600	14,200	63,400	96,700	88,600	51,800	27,100
1970	36,200	18,200	17,000	11,200	6,020	5,780	6,430	65,000	113,000	117,000	93,300	57,700
1971	28,700	21,400	18,400	17,100	16,200	5,500	5,980	34,800	125,000	115,000	104,000	55,000
1972	26,700	16,700	15,100	15,100	15,200	12,500	12,000	40,100	97,900	117,000	108,000	82,500
1973	40,100	20,800	16,600	16,000	15,700	13,400	13,100	47,000	97,300	95,400	79,200	44,300
1974	26,100	17,100	16,400	16,300	16,600	14,200	14,200	48,900	83,000	85,800	80,200	74,200
1975	23,700	17,400	17,600	17,900	18,500	7,620	6,780	39,600	108,000	118,000	82,600	72,000
1976	33,300	15,800	13,300	14,500	14,400	12,300	13,200	66,000	92,300	105,000	89,300	49,000
1977	33,600	23,700	19,600	17,700	17,500	13,600	12,300	51,600	140,000	131,000	119,000	83,500
1978	39,600	17,200	13,500	14,000	14,700	12,800	12,500	44,500	80,700	106,000	94,800	54,200
1979	39,300	20,500	16,300	16,700	16,600	14,000	14,800	75,500	105,000	124,000	119,000	74,800
1980	59,700	35,600	20,800	17,400	17,100	15,300	17,500	61,800	124,000	163,000	128,000	78,200
1981	36,000	20,500	14,800	14,500	15,300	12,300	15,500	74,600	97,600	134,000	156,000	68,400

WY	Susitna River at Susitna Station cont.											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1982	34,700	22,500	18,300	16,300	15,500	12,000	11,500	39,700	91,800	99,600	90,900	110,000
1983	36,200	20,500	16,100	15,300	16,200	13,200	13,000	55,800	88,700	90,800	101,000	55,800
1984	40,600	23,800	17,600	14,300	14,200	12,200	18,200	55,300	89,400	94,400	111,000	51,700
1985	32,900	16,000	14,600	15,200	15,200	12,800	12,300	42,600	96,900	117,000	104,000	84,200
1986	52,900	23,800	17,900	16,400	16,100	12,500	13,000	43,600	79,500	112,000	93,400	72,700
1987	87,400	22,100	15,900	15,200	15,600	13,600	15,000	60,200	94,900	119,000	120,000	74,100
1988	36,000	24,500	19,400	18,200	18,000	15,900	16,900	74,600	116,000	126,000	103,000	71,500
1989	42,800	18,800	13,500	13,400	14,200	13,100	14,000	64,300	98,800	113,000	152,000	116,000
1990	60,800	23,700	15,500	15,700	16,200	15,100	24,600	105,000	120,000	120,000	107,000	107,000
1991	36,100	16,800	13,900	14,700	15,500	12,800	14,200	57,300	118,000	112,000	97,500	67,200
1992	39,300	19,500	18,600	17,800	17,500	15,800	26,800	55,700	95,800	103,000	75,500	38,300
1993	21,600	18,900	17,800	16,800	15,800	13,300	17,300	93,400	110,000	98,000	95,000	117,000
1994	61,700	24,600	18,800	16,900	16,400	13,400	19,600	77,400	119,000	99,500	103,000	47,500
1995	28,000	18,900	16,500	15,700	15,700	13,800	16,700	80,500	104,000	109,000	94,900	98,800
1996	37,400	19,300	14,200	14,100	14,700	13,000	14,200	47,800	76,100	86,400	90,100	50,700
1997	23,200	17,600	17,400	17,400	17,900	7,930	7,980	47,100	88,200	108,000	109,000	64,500
1998	24,900	16,200	15,400	15,200	15,900	13,800	9,640	44,900	109,000	112,000	102,000	74,700
1999	41,000	21,700	18,300	16,600	15,200	12,000	12,800	47,000	102,000	101,000	108,000	54,900
2000	37,100	21,800	17,700	16,100	15,800	13,200	14,400	55,400	124,000	121,000	83,800	78,700
2001	44,300	21,600	18,100	16,800	16,200	13,400	13,800	45,100	118,000	94,100	103,000	56,800
2002	29,900	18,300	15,400	14,900	15,200	12,900	12,400	63,400	79,800	86,300	103,000	87,900
2003	65,900	34,500	19,300	14,300	16,700	12,800	17,600	49,600	106,000	115,000	106,000	66,900
2004	44,000	20,400	16,100	15,500	15,400	13,000	17,800	93,600	104,000	98,400	93,500	39,400
2005	30,100	17,700	15,800	15,800	15,800	14,300	23,700	118,000	127,000	121,000	113,000	119,000
2006	49,400	16,600	15,500	15,500	15,300	13,200	13,300	61,100	91,400	102,000	125,000	69,800
2007	66,300	22,900	16,400	15,200	14,900	12,300	15,300	60,800	78,700	98,300	97,700	79,400
2008	34,400	20,800	17,700	14,900	14,600	12,800	13,100	54,000	96,300	95,900	94,200	72,900
2009	34,100	15,500	15,000	15,500	15,500	13,500	21,200	93,600	99,800	92,000	88,000	65,300
2010	44,300	23,100	16,300	15,500	15,600	13,300	14,900	72,300	86,900	109,000	107,000	82,100
Average	38,100	19,800	16,300	15,500	15,400	12,700	14,100	60,300	104,000	108,000	103,000	72,100
Maximum	87,400	35,600	23,400	18,200	18,500	15,900	26,800	118,000	140,000	163,000	156,000	119,000
Minimum	19,200	13,400	13,300	11,200	6,020	5,500	5,980	17,500	76,100	85,800	51,800	27,100
Median	36,000	19,000	16,100	15,400	15,500	13,000	13,200	60,200	104,000	109,000	103,000	72,700

APPENDIX G. MONTHLY FLOW DURATION CURVES FOR POST-PROJECT CONDITIONS

Susitna-Watana Hydroelectric Project (FERC No. 14241)

Stream Flow Assessment

Prepared for

Alaska Energy Authority

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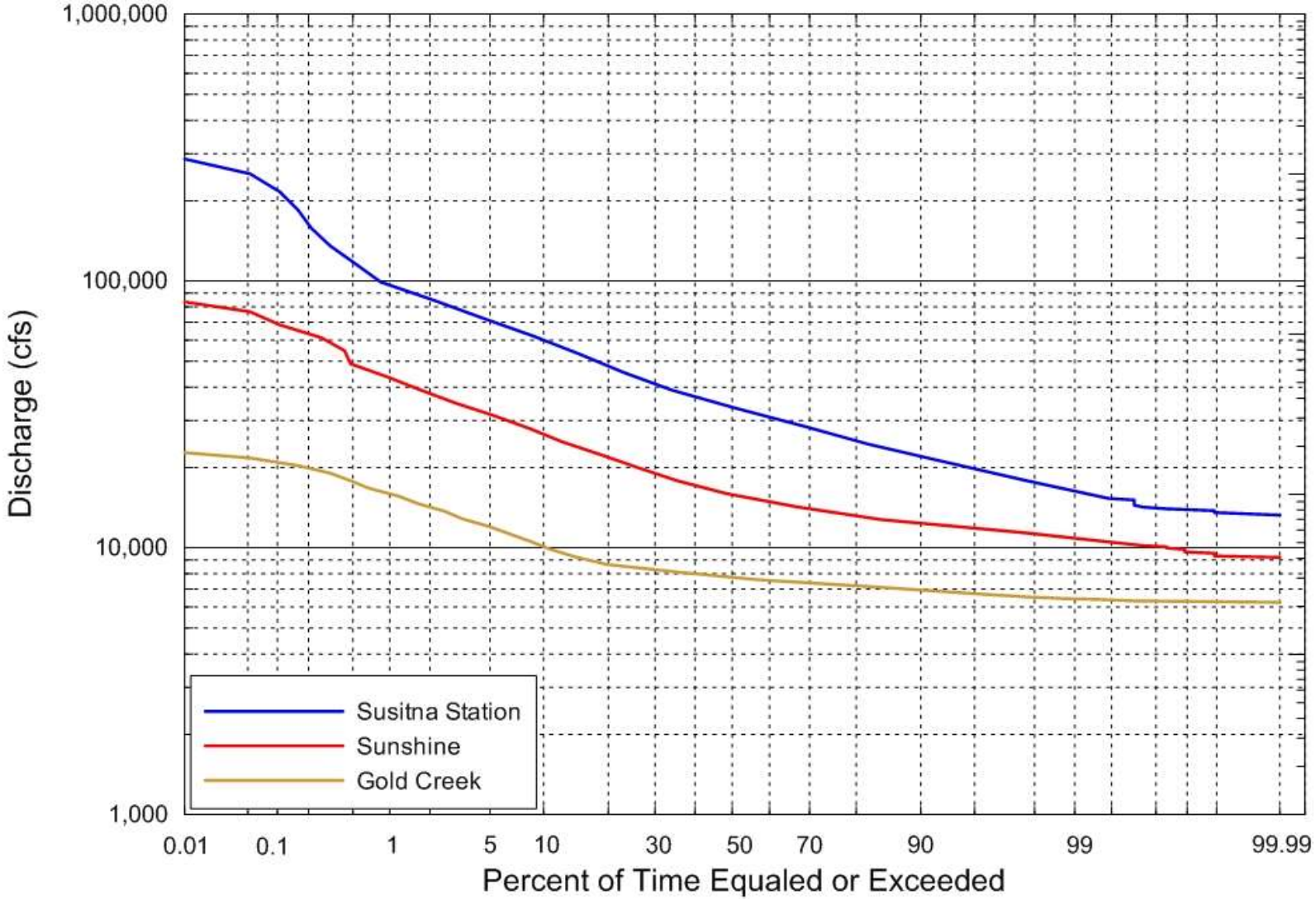


Figure G-1 – Monthly Flow-duration Curves for October for three Mainstem Gages for Max LF OS-1 Conditions based on the HEC-ResSim Model

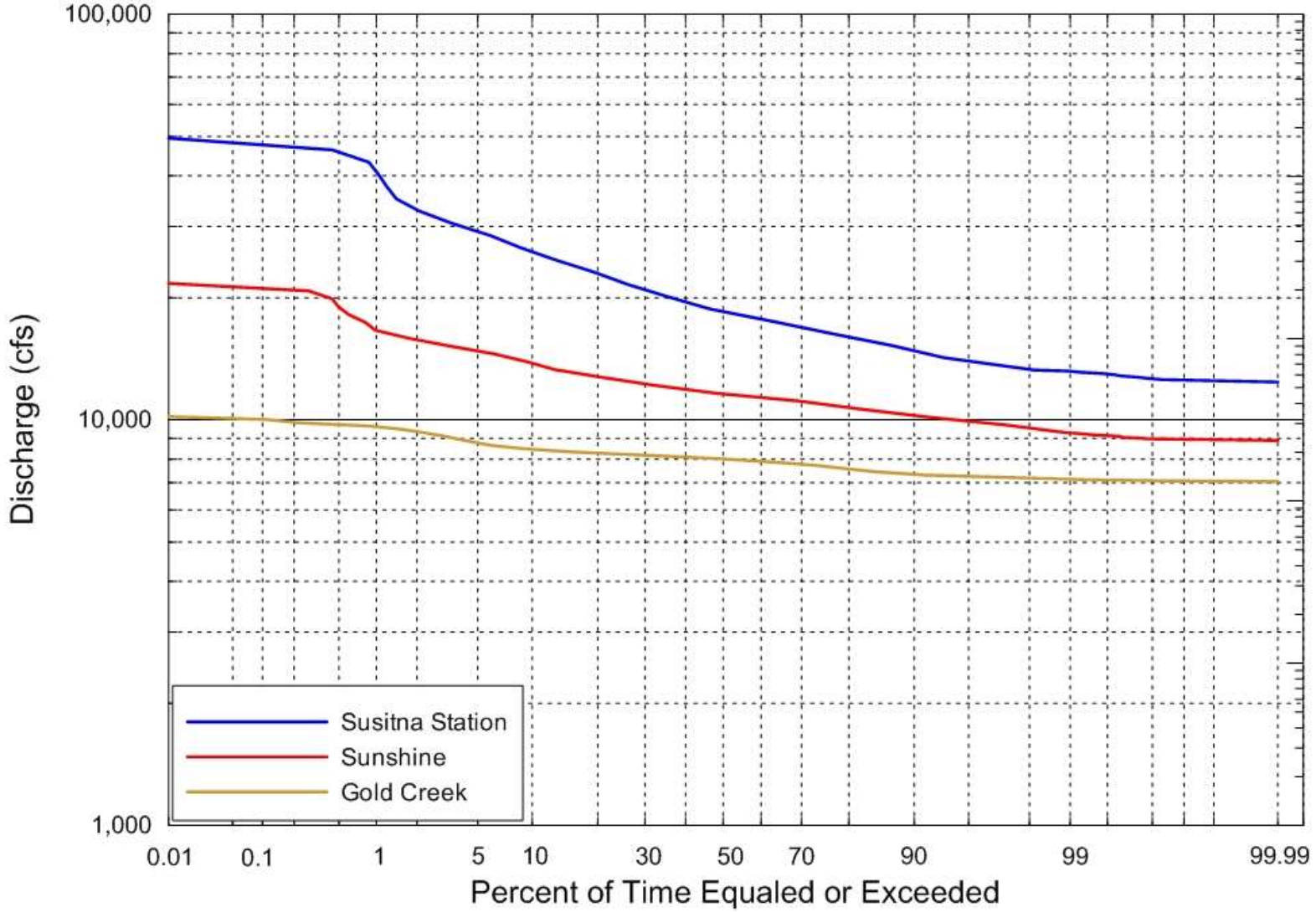


Figure G-2 – Monthly Flow-duration Curves for November for three Mainsem Gages for Max LF OS-1 Conditions based on the HEC-ResSim Model

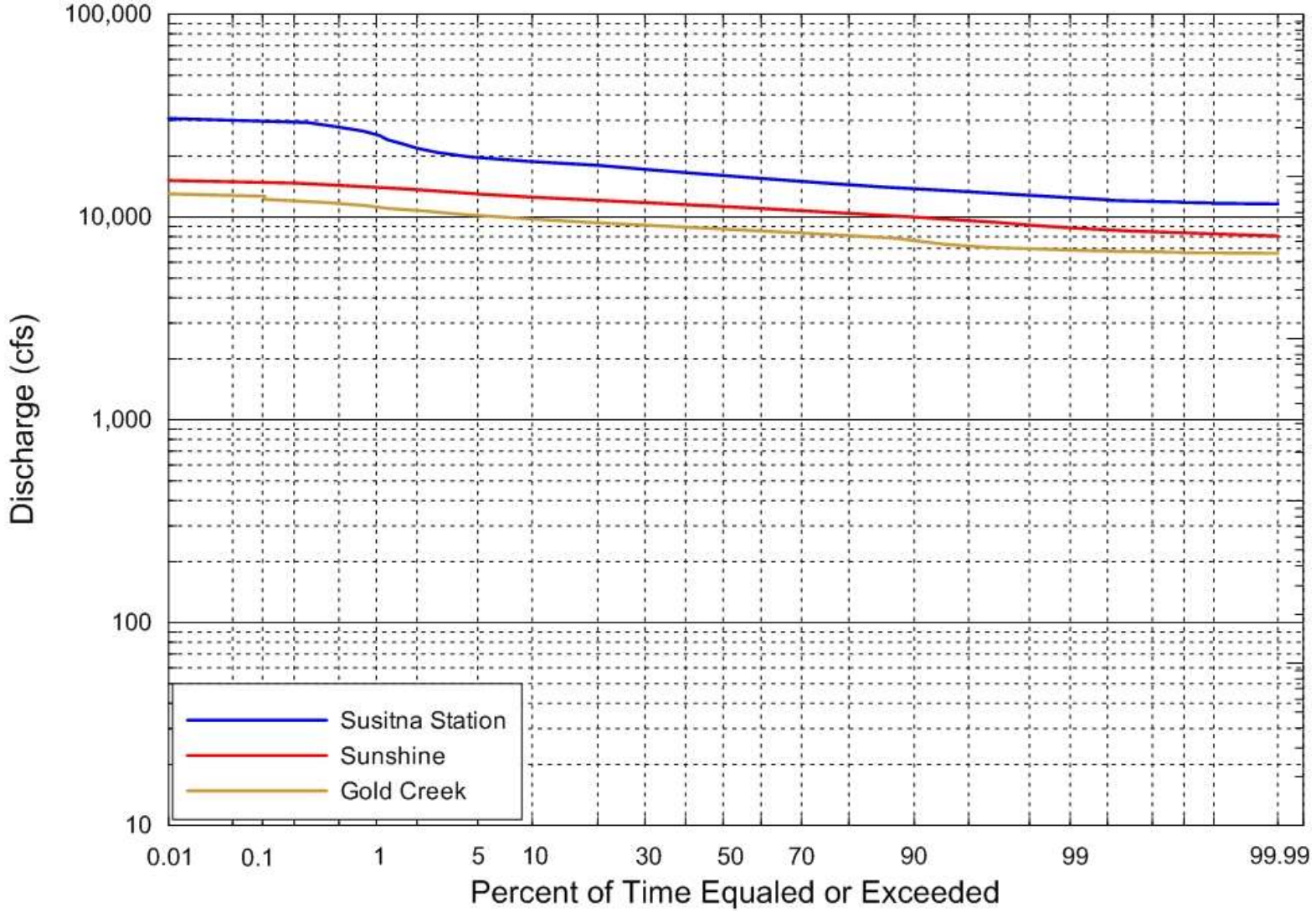


Figure G-3 – Monthly Flow-duration Curves for December for three Mainstem Gages for Max LF OS-1 Conditions based on the HEC-ResSim Model

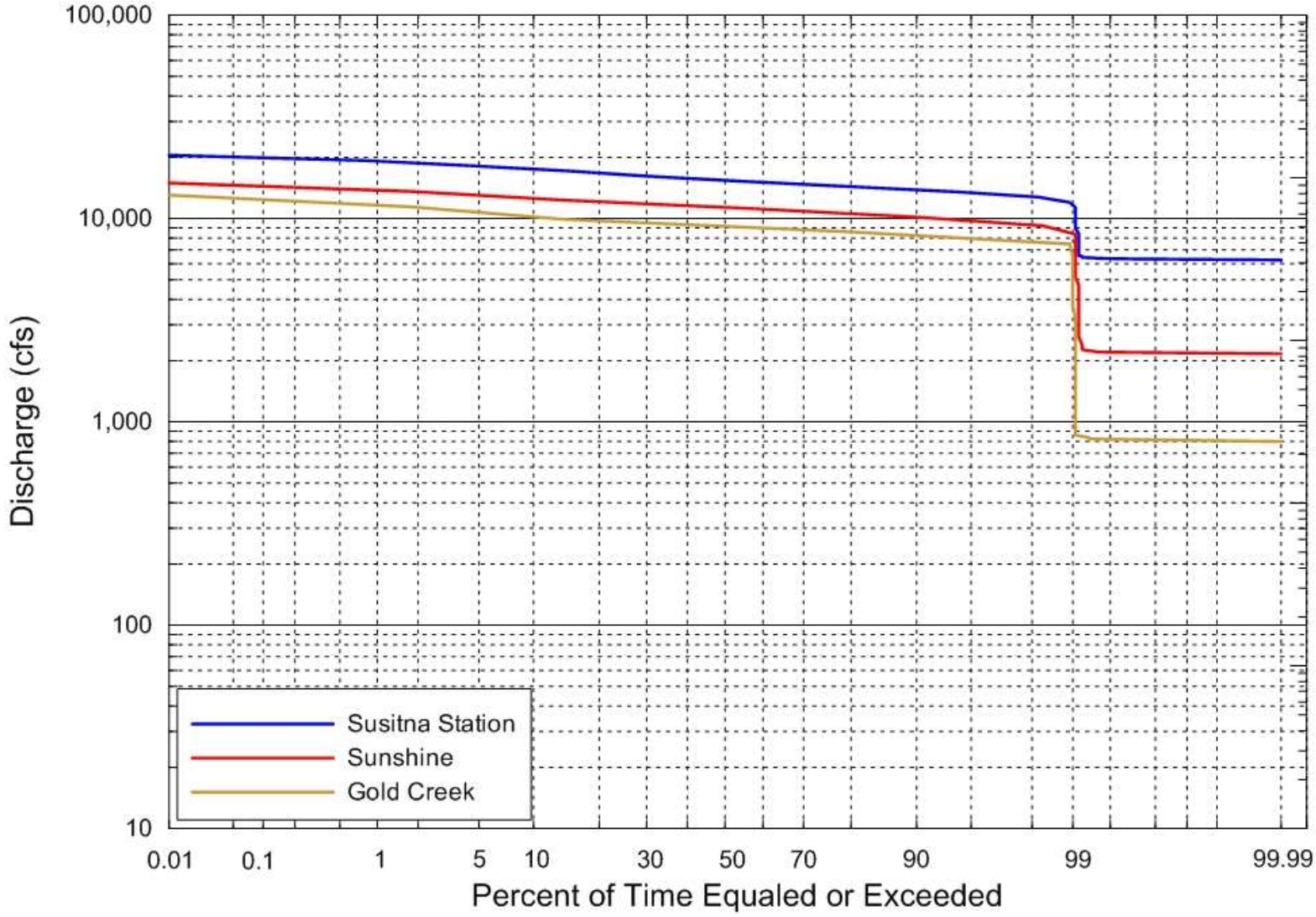
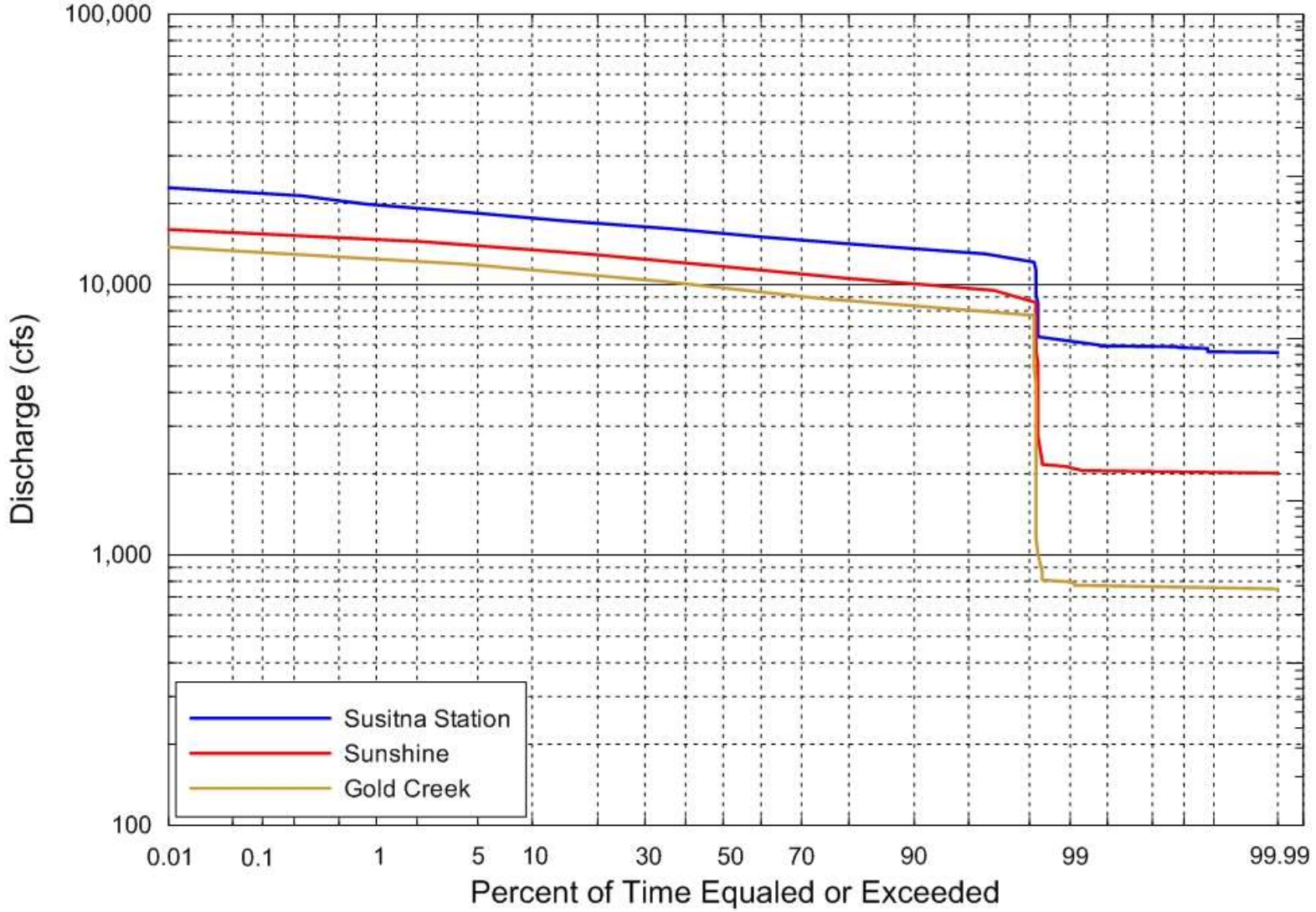


Figure G-4 – Monthly Flow-duration Curves for January for three Mainstem Gages for Max LF OS-1 Conditions based on the HEC-ResSim Model



igure G-5 – Monthly Flow-duration Curves for February for three Mainstem Gages for Max LF OS-1 Conditions based on the HEC-ResSim Model

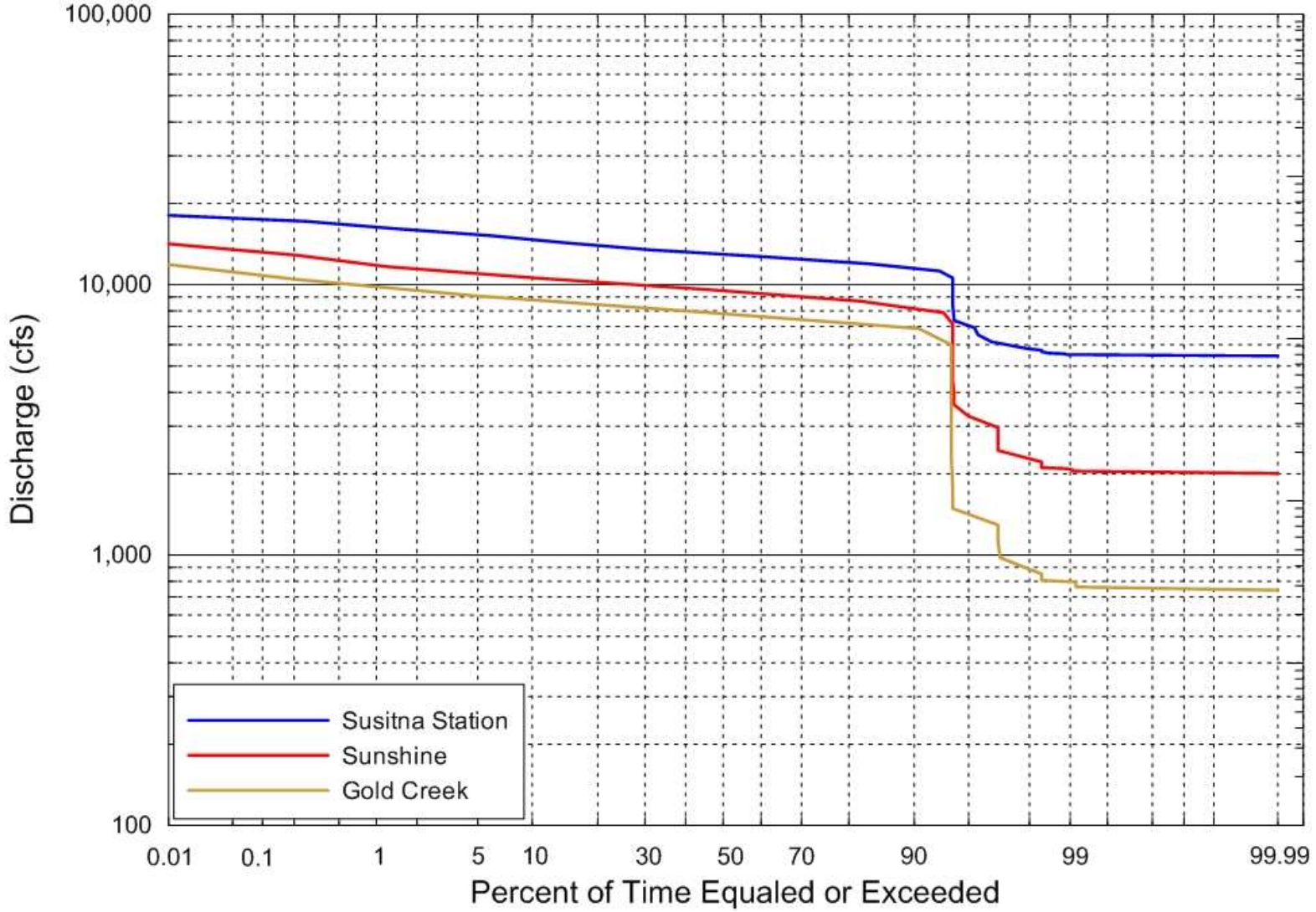


Figure G-6 – Monthly Flow-duration Curves for March for three Mainstem Gages for Max LF OS-1 Conditions based on the HEC-ResSim Model

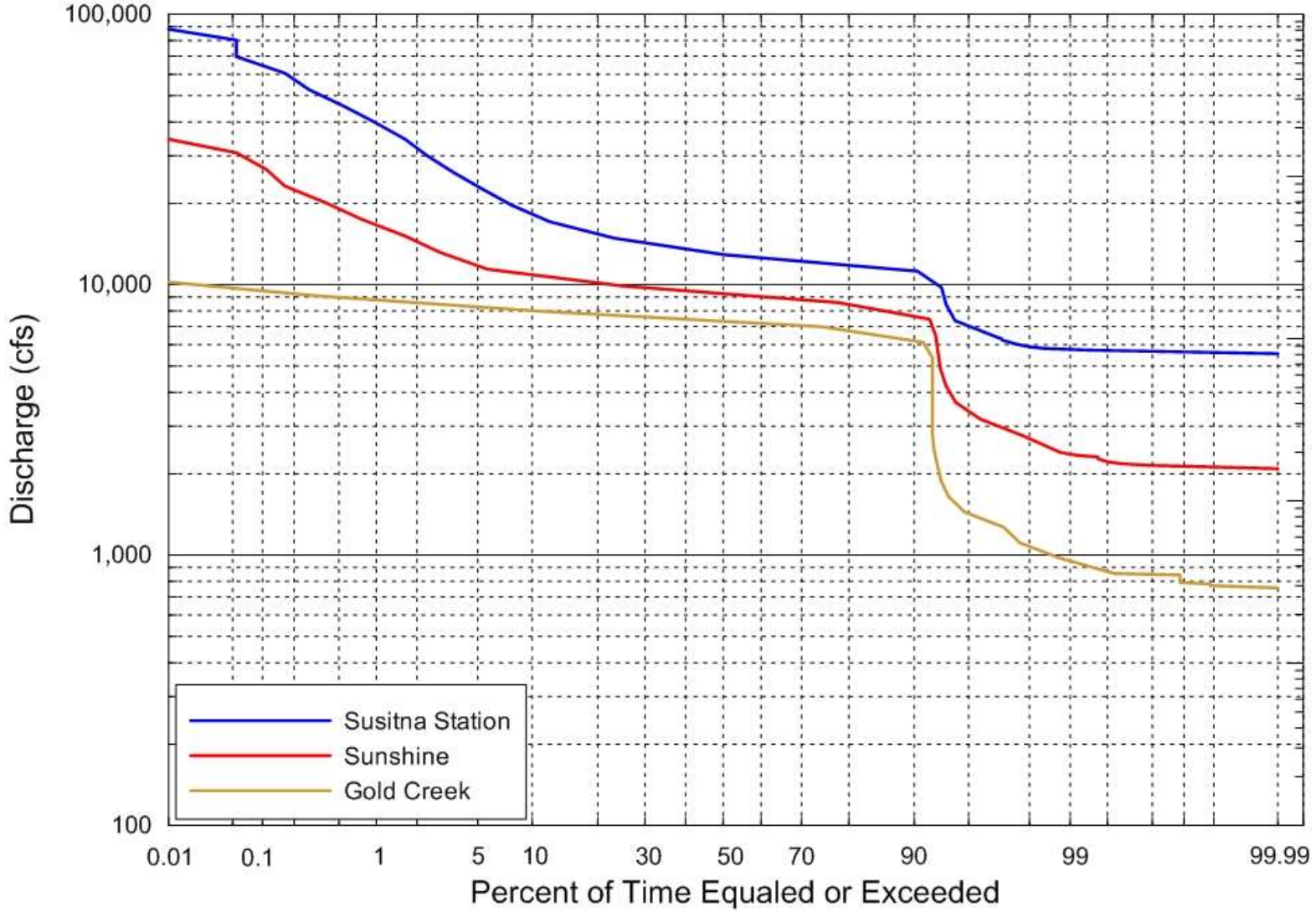


Figure G-7 – Monthly Flow-duration Curves for April for three Mainstem Gages for Max LF OS-1 Conditions based on the HEC-ResSim Model

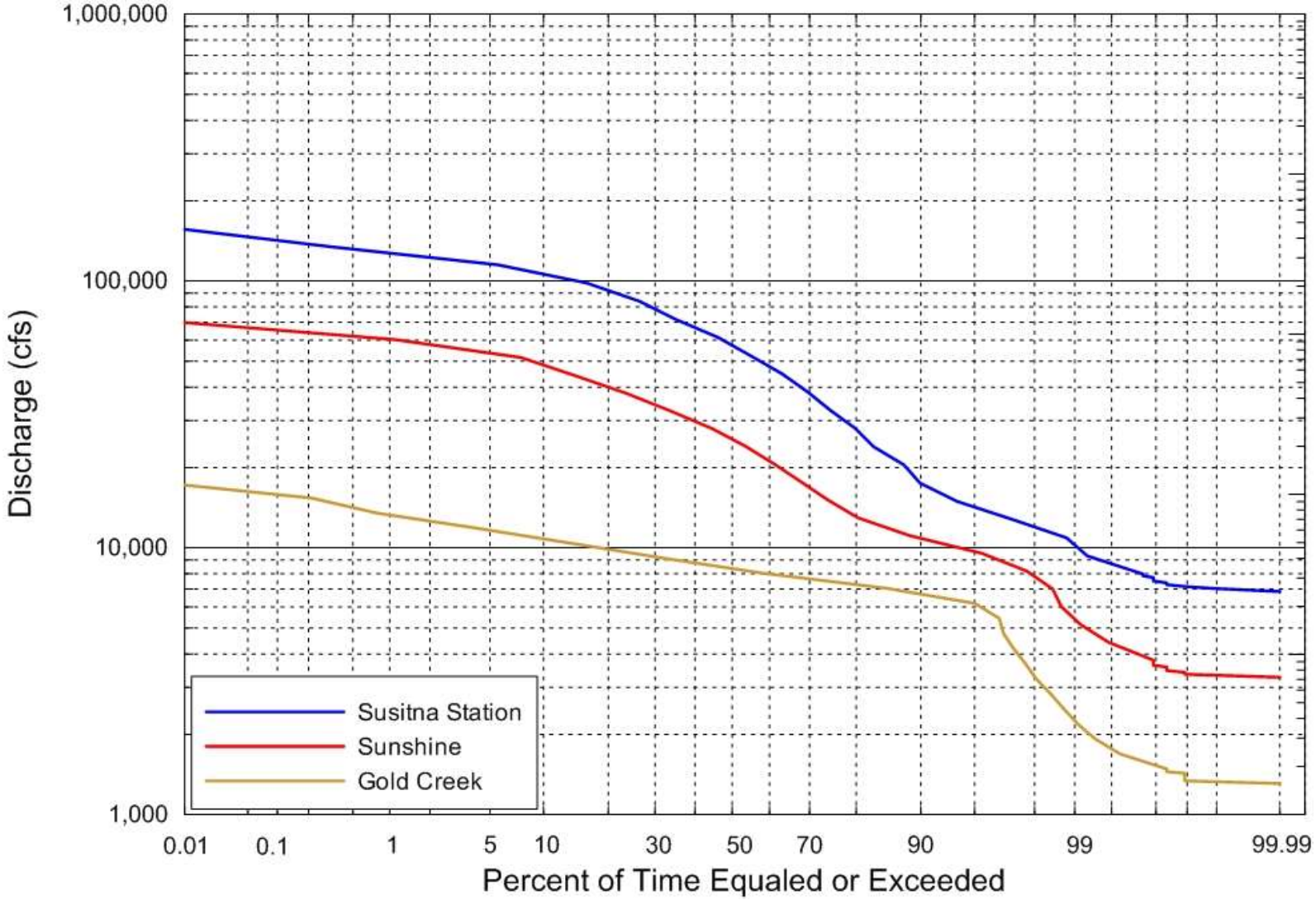


Figure G-8 – Monthly Flow-duration Curves for May for three Mainstem Gages for Max LF OS-1 Conditions based on the HEC-ResSim Model

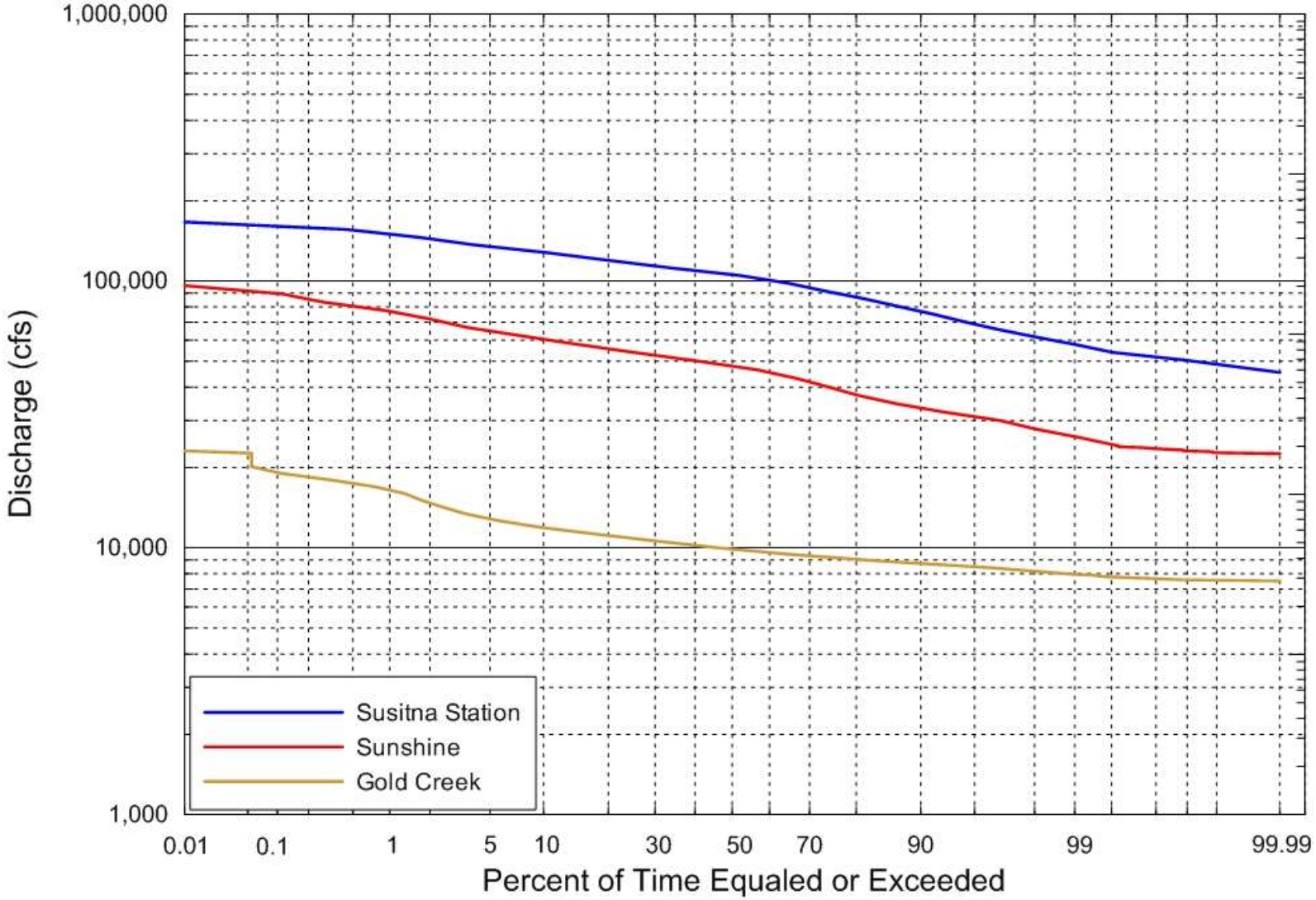


Figure G-9 – Monthly Flow-duration Curves for June for three Mainstem Gages for Max LF OS-1 Conditions based on the HEC-ResSim Model

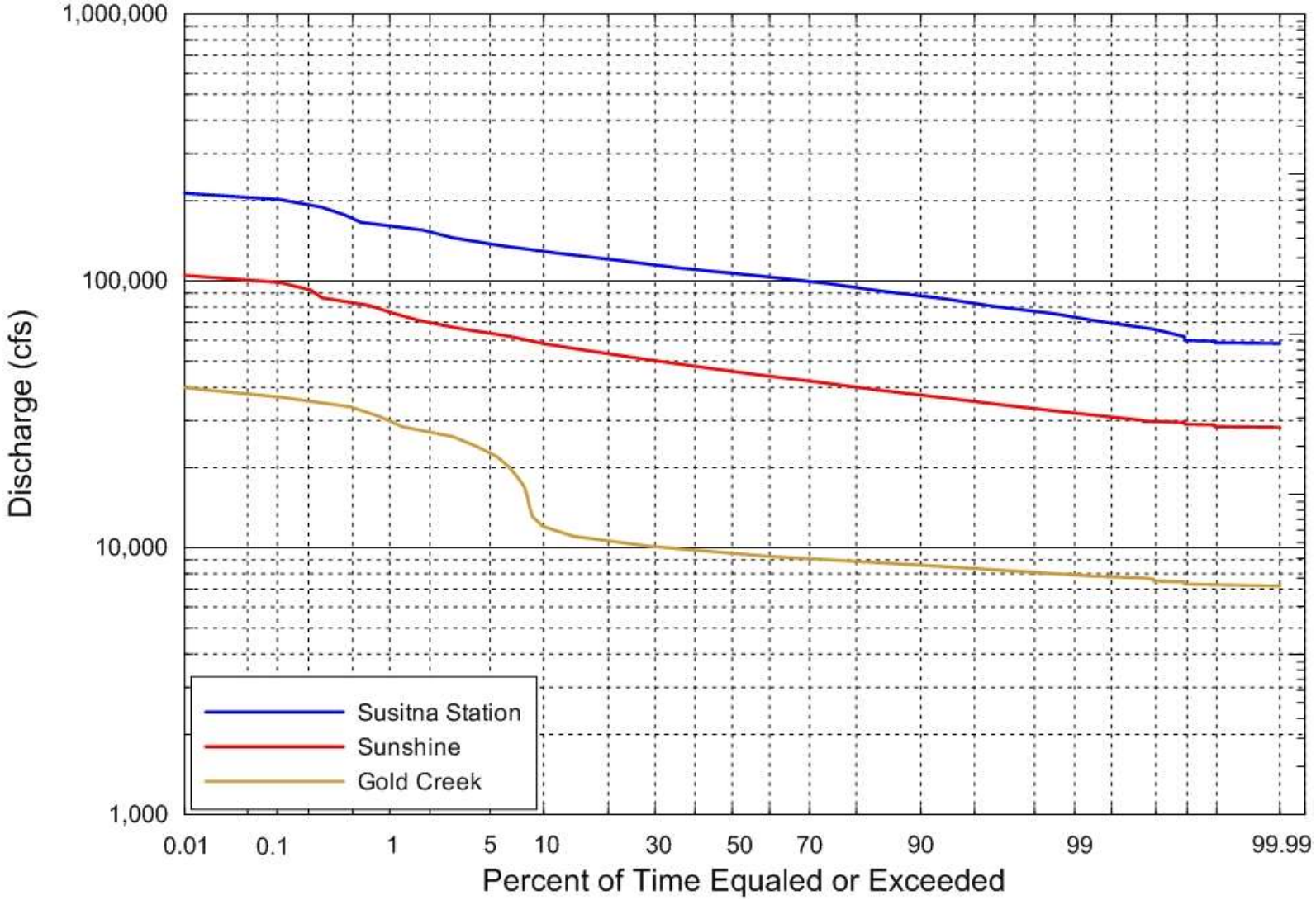


Figure G-10 – Monthly Flow-duration Curves for July for three Mainstem Gages for Max LF OS-1 Conditions based on the HEC-ResSim Model

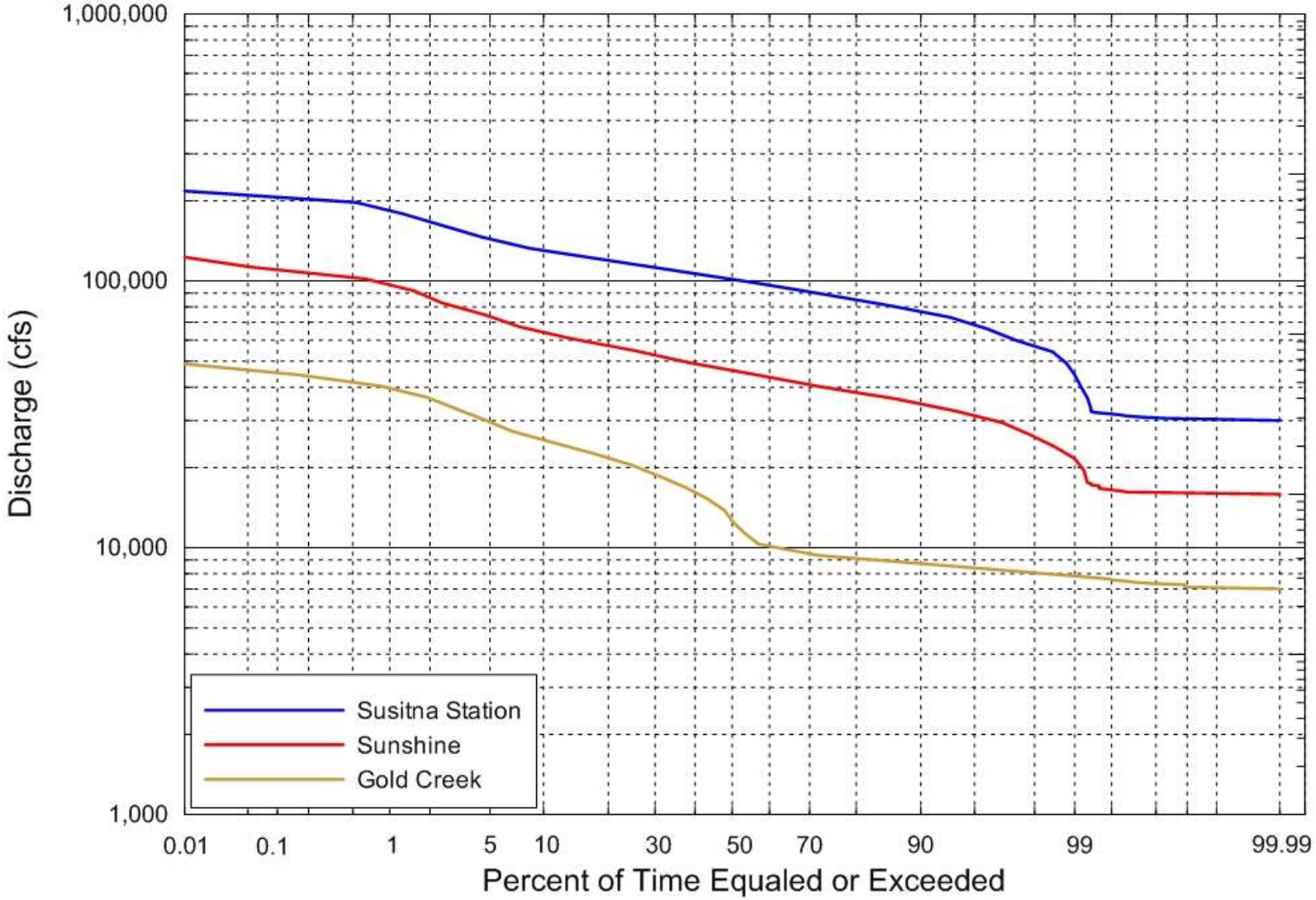


Figure G-11 – Monthly Flow-duration Curves for August for three Mainstem Gages for Max LF OS-1 Conditions based on the HEC-ResSim Model

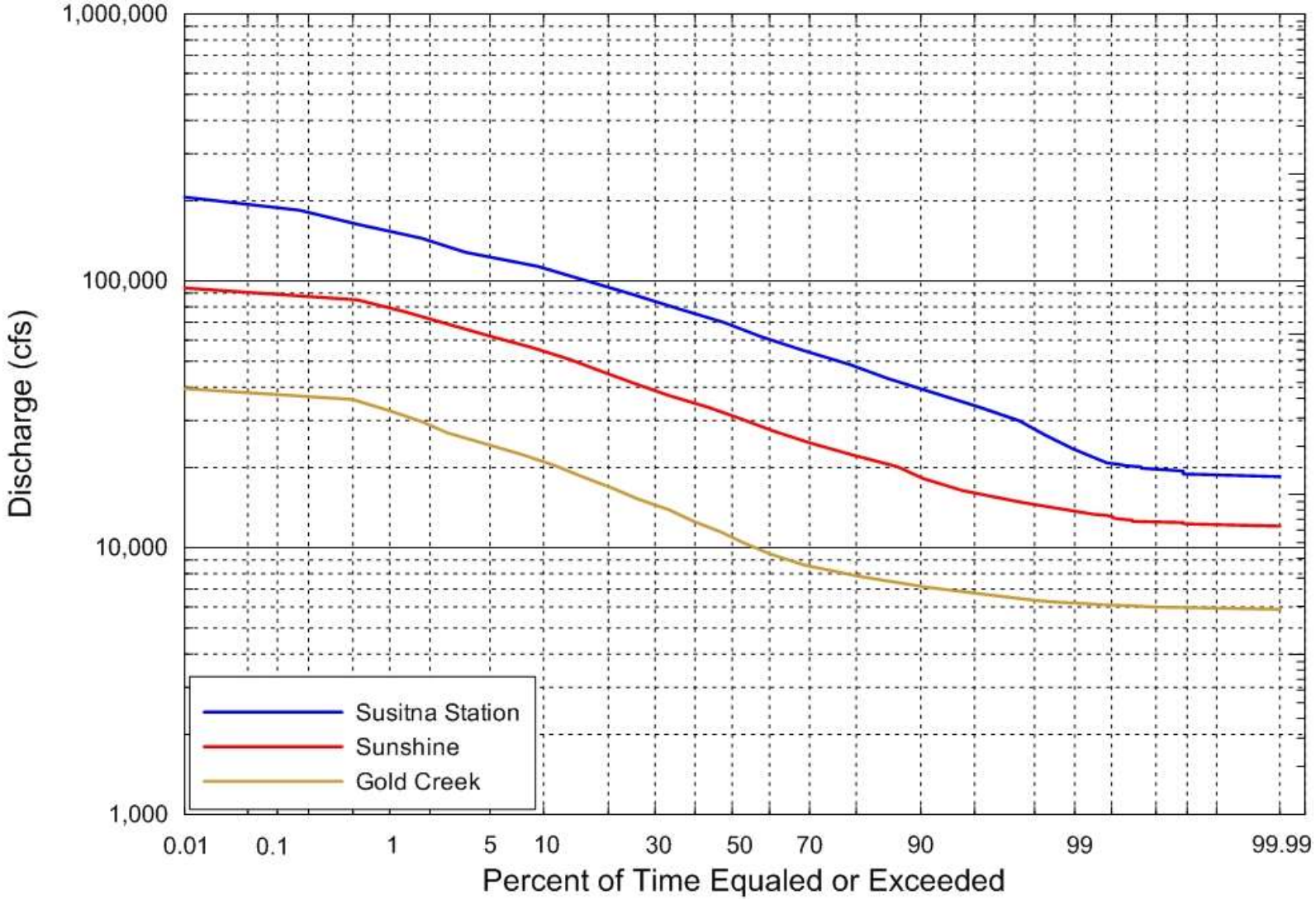


Figure G-12 – Monthly Flow-duration Curves for September for three Mainstem Gages for Max LF OS-1 Conditions based on the HEC-ResSim Model

APPENDIX H. MONTHLY FLOW DURATION COMPARISON FOR PRE-PROJECT AND POST-PROJECT CONDITIONS

Susitna-Watana Hydroelectric Project (FERC No. 14241)

Stream Flow Assessment

Prepared for

Alaska Energy Authority

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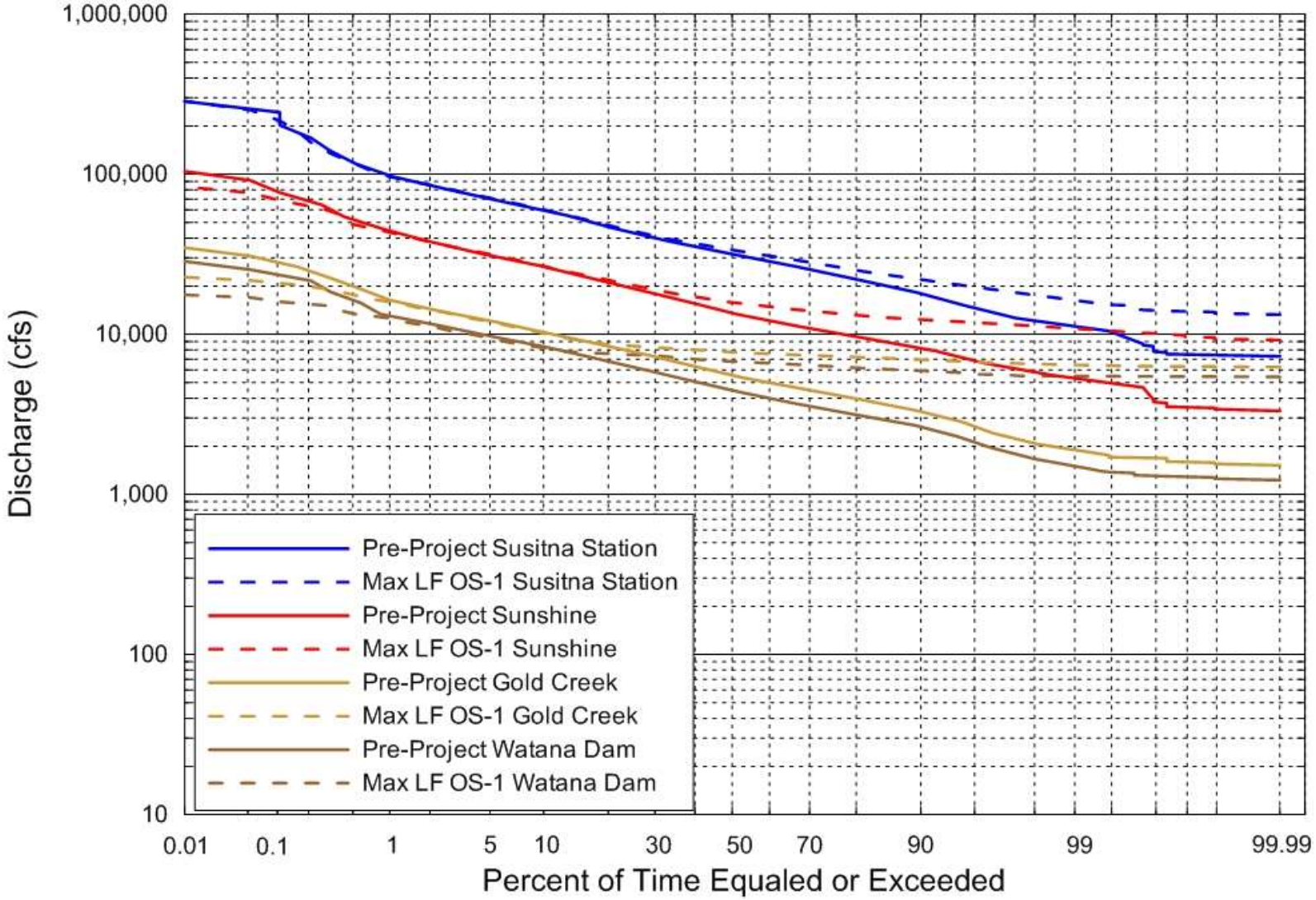

Figure H-1 – Monthly Flow-duration Curves for October to compare Pre-Project and Max LF OS-1 Conditions

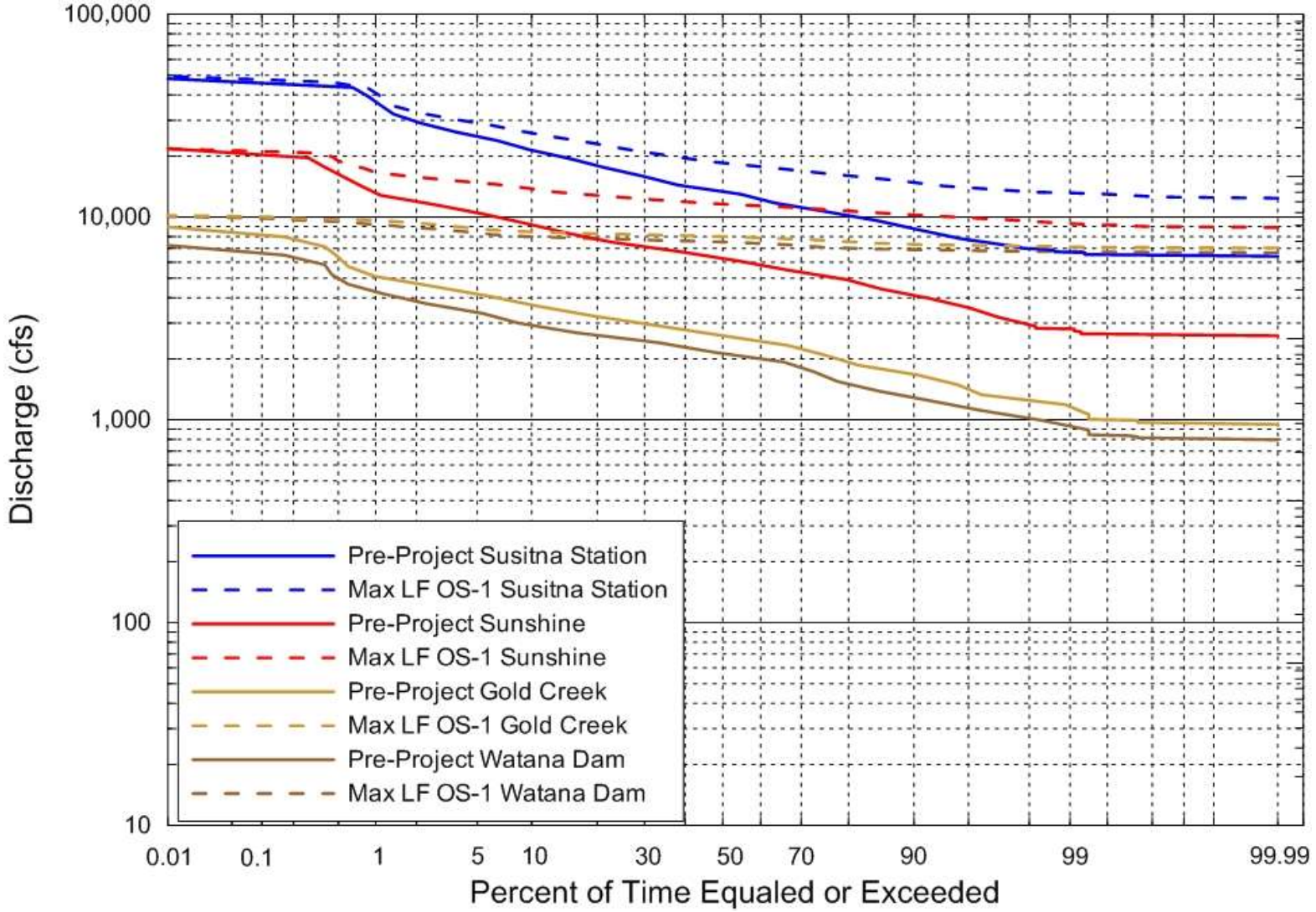

Figure H-2 – Monthly Flow-duration Curves for November to compare Pre-Project and Max LF OS-1 Conditions

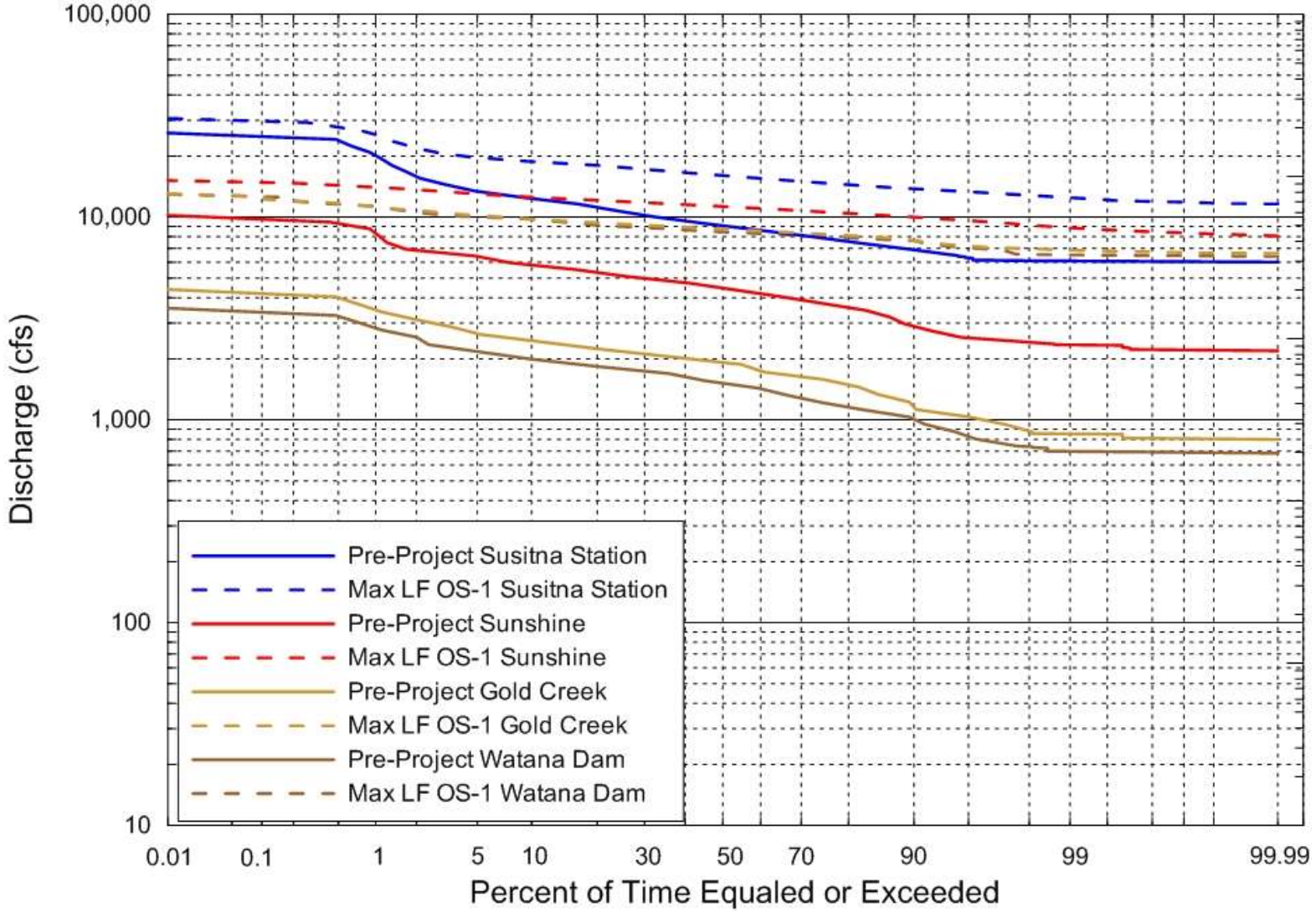

Figure H-3 – Monthly Flow-duration Curves for December to compare Pre-Project and Max LF OS-1 Conditions

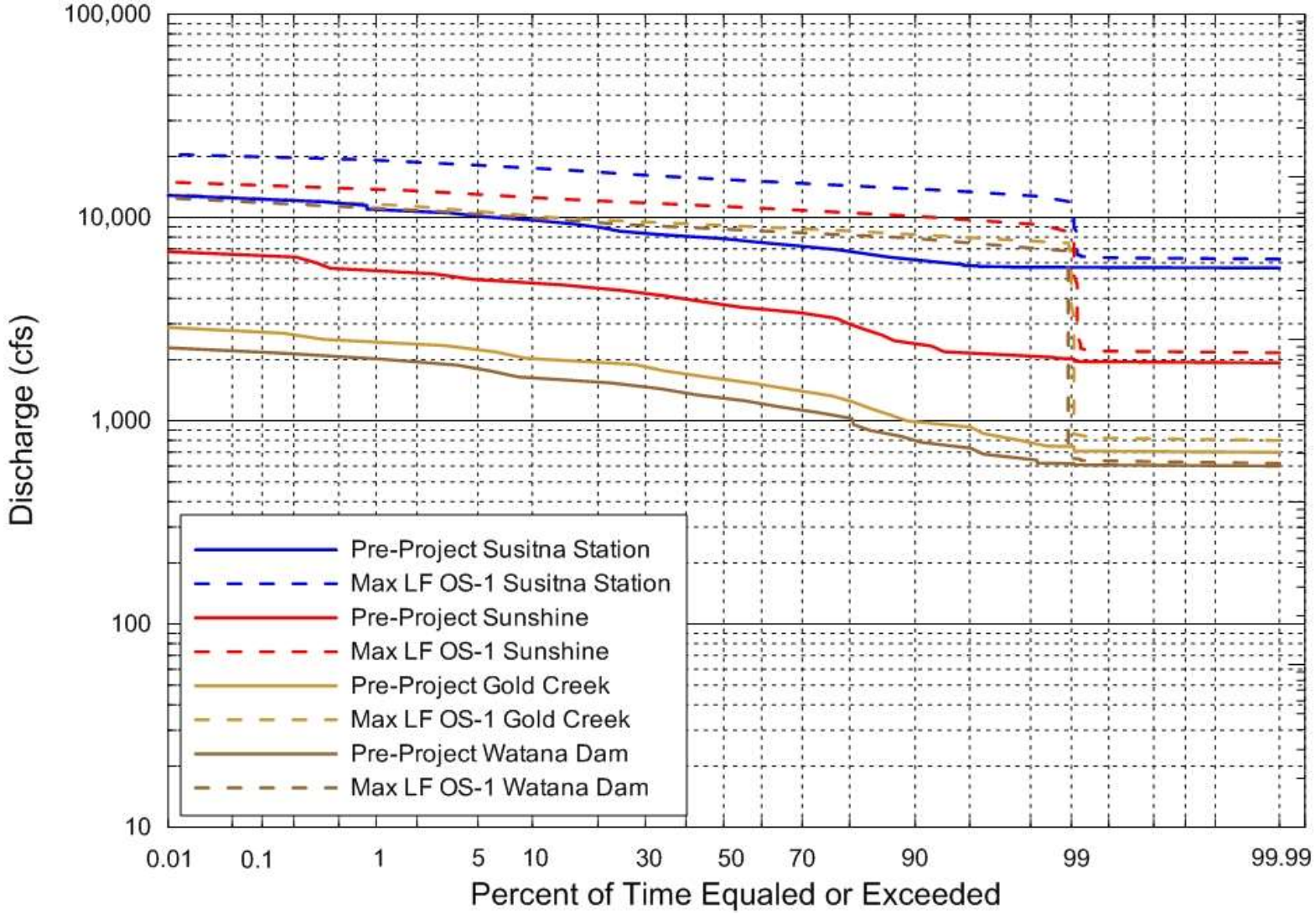

Figure H-4 – Monthly Flow-duration Curves for January to compare Pre-Project and Max LF OS-1 Conditions

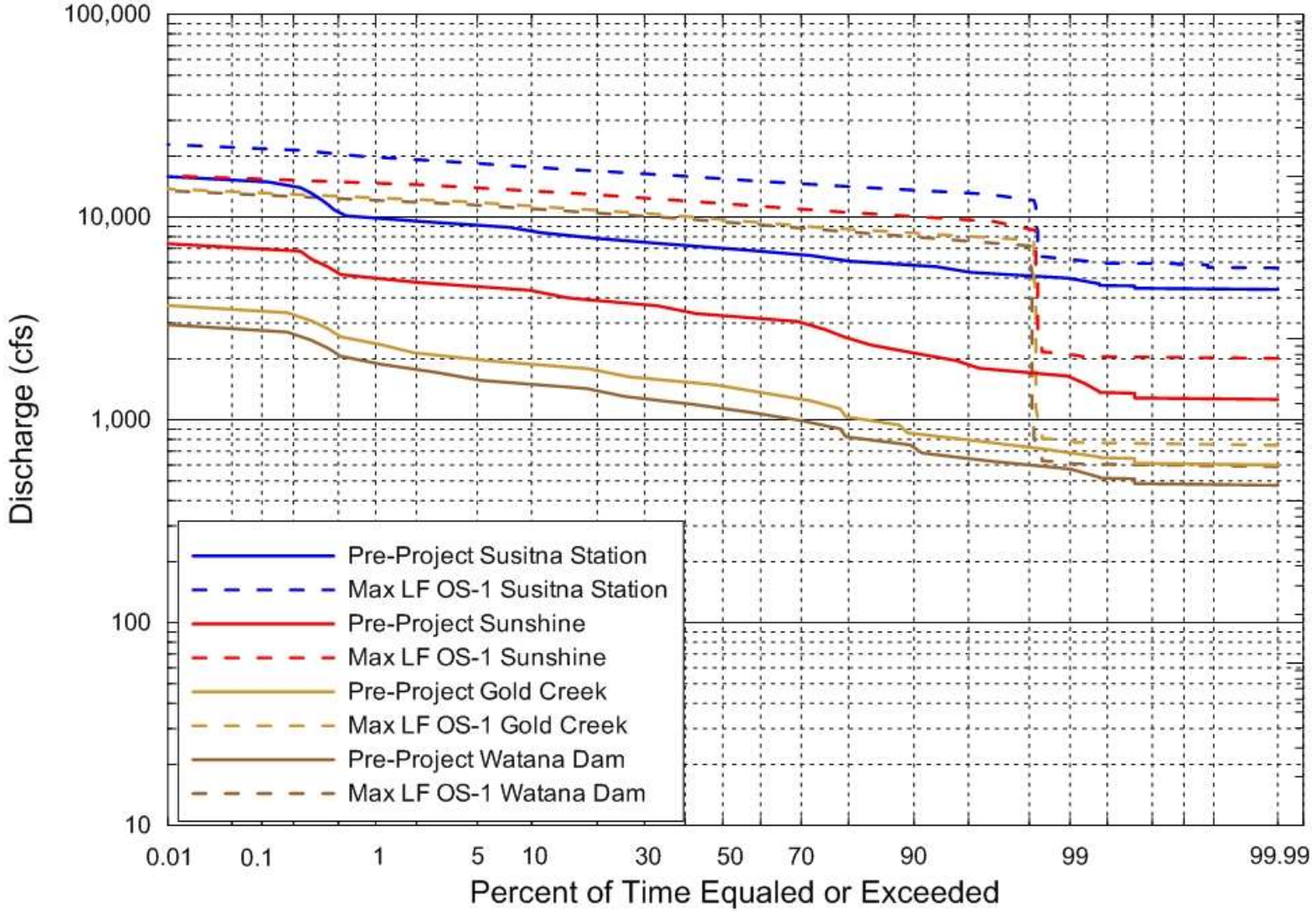

Figure H-5 – Monthly Flow-duration Curves for February to compare Pre-Project and Max LF OS-1 Conditions

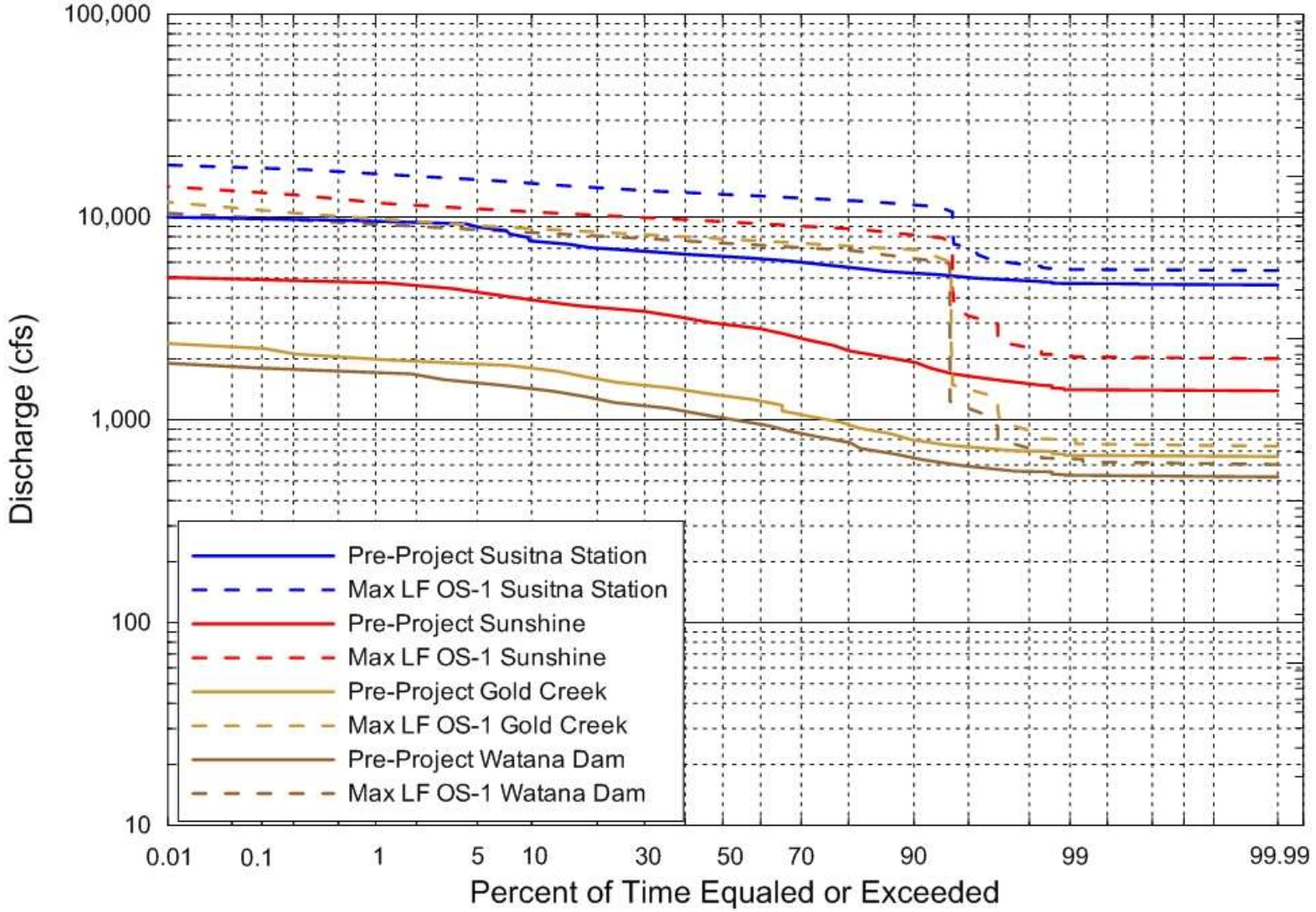

Figure H-6 – Monthly Flow-duration Curves for March to compare Pre-Project and Max LF OS-1 Conditions

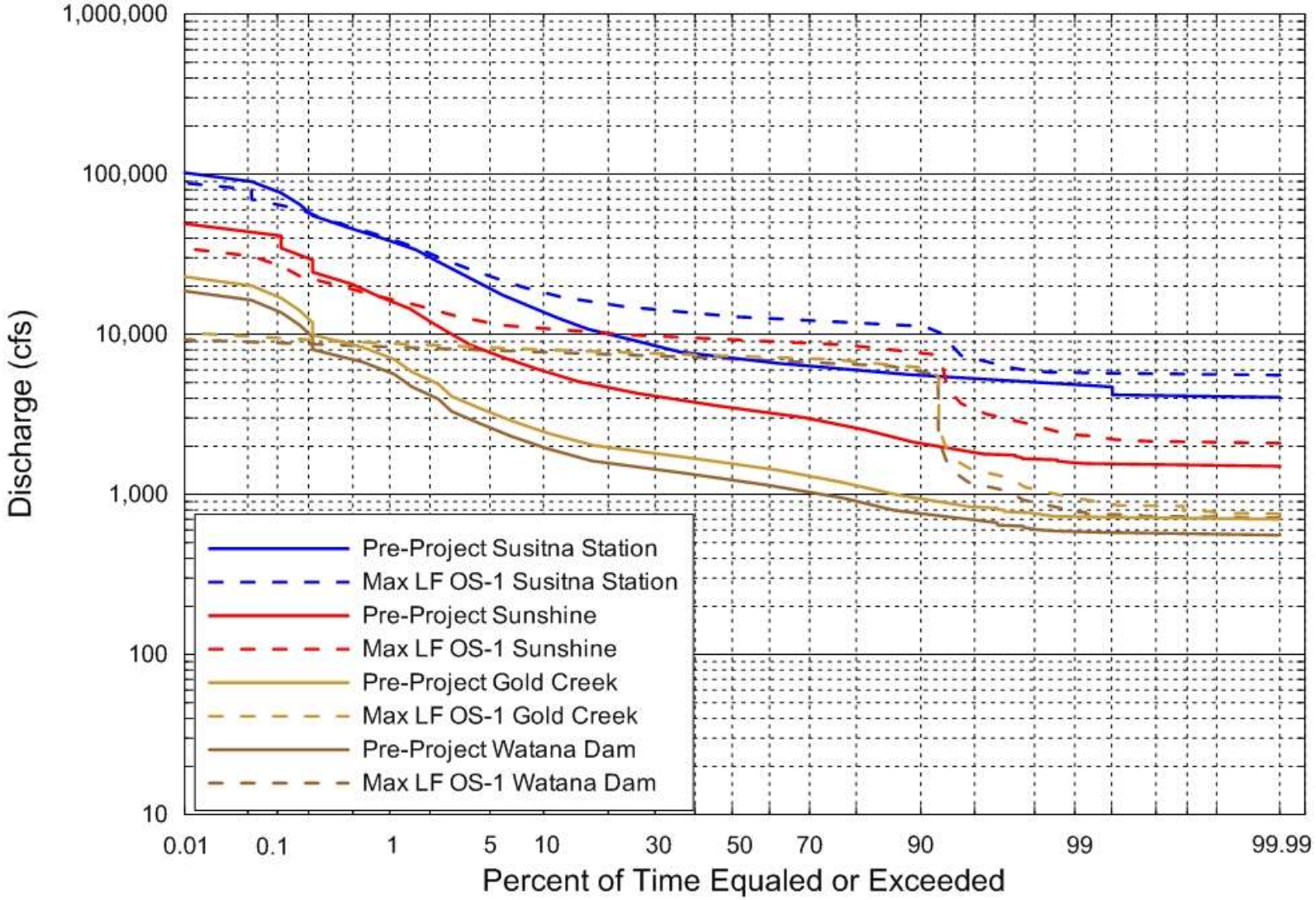

Figure H-7 – Monthly Flow-duration Curves for April to compare Pre-Project and Max LF OS-1 Conditions

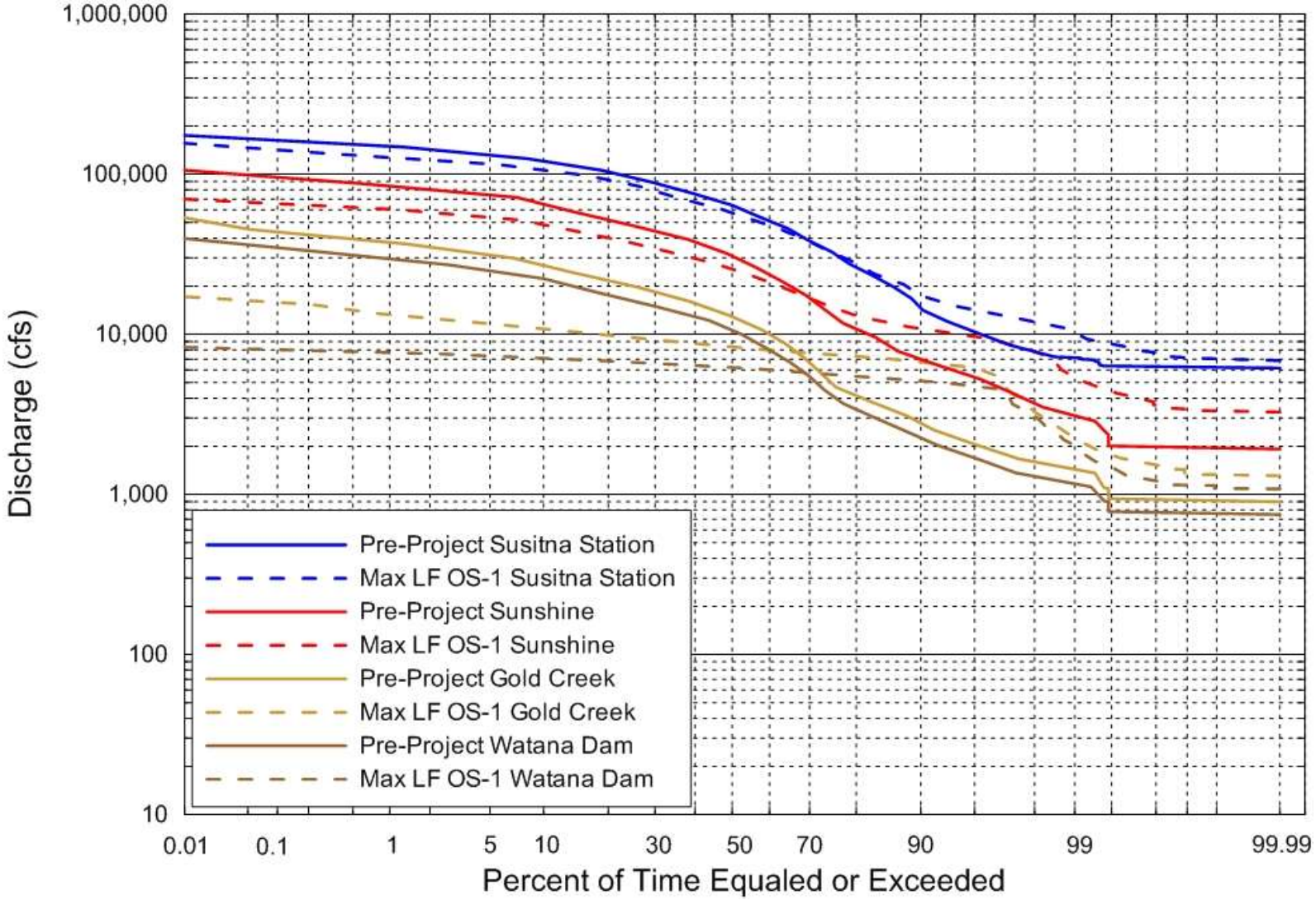

Figure H-8 – Monthly Flow-duration Curves for May to compare Pre-Project and Max LF OS-1 Conditions

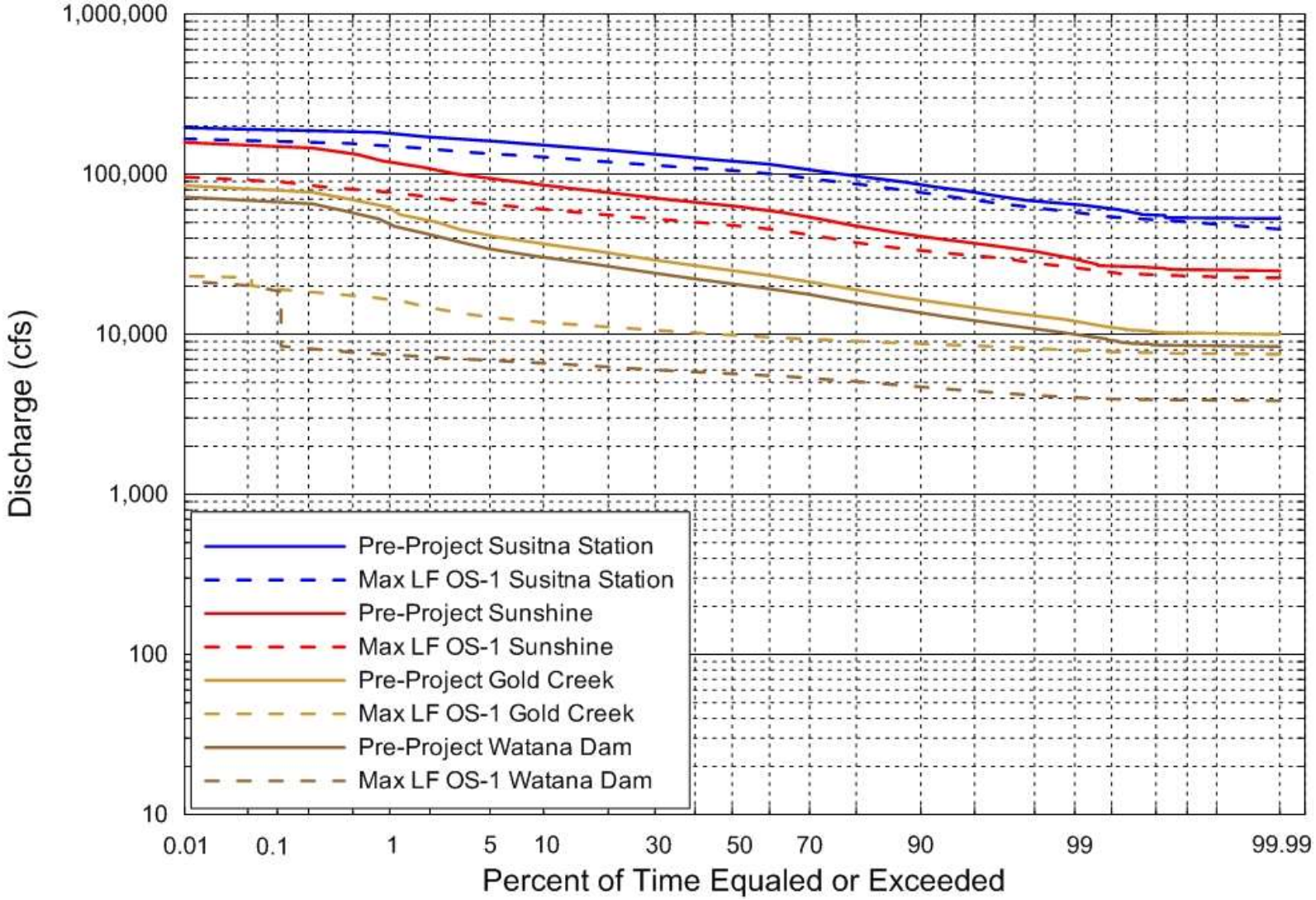

Figure H-9 – Monthly Flow-duration Curves for June to compare Pre-Project and Max LF OS-1 Conditions

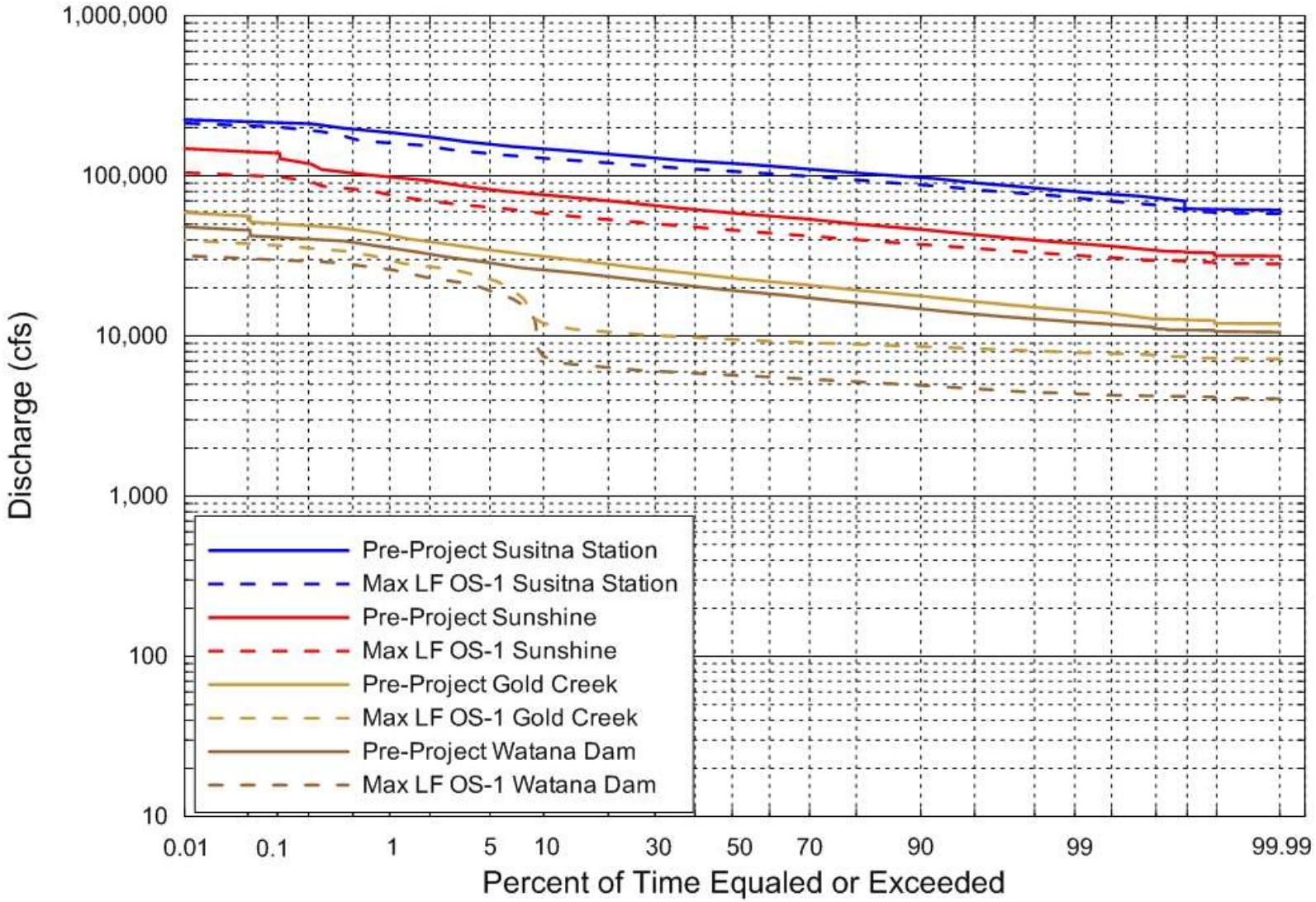

Figure H-10 – Monthly Flow-duration Curves for July to compare Pre-Project and Max LF OS-1 Conditions

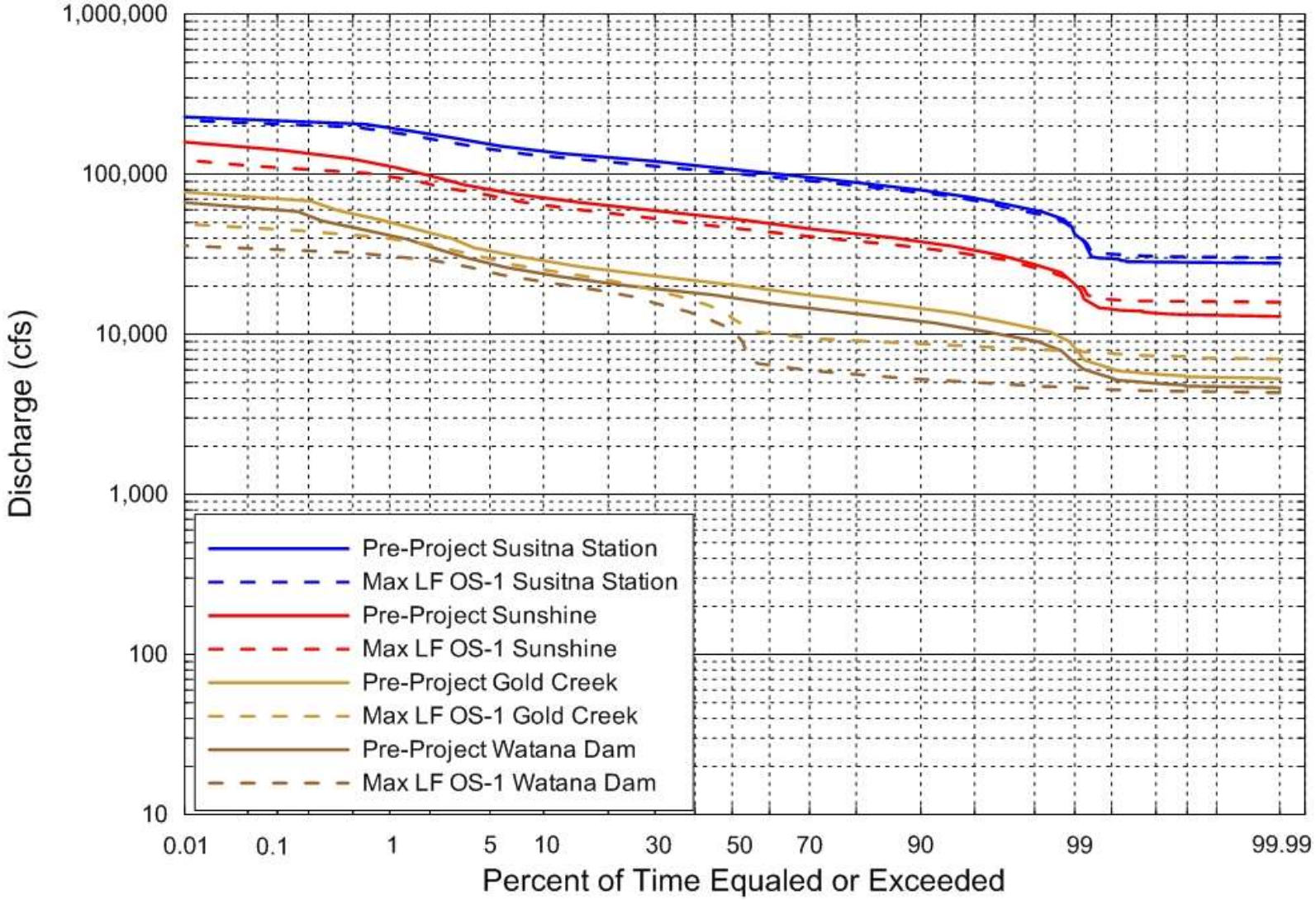

Figure H-11 – Monthly Flow-duration Curves for August to compare Pre-Project and Max LF OS-1 Conditions

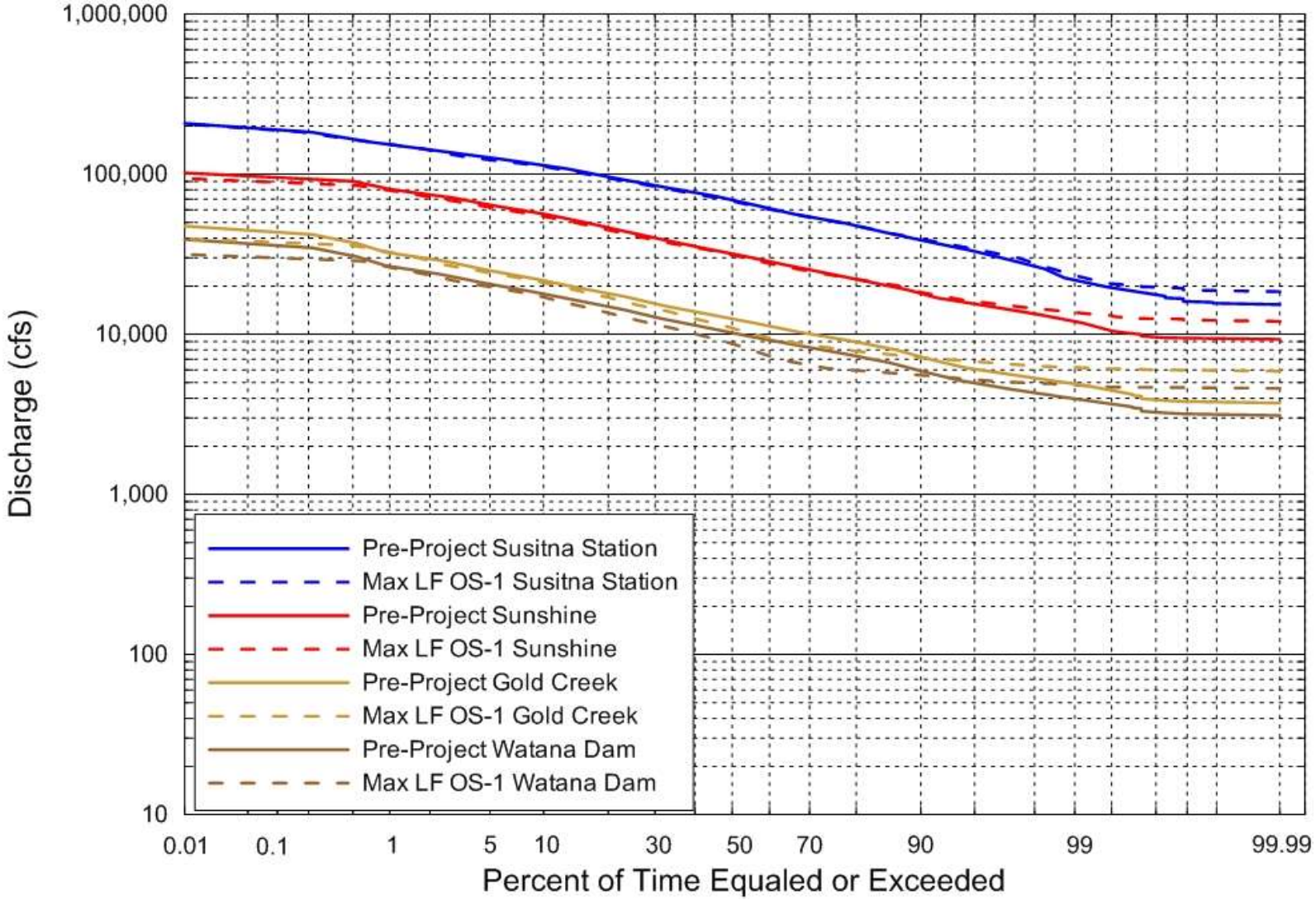

Figure H-.12 – Monthly Flow-duration Curves for September to compare Pre-Project and Max LF OS-1 Conditions.

APPENDIX I. MONTHLY FLOW EXCEEDENCE COMPARISON (CFS) FOR PRE-PROJECT AND POST-PROJECT CONDITIONS

Susitna-Watana Hydroelectric Project (FERC No. 14241)

Stream Flow Assessment

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

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February 2013

Table I-1 – Monthly Flow Exceedence Ordinate (cfs) Comparison for Pre-Project and Max LF OS-1 Conditions at the Proposed Watana Dam Site

Watana Dam												
Percentile	Oct		Nov		Dec		Jan		Feb		Mar	
	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1
99%	1,540	5,440	924	6,750	696	6,510	618	656	588	597	532	643
95%	2,170	5,640	1,120	6,830	875	6,990	756	7,670	635	7,960	595	1,120
90%	2,610	5,890	1,340	6,900	981	7,640	795	7,910	750	8,250	643	6,650
75%	3,410	6,320	1,680	7,090	1,210	8,070	1,060	8,420	957	8,580	807	6,990
50%	4,460	6,680	2,100	7,540	1,520	8,460	1,280	8,910	1,120	9,360	1,040	7,590
25%	6,300	7,450	2,510	7,770	1,770	8,990	1,520	9,260	1,320	10,400	1,200	7,930
10%	8,390	8,230	2,950	8,010	1,980	9,740	1,640	9,790	1,450	11,100	1,440	8,270
5%	9,740	9,450	3,400	8,360	2,170	9,960	1,790	10,300	1,600	11,400	1,520	8,540
1%	13,000	12,600	4,220	9,170	2,820	11,300	2,030	11,500	1,930	12,800	1,700	9,260
Percentile	Apr		May		Jun		Jul		Aug		Sep	
	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1
99%	581	776	1,150	2,010	10,100	4,040	12,300	4,370	6,790	4,650	3,970	4,830
95%	694	1,150	1,690	4,760	12,100	4,400	13,700	4,670	10,700	4,950	4,960	5,170
90%	755	5,910	2,260	5,120	13,600	4,670	14,800	4,930	12,100	5,220	5,910	5,520
75%	956	6,700	4,090	5,610	16,700	5,230	16,700	5,310	14,000	5,750	7,860	6,090
50%	1,220	7,050	10,700	6,220	20,700	5,680	19,200	5,700	17,000	10,400	10,100	8,710
25%	1,520	7,470	16,400	6,690	25,200	6,100	22,600	6,150	19,900	17,200	13,800	12,500
10%	2,010	7,750	22,200	7,040	30,400	6,620	26,100	7,440	23,600	21,400	17,900	17,200
5%	2,650	7,940	25,000	7,290	34,100	6,890	28,700	19,300	27,000	24,600	20,600	19,900
1%	5,680	8,450	30,800	7,820	49,200	7,430	35,200	26,000	42,200	31,000	26,200	26,000

Table I-2 – Monthly Flow Exceedence Ordinate (cfs) Comparison for Pre-Project and Max LF OS-1 Conditions for the Susitna River at Gold Creek

Susitna River at Gold Creek												
Percentile	Oct		Nov		Dec		Jan		Feb		Mar	
	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1
99%	1,900	6,440	1,100	7,140	850	6,880	750	7,070	700	795	660	800
95%	2,710	6,710	1,400	7,250	1,100	7,210	950	7,880	800	8,160	750	1,400
90%	3,300	6,920	1,700	7,330	1,200	7,660	980	8,220	860	8,500	800	6,900
75%	4,200	7,300	2,100	7,690	1,600	8,240	1,400	8,720	1,200	8,850	1,000	7,250
50%	5,500	7,730	2,600	8,010	1,900	8,740	1,600	9,190	1,400	9,800	1,300	7,850
25%	7,790	8,390	3,100	8,230	2,200	9,230	1,900	9,560	1,690	10,700	1,500	8,210
10%	10,300	10,100	3,690	8,450	2,500	9,760	2,000	10,300	1,850	11,400	1,800	8,620
5%	12,000	12,000	4,200	8,760	2,700	10,200	2,200	10,600	2,000	11,700	1,900	9,040
1%	16,100	15,900	5,100	9,610	3,460	11,300	2,500	11,700	2,400	13,200	2,100	9,650
Percentile	Apr		May		Jun		Jul		Aug		Sep	
	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1
99%	710	952	1,400	2,240	12,100	7,980	14,600	7,880	8,240	7,900	4,910	6,200
95%	830	1,420	2,100	6,200	14,900	8,480	16,400	8,380	12,900	8,420	6,000	6,730
90%	930	6,250	2,800	6,620	16,400	8,700	17,800	8,600	14,500	8,730	7,340	7,170
75%	1,200	6,970	5,000	7,460	20,000	9,200	20,000	9,000	17,000	9,260	9,560	8,150
50%	1,520	7,390	13,000	8,300	25,100	9,890	23,000	9,480	20,400	12,600	12,500	11,000
25%	1,820	7,750	20,000	9,560	30,500	10,800	26,900	10,300	24,000	20,300	16,800	15,500
10%	2,500	7,990	27,100	10,800	36,700	11,900	31,300	12,000	28,500	25,600	21,800	21,100
5%	3,300	8,210	31,000	11,600	41,100	12,800	34,500	22,400	32,700	29,500	25,000	24,200
1%	7,000	8,730	37,800	13,300	58,800	16,500	42,600	29,700	51,100	39,600	32,000	32,200

Table I-3 – Monthly Flow Exceedence Ordinate (cfs) Comparison for Pre-Project and Max LF OS-1 Conditions for the Susitna River at Sunshine

Susitna River at Sunshine												
Percentile	Oct		Nov		Dec		Jan		Feb		Mar	
	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1
99%	5,280	11,000	2,820	9,300	2,340	8,880	2,030	8,840	1,570	2,110	1,390	2,080
95%	6,880	11,800	3,590	9,920	2,500	9,590	2,110	9,810	1,900	9,760	1,650	3,270
90%	8,120	12,400	4,100	10,300	2,830	10,000	2,370	10,200	2,120	10,100	1,920	8,290
75%	10,400	13,500	5,140	10,900	3,750	10,600	3,260	10,700	2,830	10,700	2,370	8,920
50%	13,600	15,800	6,100	11,600	4,520	11,300	3,700	11,400	3,280	11,700	2,930	9,510
25%	19,500	20,200	7,470	12,500	5,190	11,900	4,350	11,900	3,760	12,700	3,490	10,000
10%	26,300	26,800	9,150	13,800	5,840	12,500	4,780	12,600	4,330	13,500	3,920	10,600
5%	31,300	31,700	10,400	14,700	6,370	13,000	4,940	13,100	4,510	14,000	4,390	11,100
1%	45,000	42,900	13,000	16,500	8,490	14,000	5,620	13,900	4,990	15,100	4,790	11,700
Percentile	Apr		May		Jun		Jul		Aug		Sep	
	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1
99%	1,560	2,360	3,060	5,400	29,700	26,400	38,000	32,000	21,000	21,900	12,000	13,800
95%	1,850	3,360	5,340	9,710	37,000	31,100	43,000	35,000	33,900	31,400	15,300	15,900
90%	2,030	7,850	6,990	10,700	40,800	33,400	46,400	37,400	38,000	34,900	18,000	18,300
75%	2,660	8,700	13,100	14,600	50,600	39,800	52,000	41,100	44,500	39,500	23,800	23,300
50%	3,520	9,320	31,100	25,900	63,500	48,000	58,600	45,800	52,900	46,000	32,000	31,300
25%	4,330	9,890	47,800	36,900	73,900	54,100	67,600	51,800	61,200	55,100	42,600	41,400
10%	5,900	10,700	65,800	48,500	85,100	60,400	76,800	58,200	71,400	64,800	56,200	54,300
5%	7,760	11,600	75,100	54,900	93,400	65,000	82,500	63,900	80,000	73,300	64,200	62,000
1%	15,700	17,000	85,100	60,400	119,000	77,200	97,600	77,000	111,000	97,800	80,300	80,300

Table I-4 – Monthly Flow Exceedence Ordinate (cfs) Comparison for Pre-Project and Max LF OS-1 Conditions for the Susitna River at Susitna Station

Susitna River at Susitna Station												
Percentile	Oct		Nov		Dec		Jan		Feb		Mar	
	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1
99%	11,000	16,500	6,700	13,200	6,000	12,500	5,670	11,900	4,930	6,020	4,700	5,450
95%	15,000	19,600	7,750	14,000	6,280	13,300	5,810	13,400	5,340	13,200	5,070	7,000
90%	18,000	21,900	8,720	14,800	6,850	13,800	6,190	13,900	5,810	13,600	5,280	11,500
75%	23,500	26,700	10,700	16,500	7,840	14,800	7,000	14,500	6,380	14,400	5,800	12,300
50%	31,700	33,600	13,000	18,500	9,000	16,000	7,880	15,400	6,990	15,500	6,440	12,900
25%	42,900	43,800	16,700	21,800	10,700	17,600	8,570	16,400	7,530	16,600	7,000	13,700
10%	60,000	60,200	21,300	25,800	12,000	18,800	9,720	17,500	8,500	17,600	7,520	14,600
5%	70,000	70,600	25,000	29,200	13,300	19,700	10,300	18,100	9,200	18,400	9,000	15,300
1%	97,500	97,000	36,500	40,900	19,900	25,400	11,000	19,000	10,000	19,700	9,500	16,300
Percentile	Apr		May		Jun		Jul		Aug		Sep	
	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1
99%	5,000	5,760	7,160	10,100	65,500	58,200	80,200	73,700	44,100	45,200	21,600	22,900
95%	5,400	6,880	10,400	14,000	77,000	69,500	90,800	81,700	70,900	68,900	33,100	34,200
90%	5,550	11,300	14,700	17,400	86,200	77,400	98,300	88,100	79,700	76,600	38,800	39,400
75%	6,120	12,100	32,800	32,700	102,000	90,400	108,000	97,600	92,400	88,400	50,800	50,900
50%	7,000	12,900	64,000	57,700	121,000	106,000	120,000	107,000	107,000	102,000	68,600	68,000
25%	9,210	14,700	95,200	85,800	136,000	117,000	133,000	118,000	123,000	116,000	90,300	88,800
10%	13,500	18,100	122,000	106,000	152,000	128,000	147,000	129,000	138,000	129,000	114,000	112,000
5%	19,000	23,000	135,000	116,000	161,000	134,000	157,000	139,000	153,000	144,000	125,000	123,000
1%	37,100	39,000	150,000	128,000	182,000	149,000	186,000	162,000	195,000	188,000	154,000	152,000

APPENDIX J. ANNUAL AND MONTHLY STAGE EXCEEDANCE CURVES (PRE-PROJECT AND MAXIMUM LOAD FOLLOWING OS-1 CONDITIONS) FOR SUNSHINE GAGE LOCATION AND SUSITNA STATION GAGE LOCATION

Susitna-Watana Hydroelectric Project (FERC No. 14241)

Stream Flow Assessment

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

Tetra Tech

February 2013

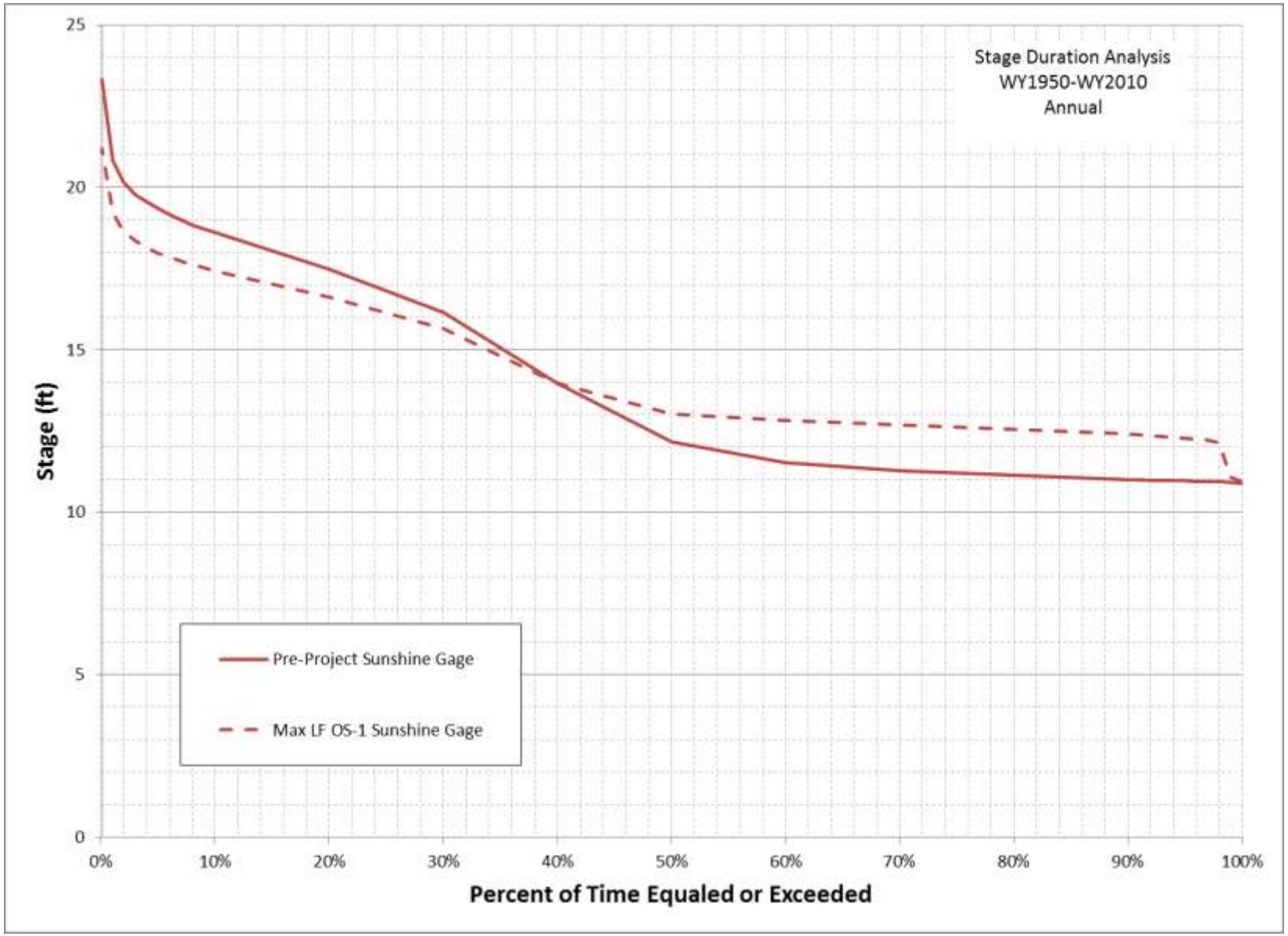

Figure J-1 - Annual Stage Exceedence Curves for pre-Project and Max LF OS-1 Conditions, Sunshine Gage

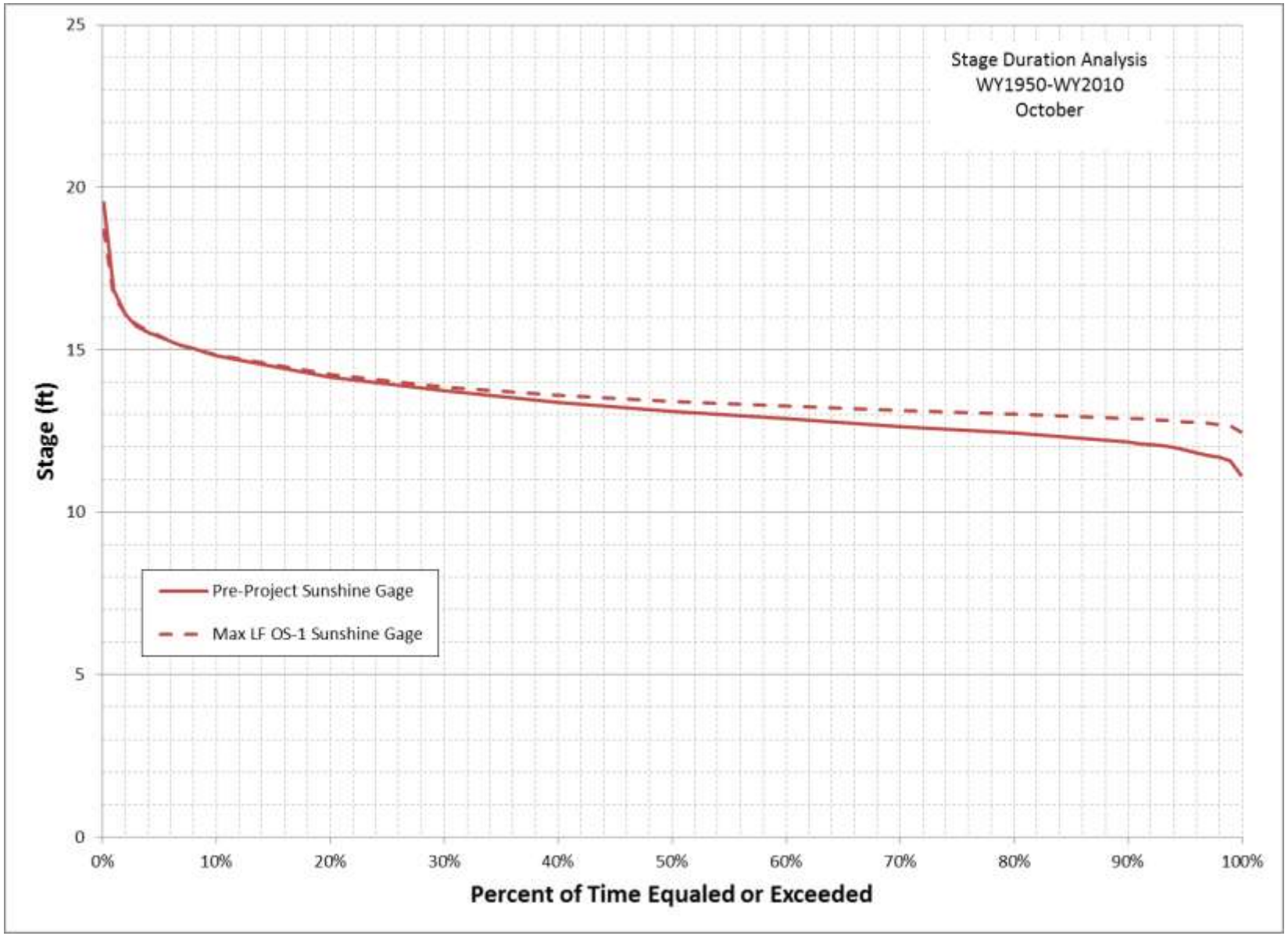

Figure J-2 - Monthly Stage Exceedence Curves for October for pre-Project and Max LF OS-1 Conditions, Sunshine Gage

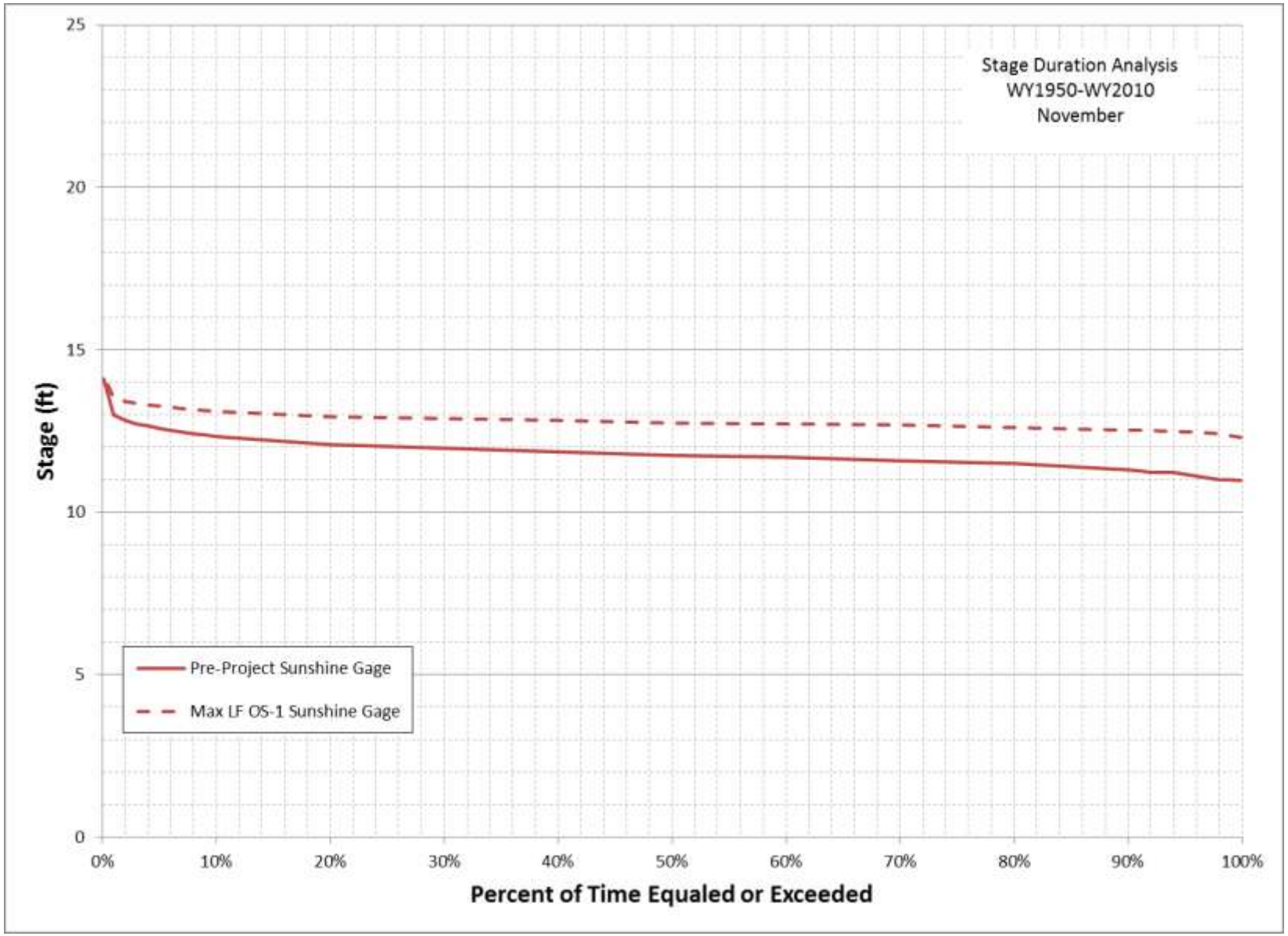

Figure J-3 - Monthly Stage Exceedence Curves for November for pre-Project and Max LF OS-1 Conditions, Sunshine Gage

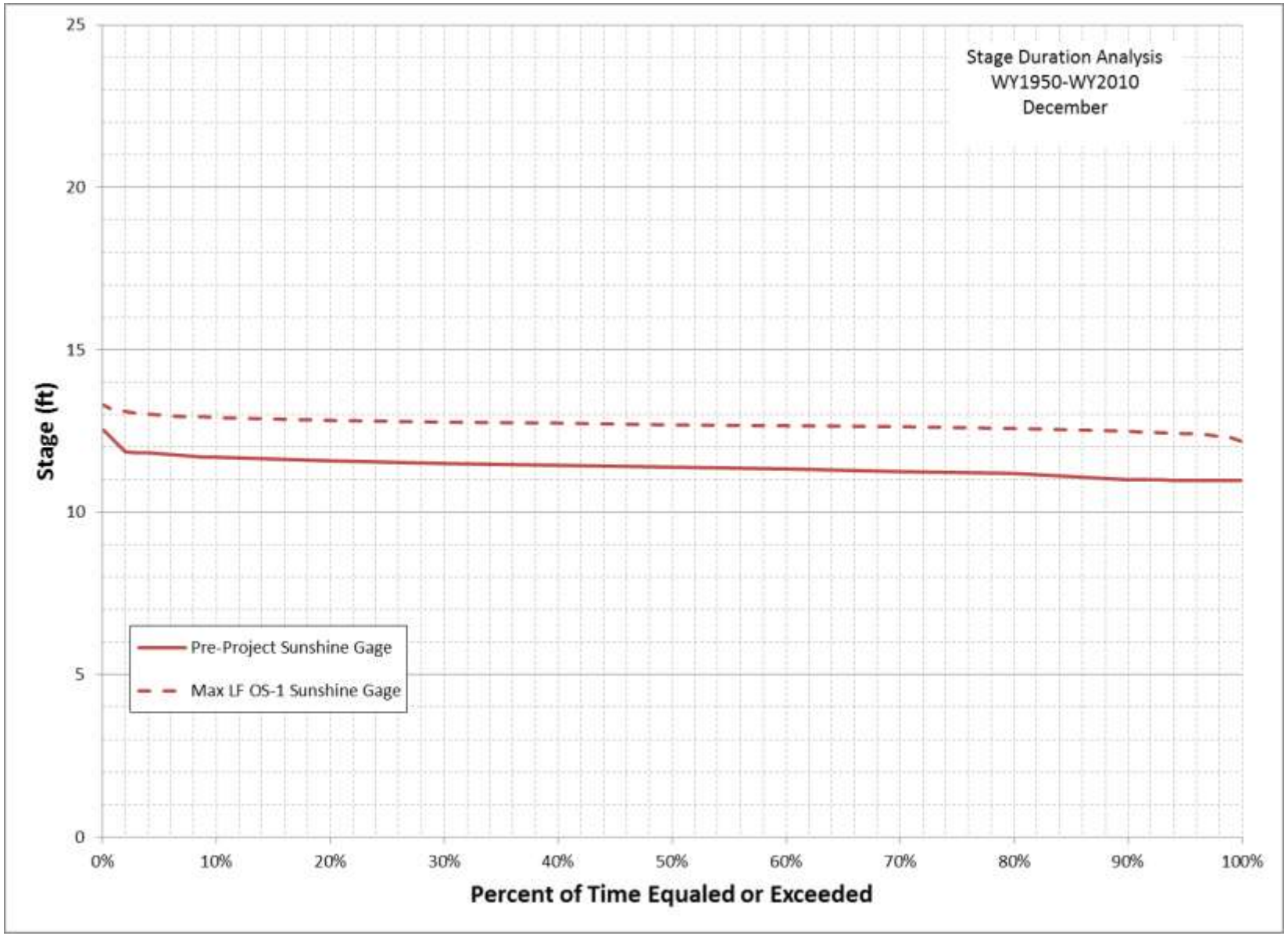

Figure J-4 - Monthly Stage Exceedence Curves for December for pre-Project and Max LF OS-1 Conditions, Sunshine Gage

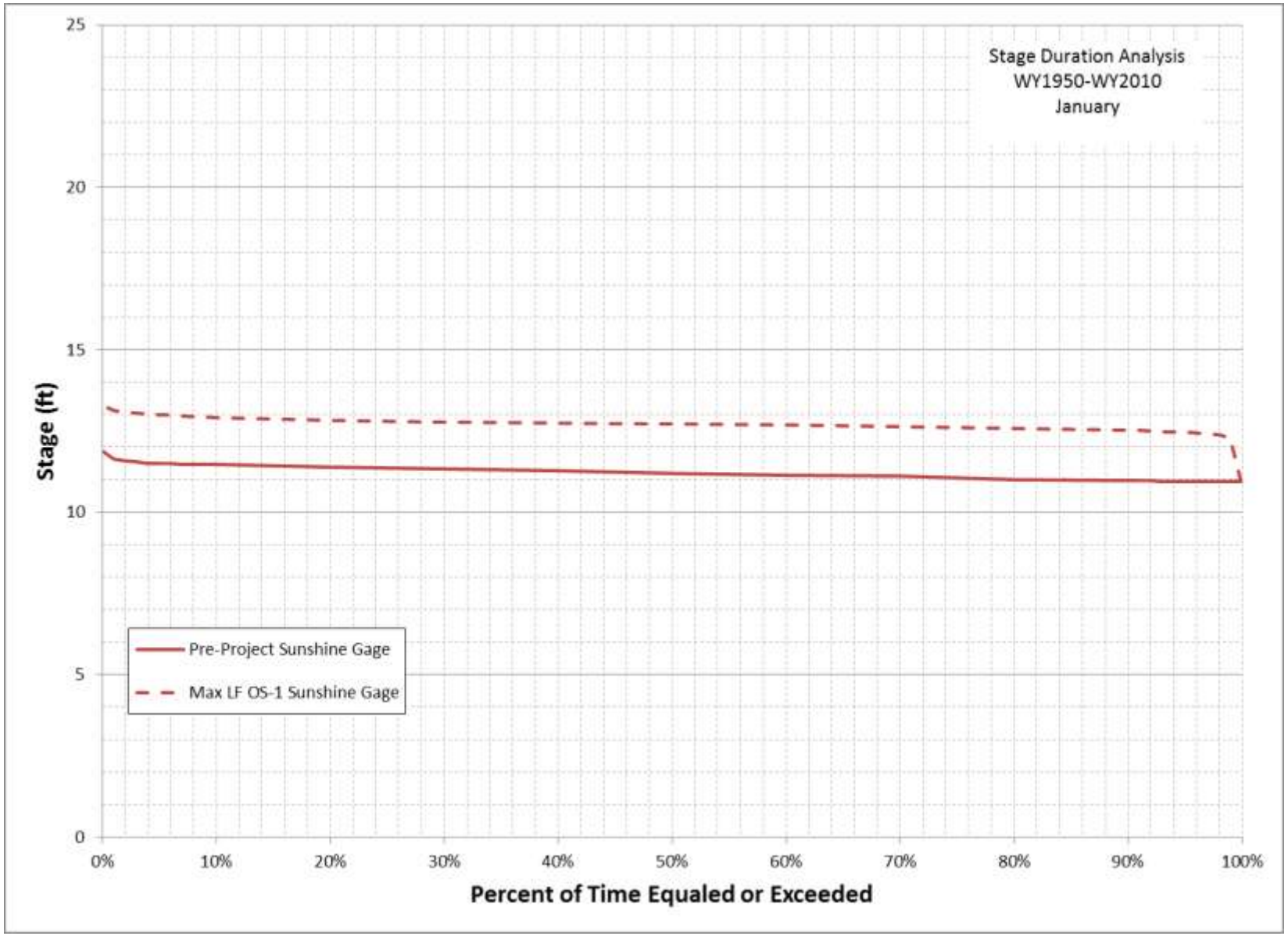

Figure J-5 - Monthly Stage Exceedence Curves for January for pre-Project and Max LF OS-1 Conditions, Sunshine Gage

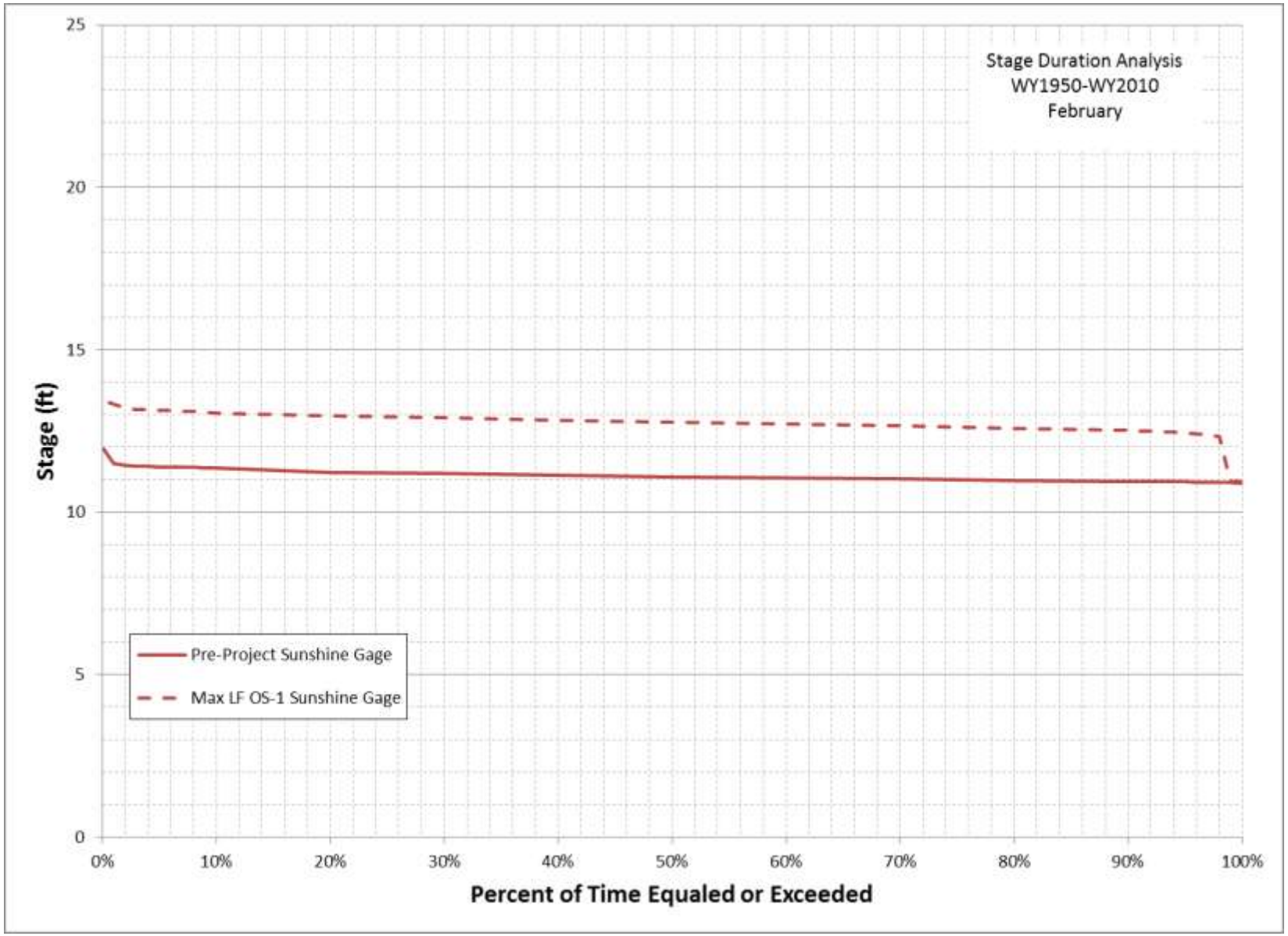

Figure J-6 - Monthly Stage Exceedence Curves for February for pre-Project and Max LF OS-1 Conditions, Sunshine Gage

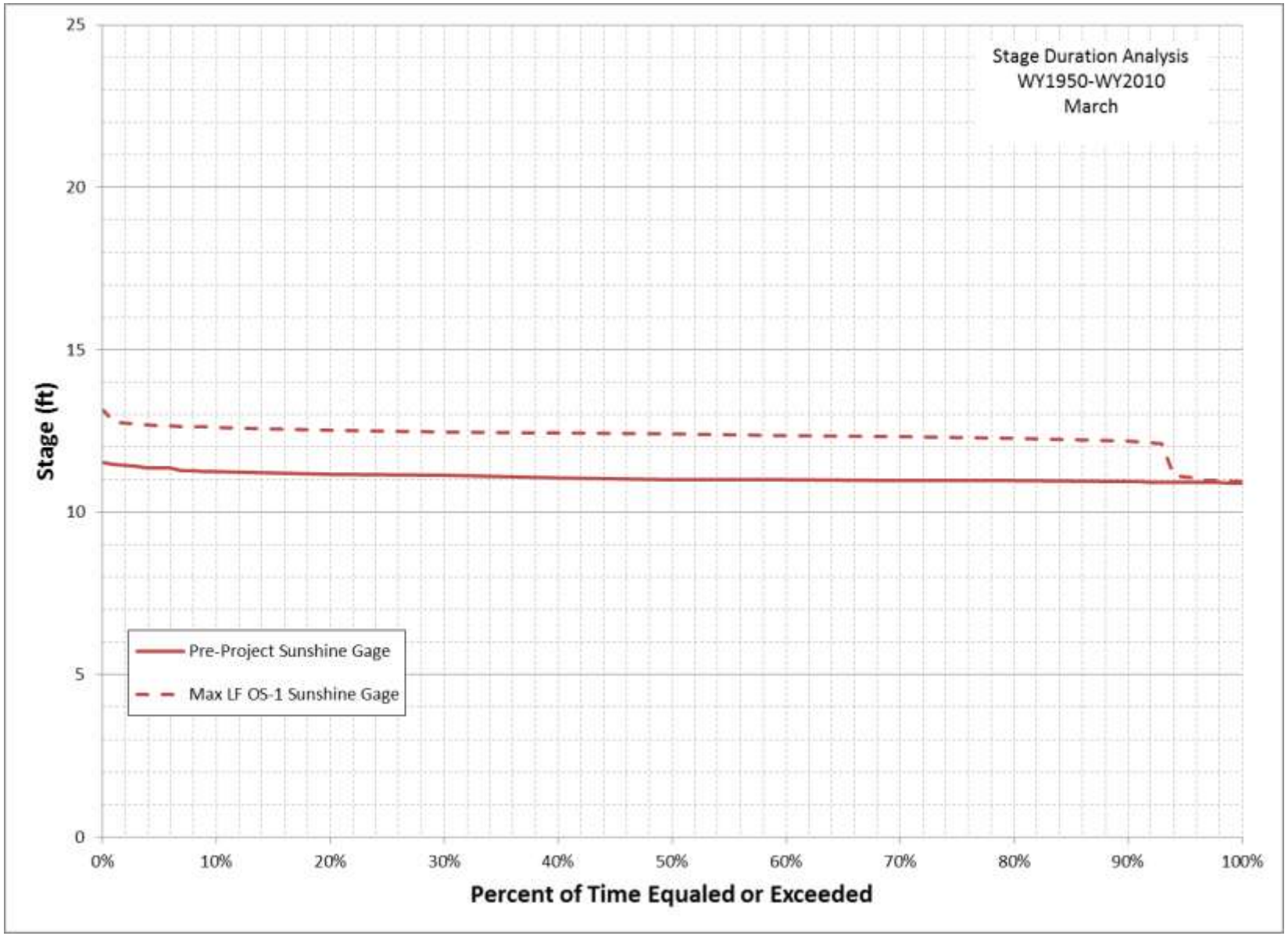

Figure J-7 - Monthly Stage Exceedence Curves for March for pre-Project and Max LF OS-1 Conditions, Sunshine Gage

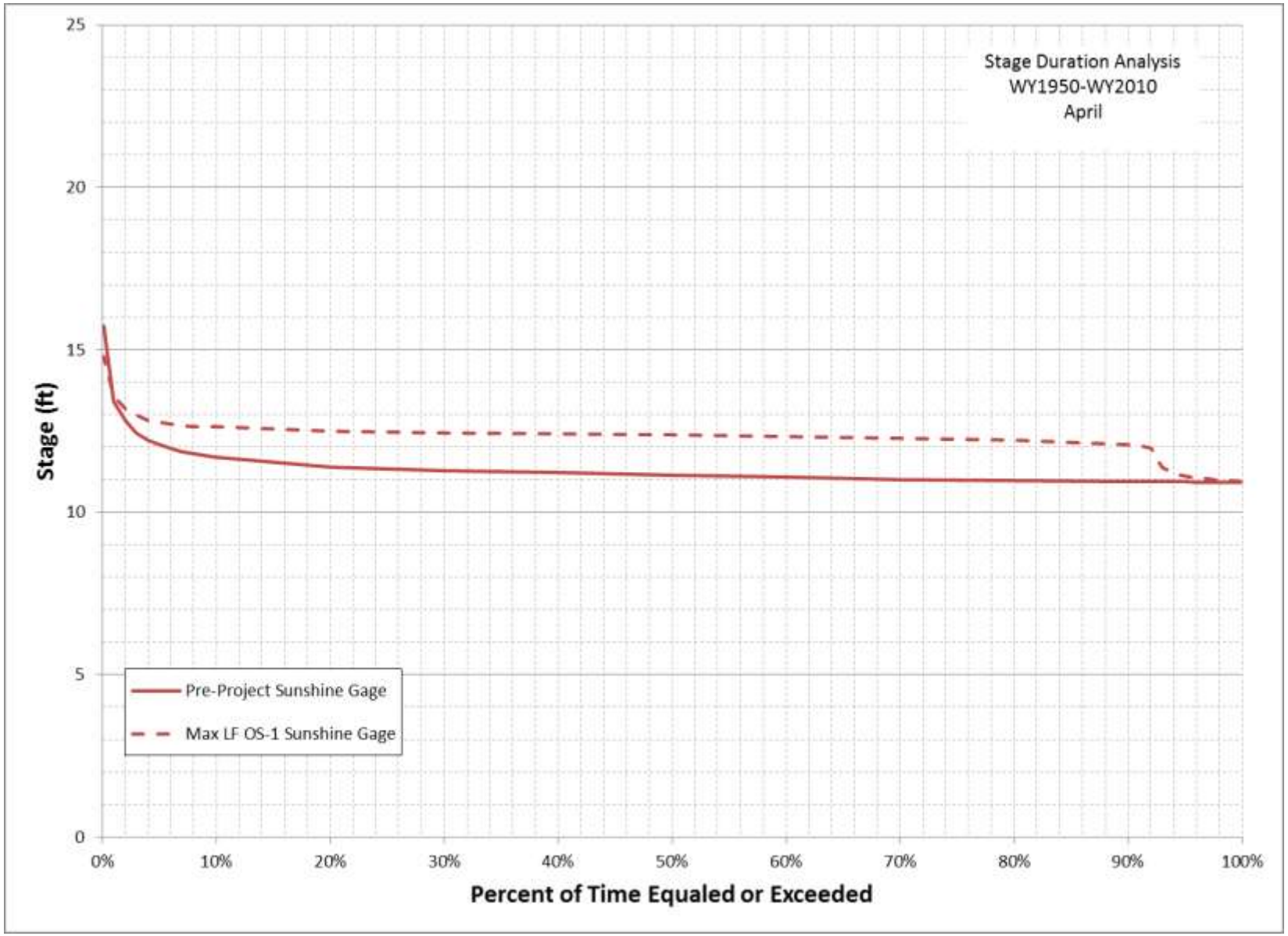

Figure J-8 - Monthly Stage Exceedence Curves for April for pre-Project and Max LF OS-1 Conditions, Sunshine Gage

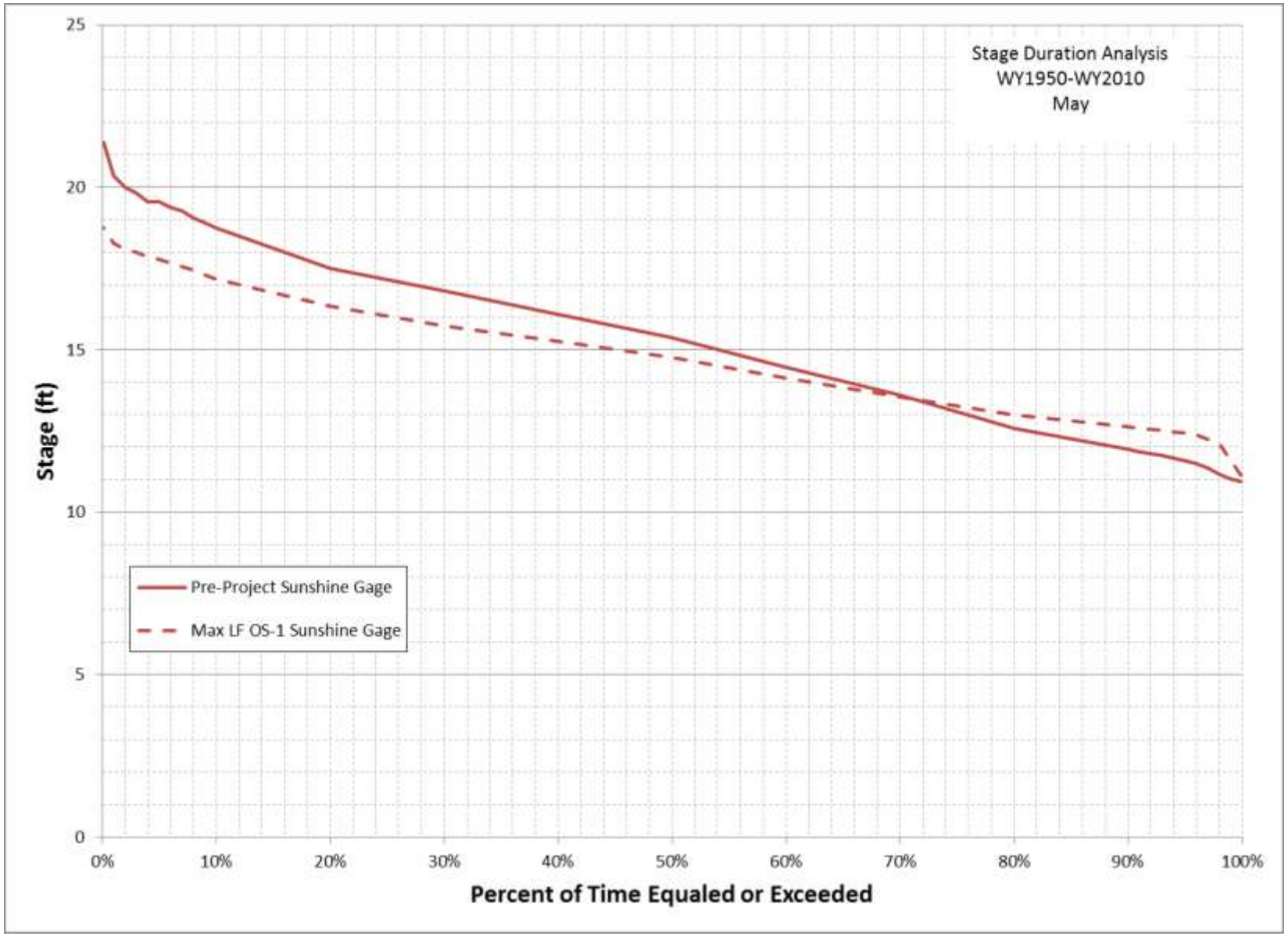

Figure J-9 - Monthly Stage Exceedence Curves for May for pre-Project and Max LF OS-1 Conditions, Sunshine Gage

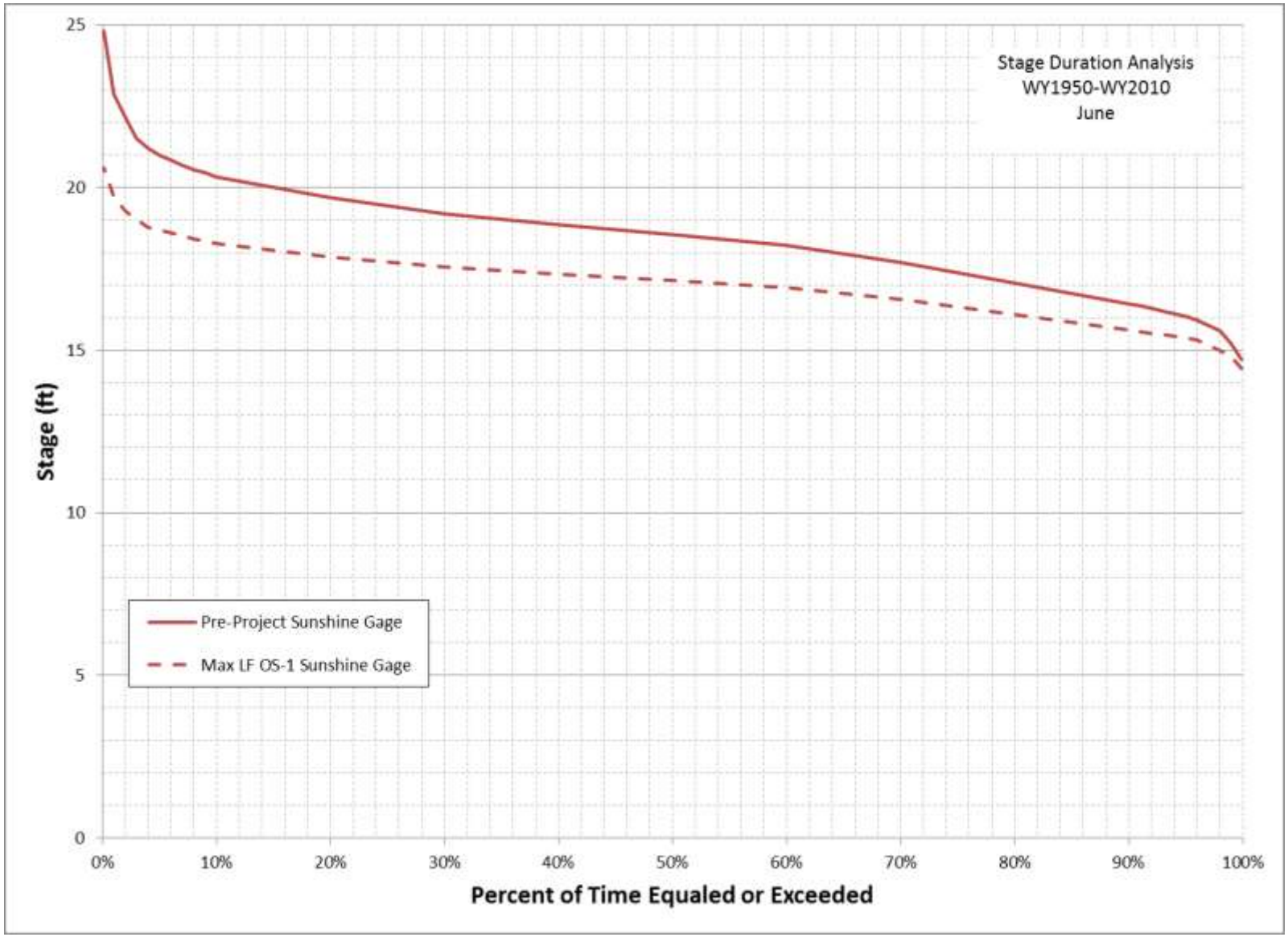

Figure J-10 - Monthly Stage Exceedence Curves for June for pre-Project and Max LF OS-1 Conditions, Sunshine Gage

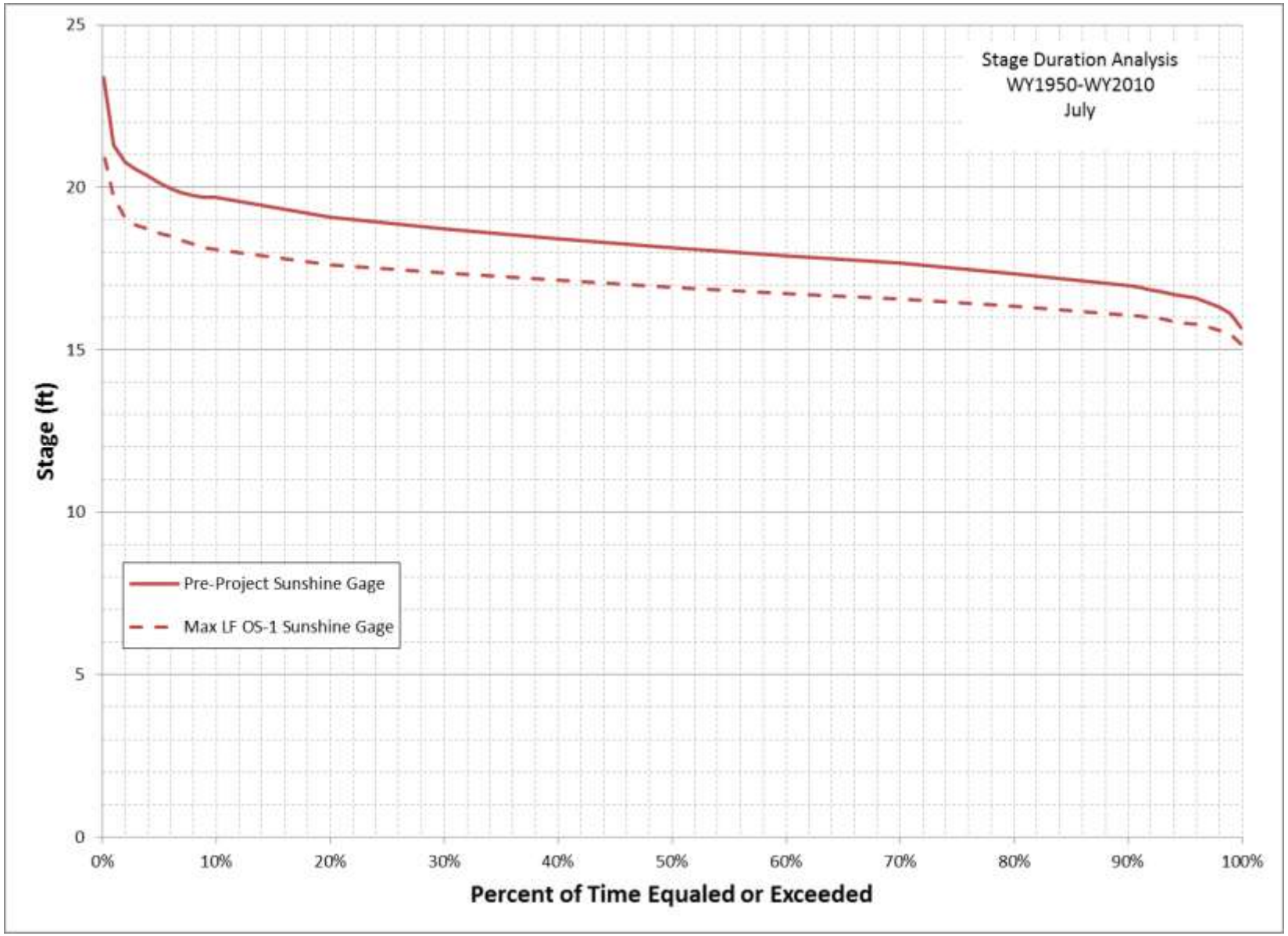

Figure J-11 - Monthly Stage Exceedence Curves for July for pre-Project and Max LF OS-1 Conditions, Sunshine Gage

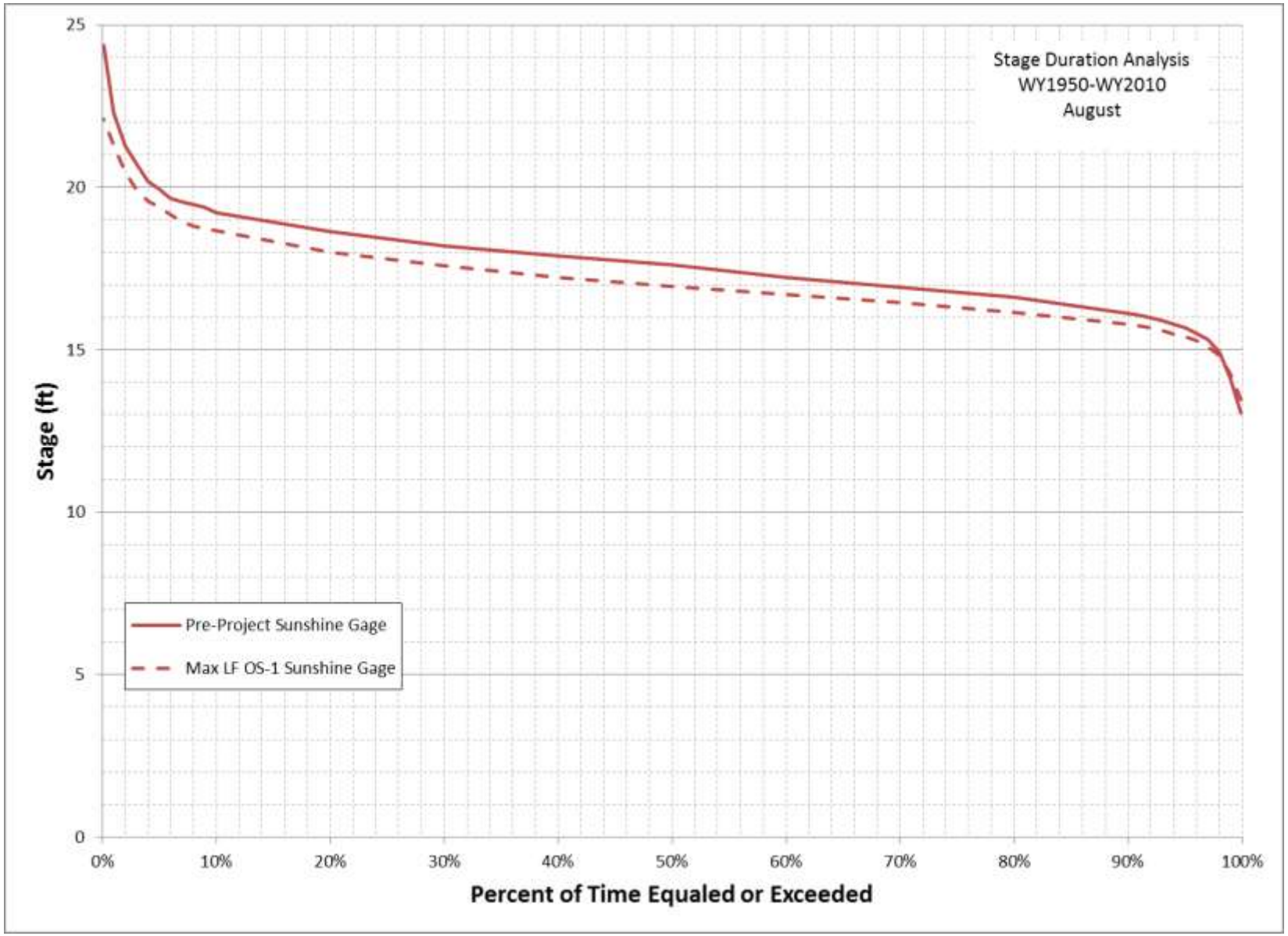

Figure J-12 - Monthly Stage Exceedence Curves for August for pre-Project and Max LF OS-1 Conditions, Sunshine Gage

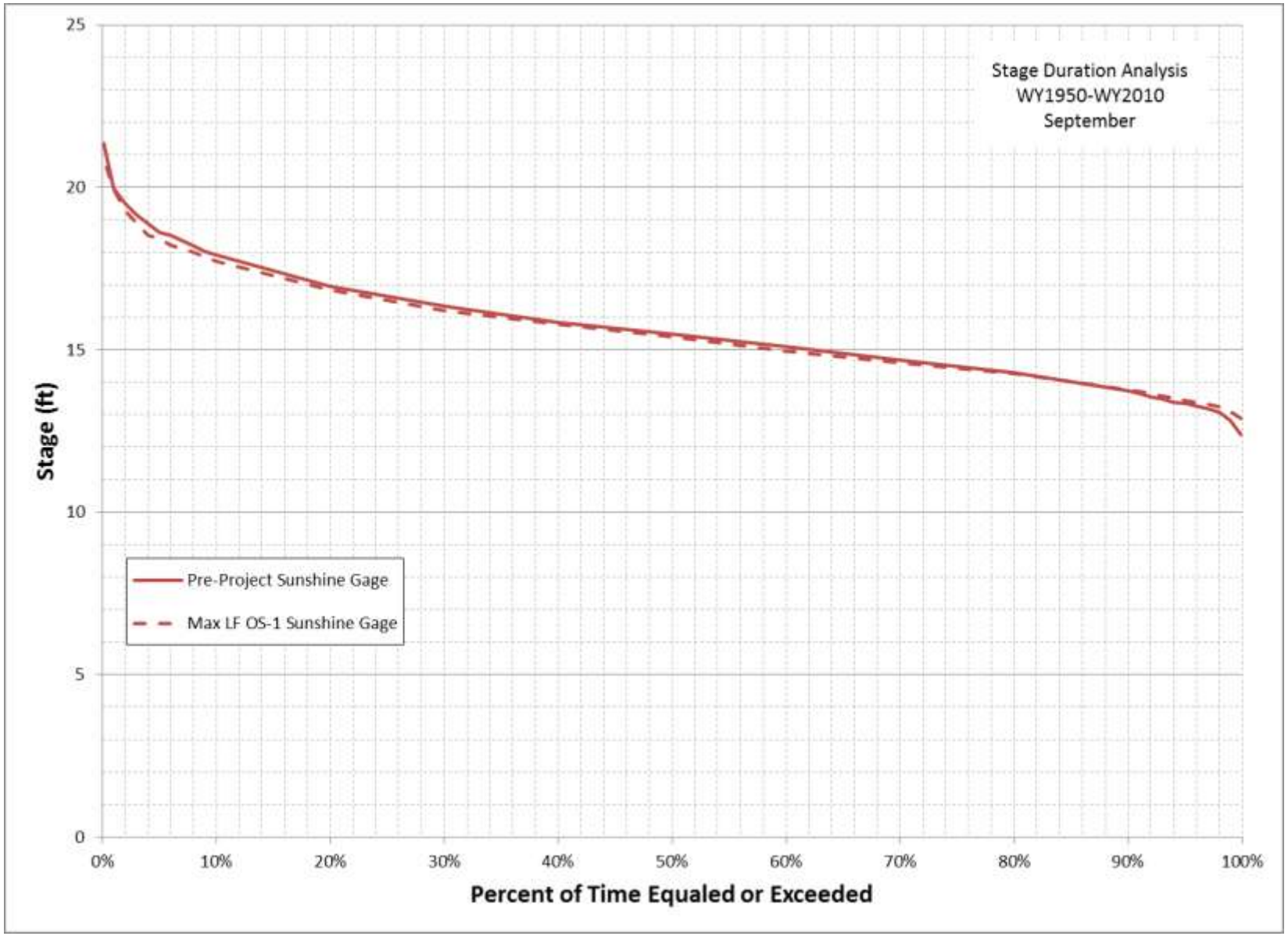

Figure J-13 - Monthly Stage Exceedence Curves for September for pre-Project and Max LF OS-1 Conditions, Sunshine Gage

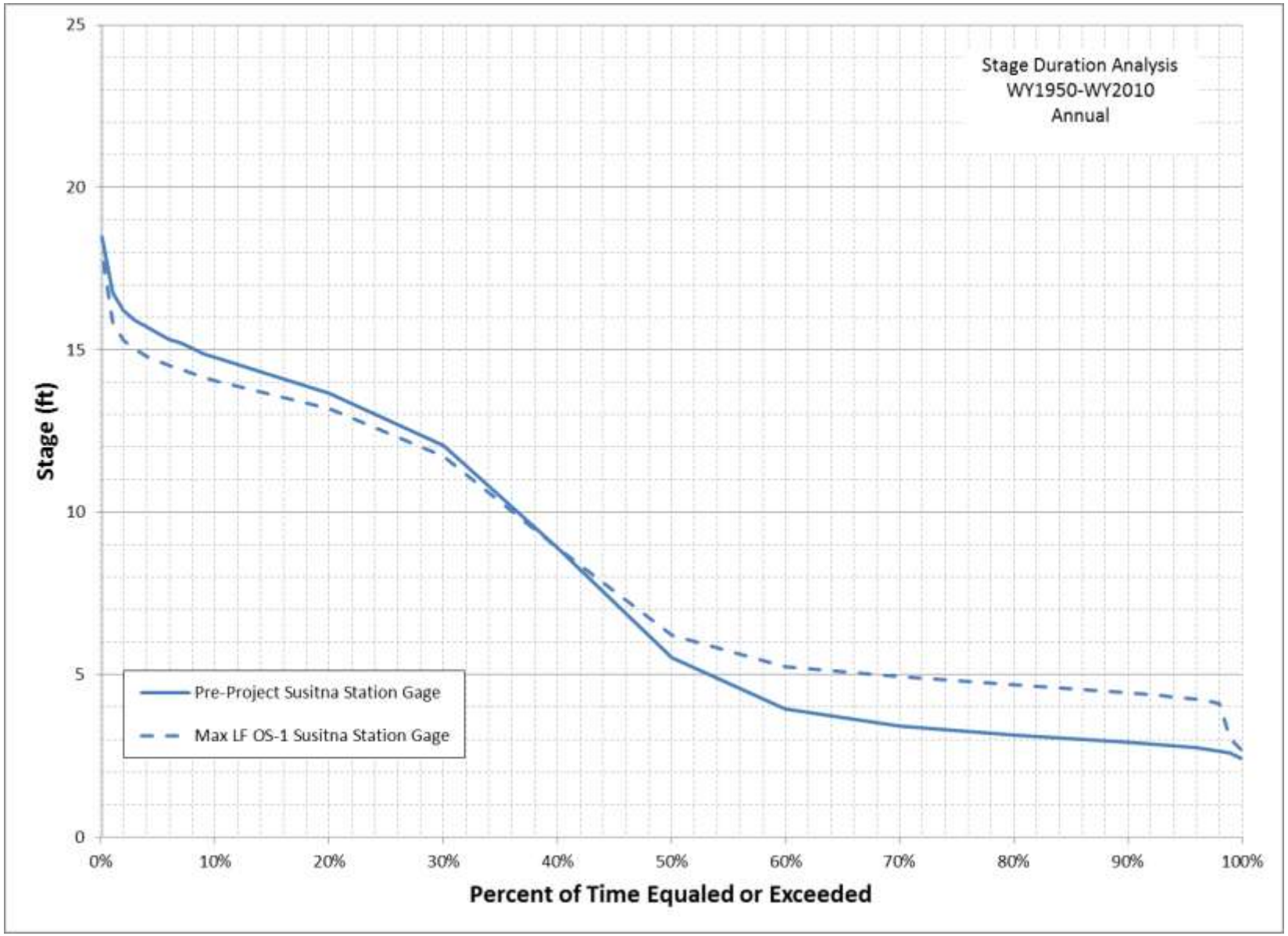

Figure J-14 - Annual Stage Exceedence Curves for pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

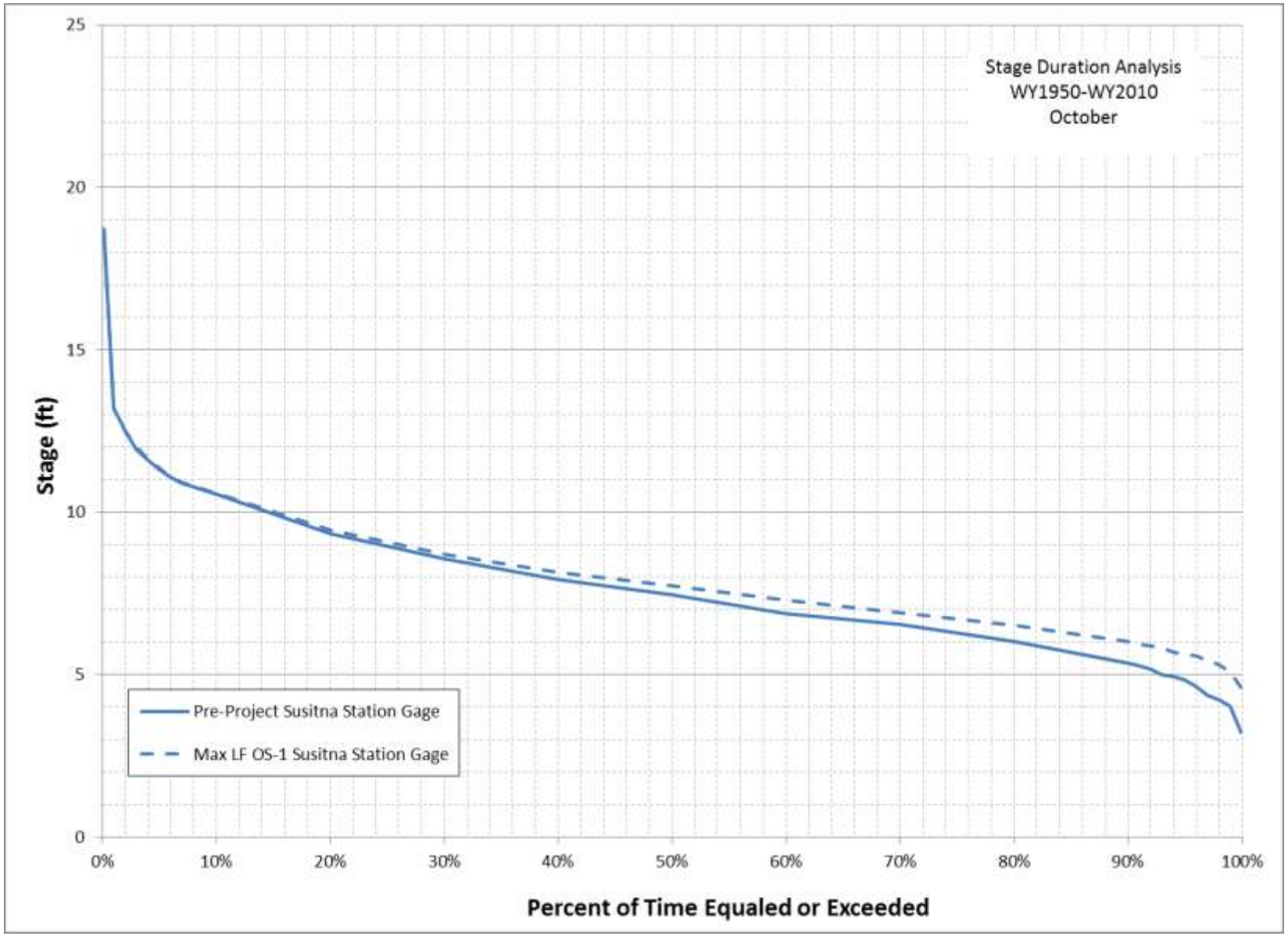

Figure J-15 - Monthly Stage Exceedence Curves for October for pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

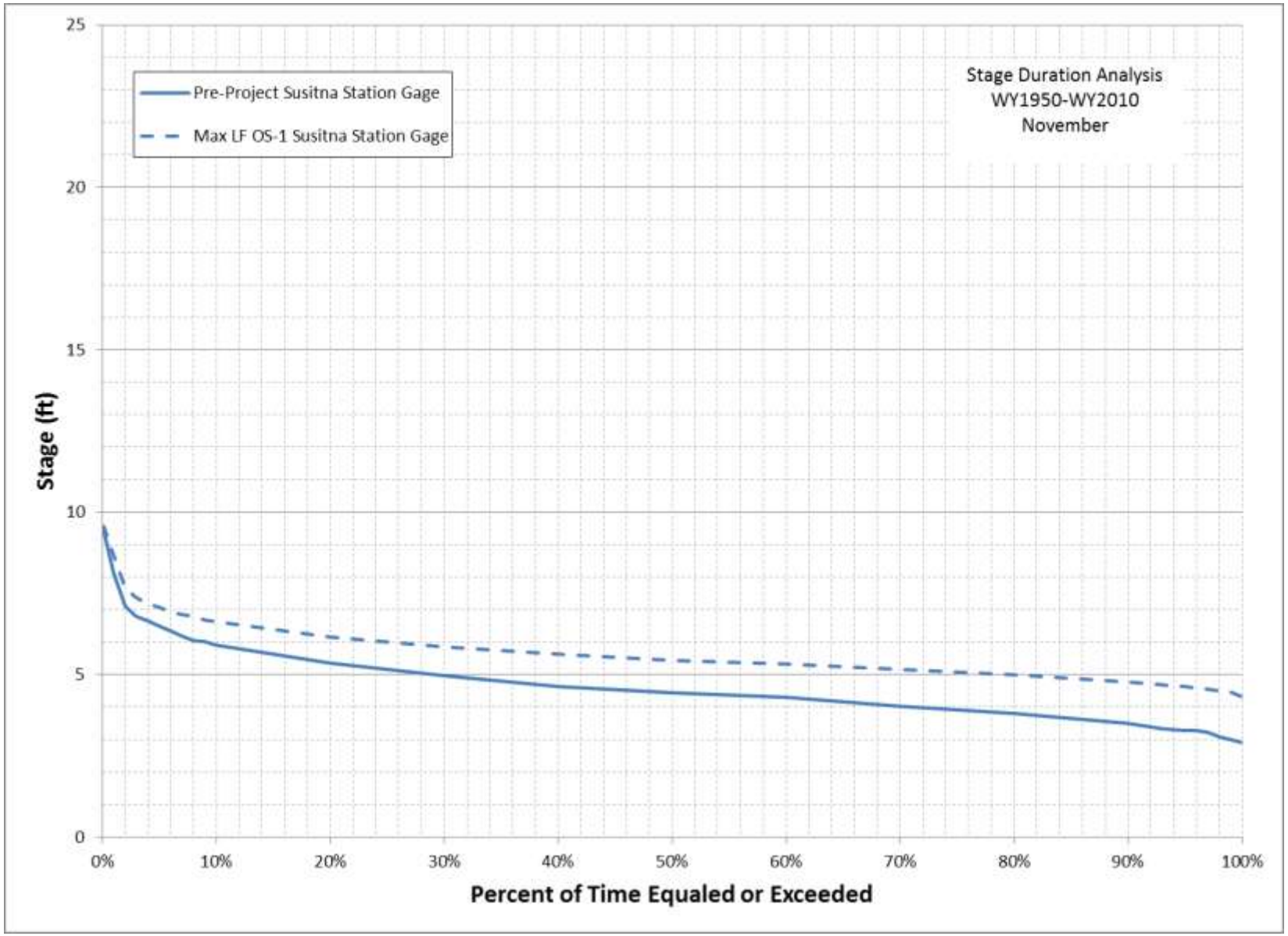

Figure J-16 - Monthly Stage Exceedence Curves for November for pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

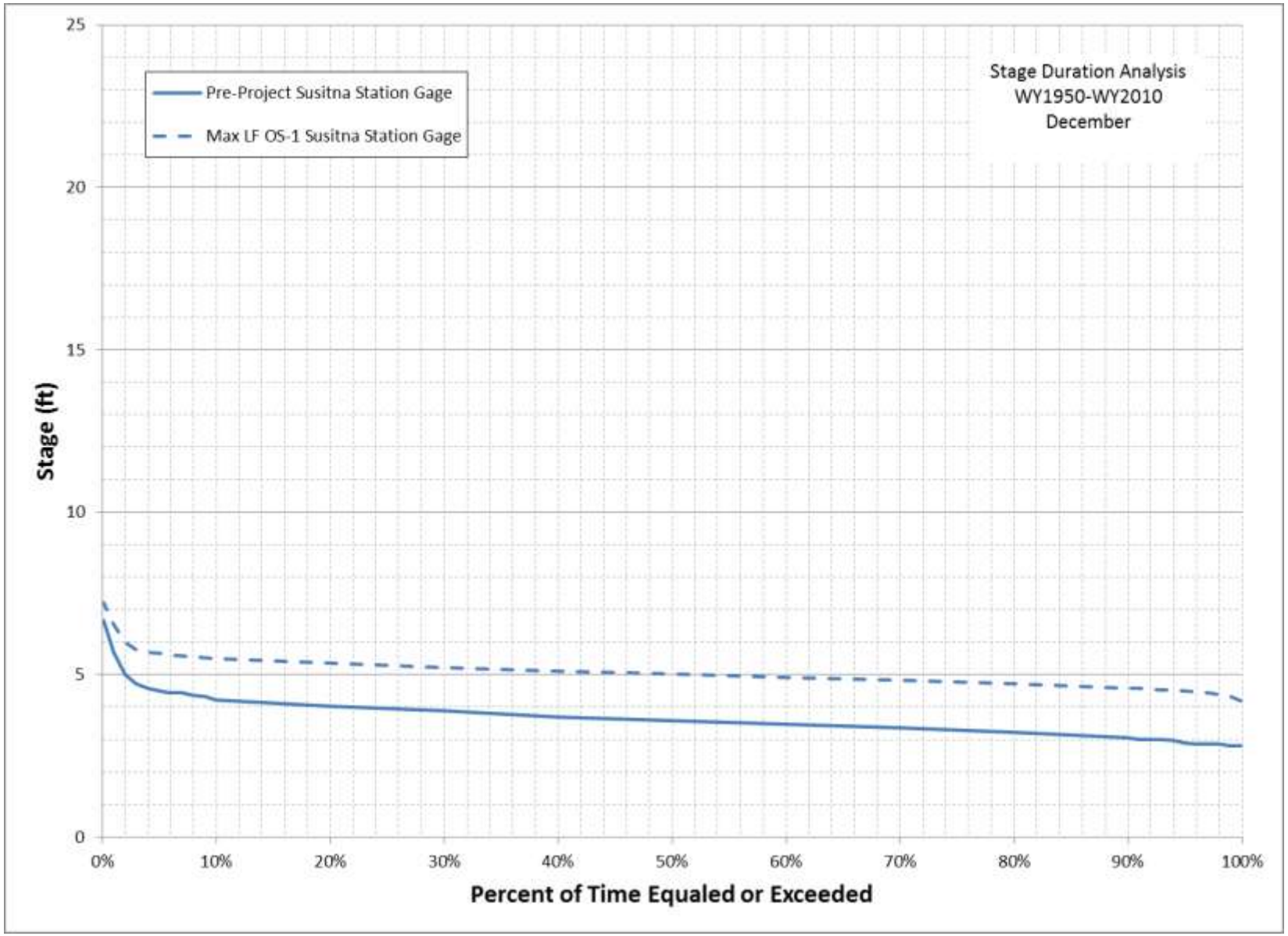

Figure J-17 - Monthly Stage Exceedence Curves for December for pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

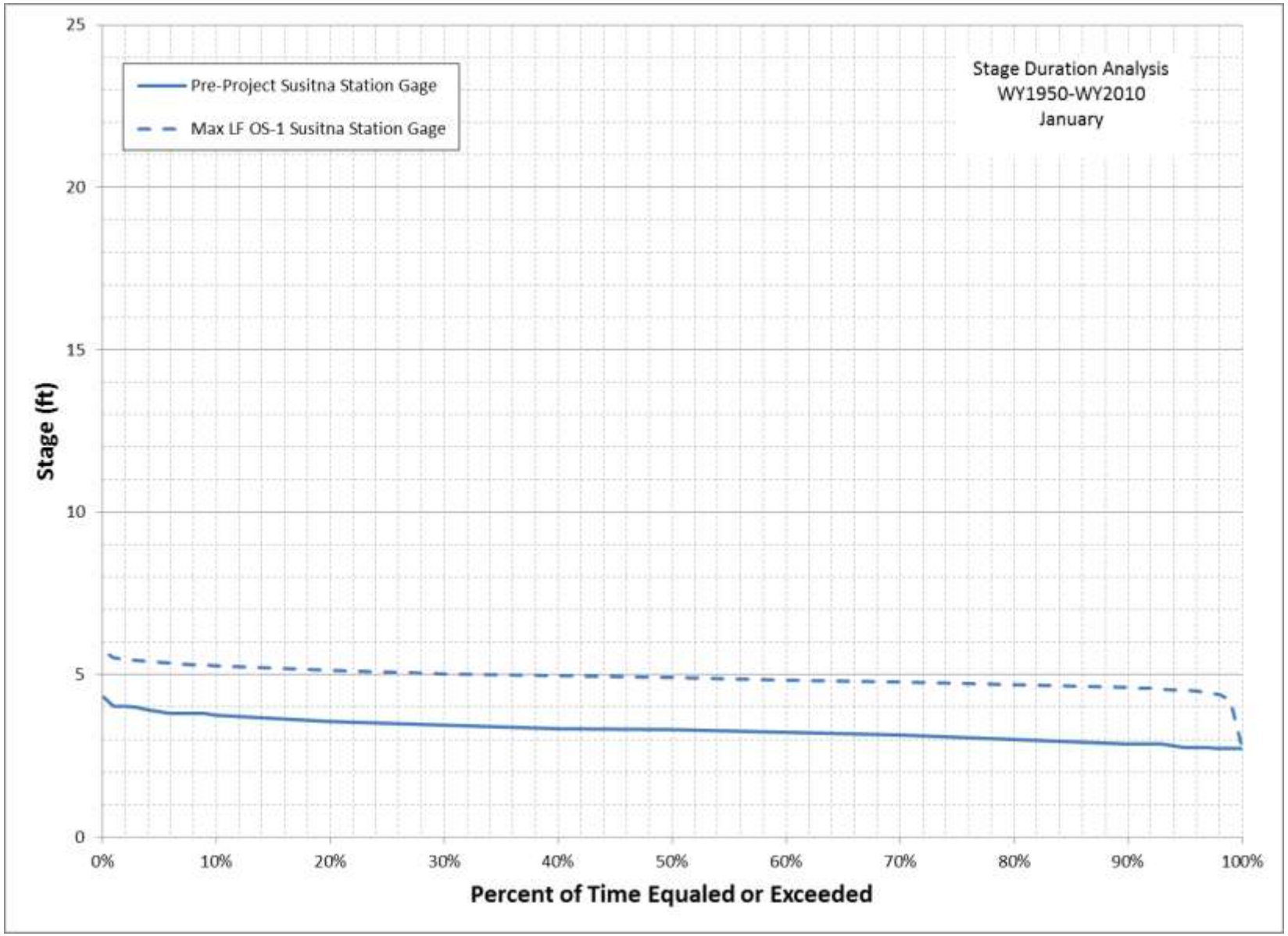

Figure J-18 - Monthly Stage Exceedence Curves for January for pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

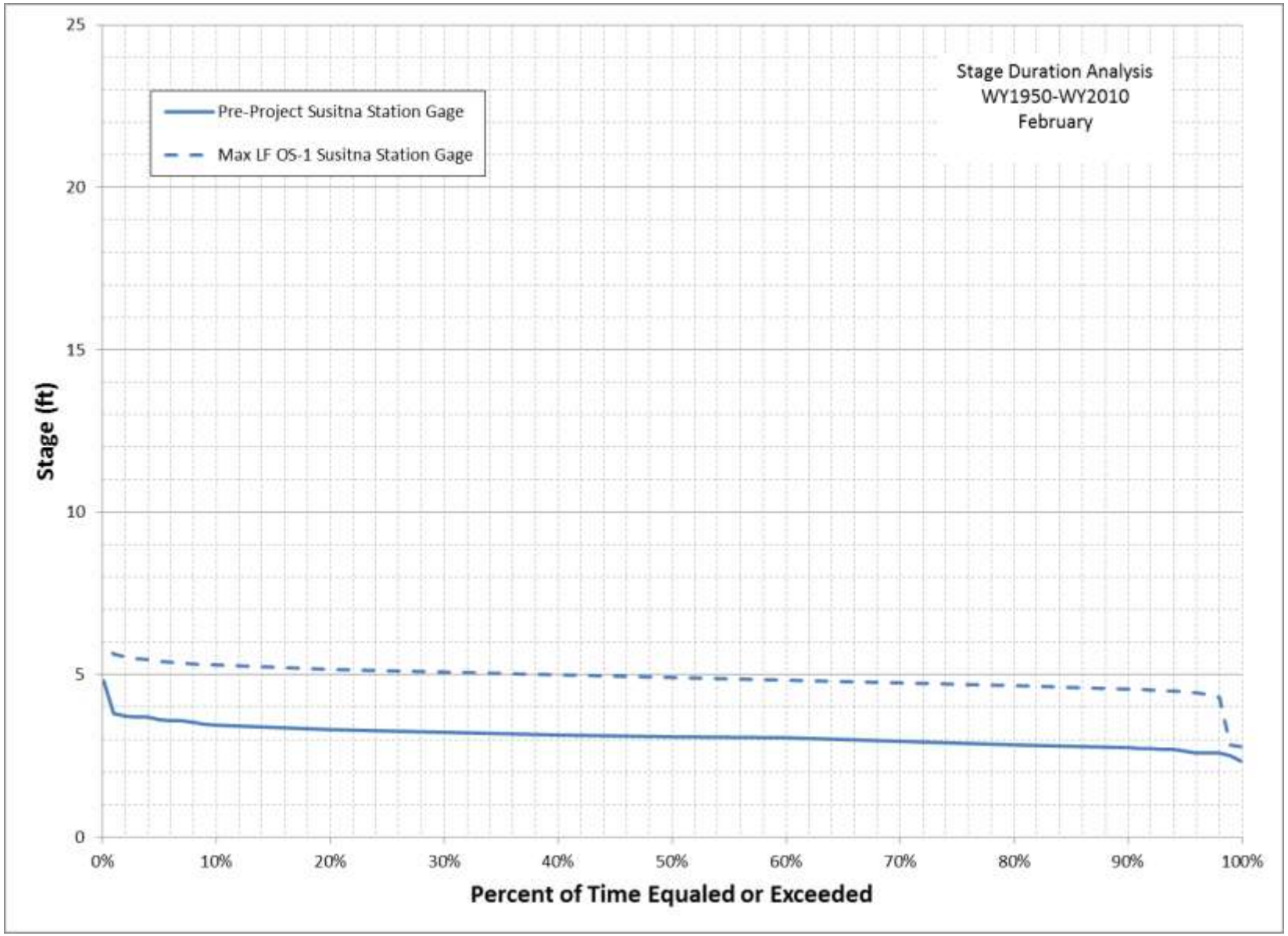

Figure J-19 - Monthly Stage Exceedence Curves for February for pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

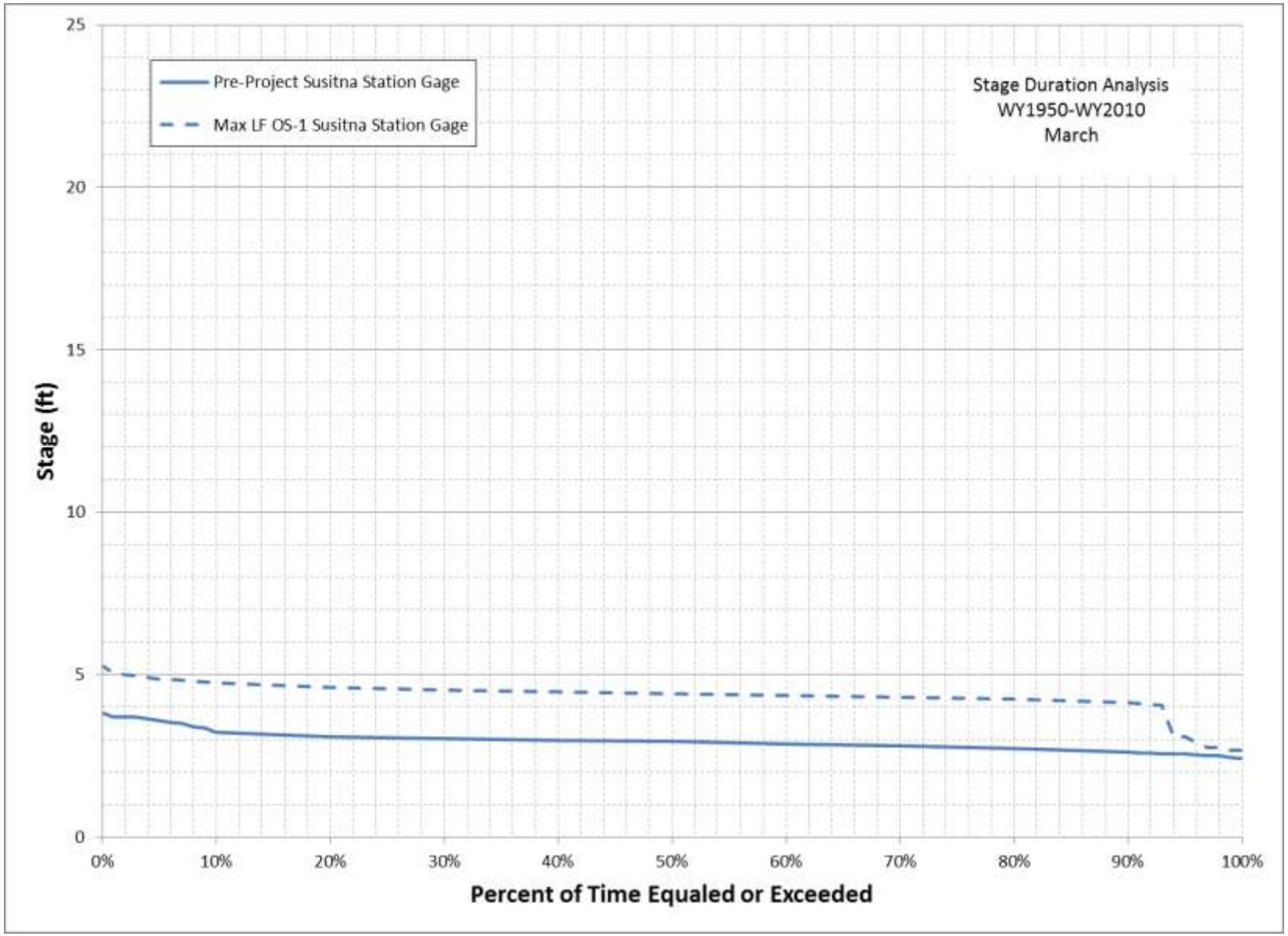

Figure J-20 - Monthly Stage Exceedence Curves for March for pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

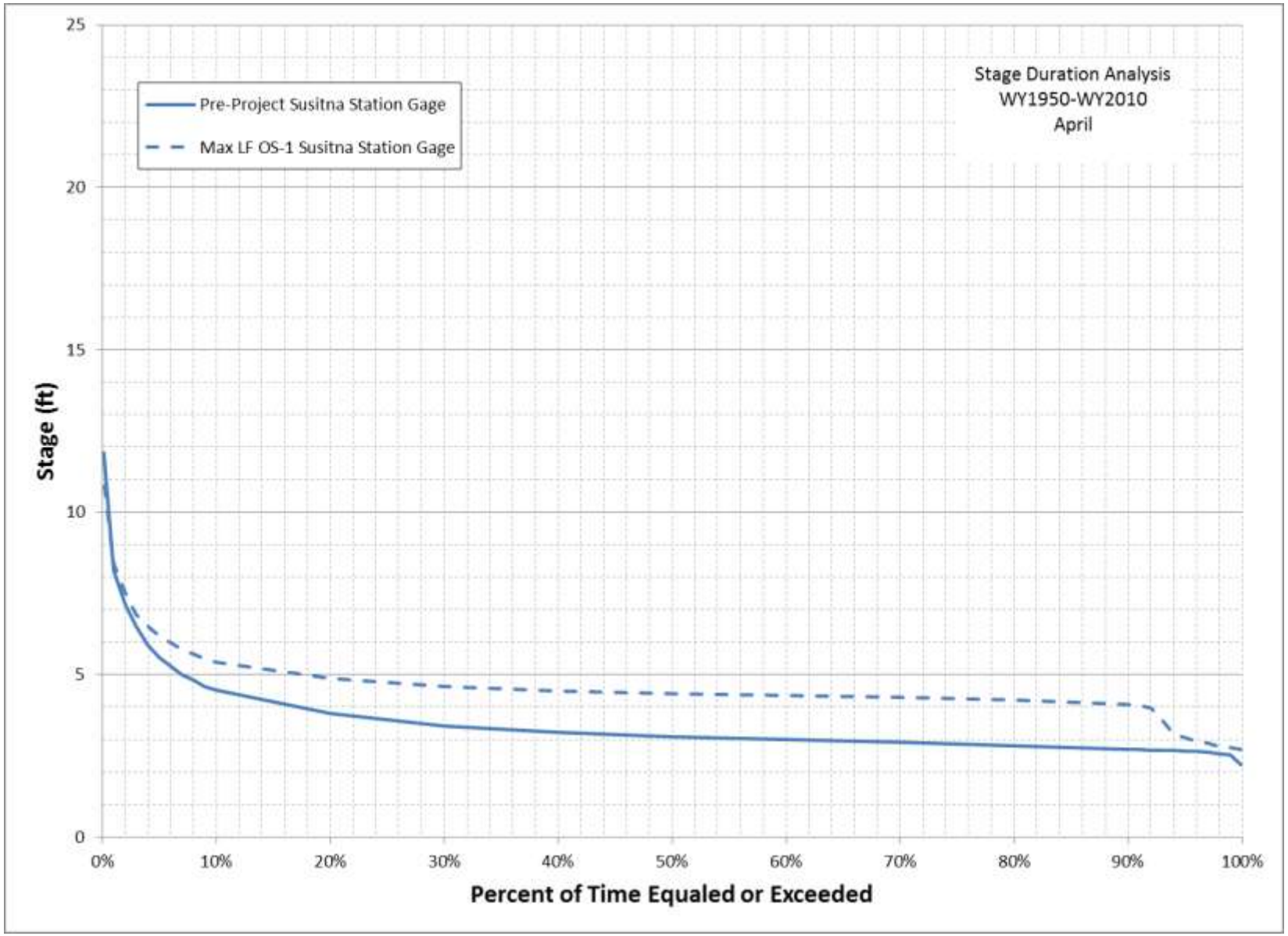

Figure J-21 - Monthly Stage Exceedence Curves for April for pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

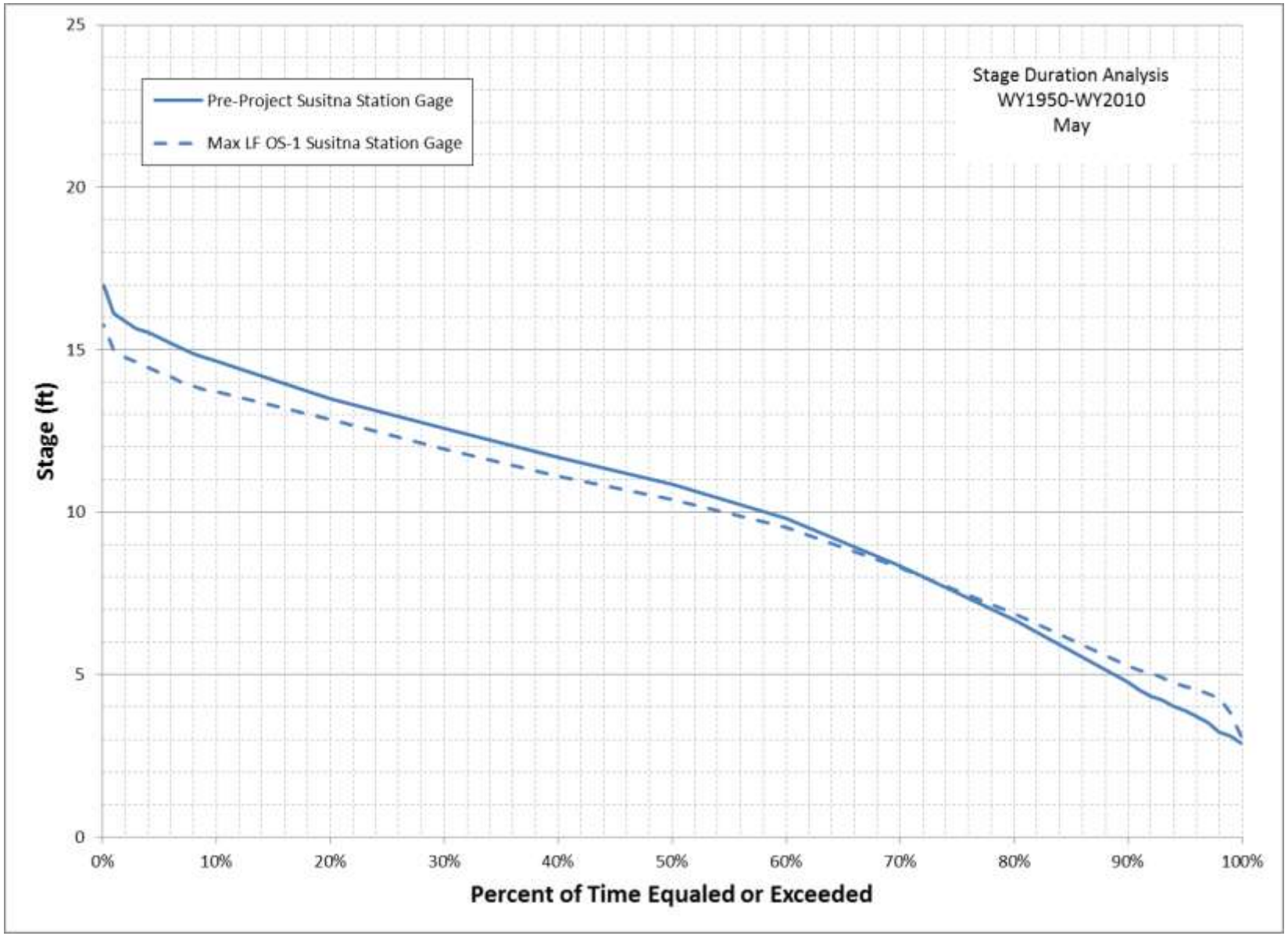

Figure J-22 - Monthly Stage Exceedence Curves for May for pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

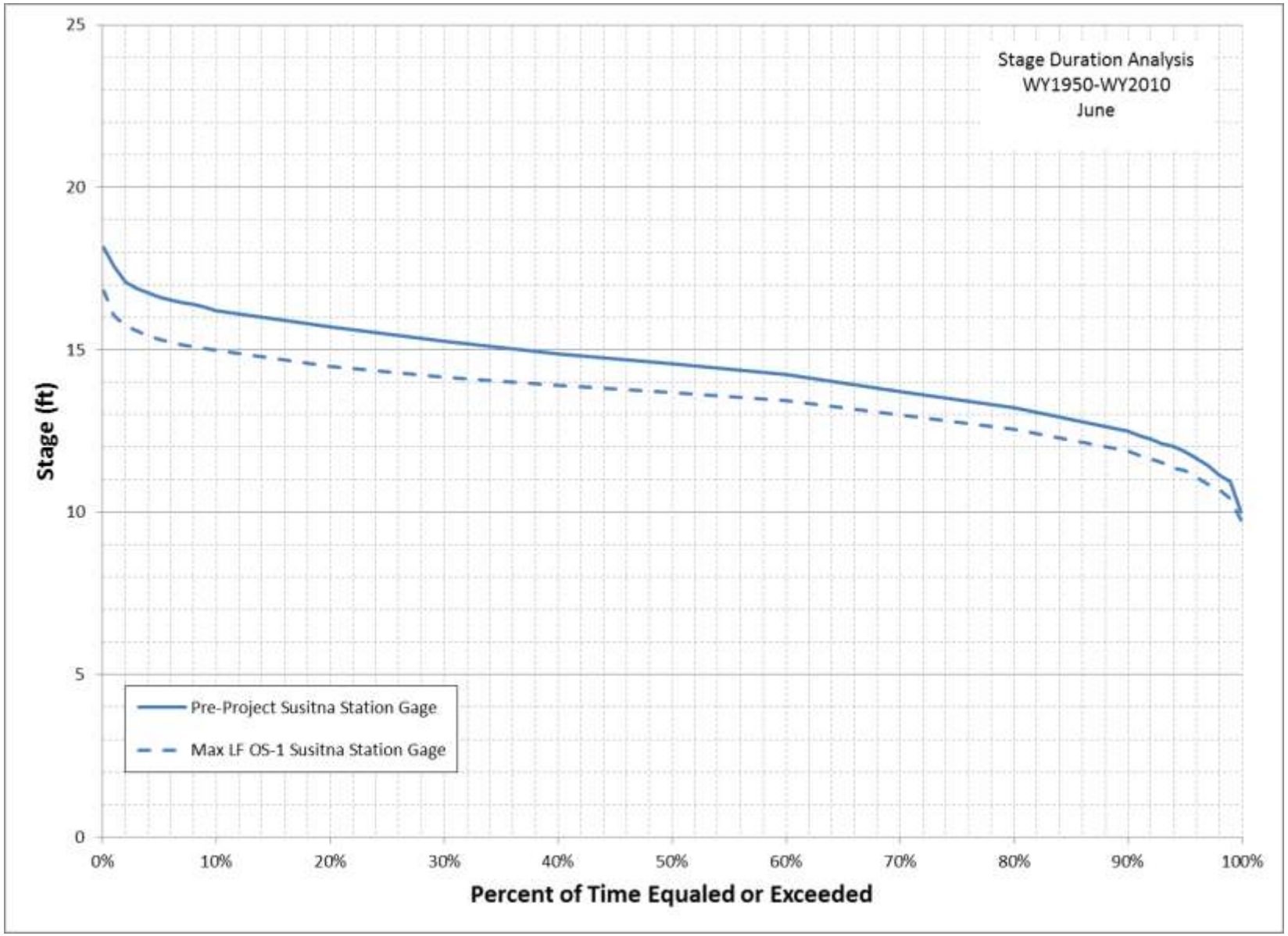

Figure J-23 - Monthly Stage Exceedence Curves for June for pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

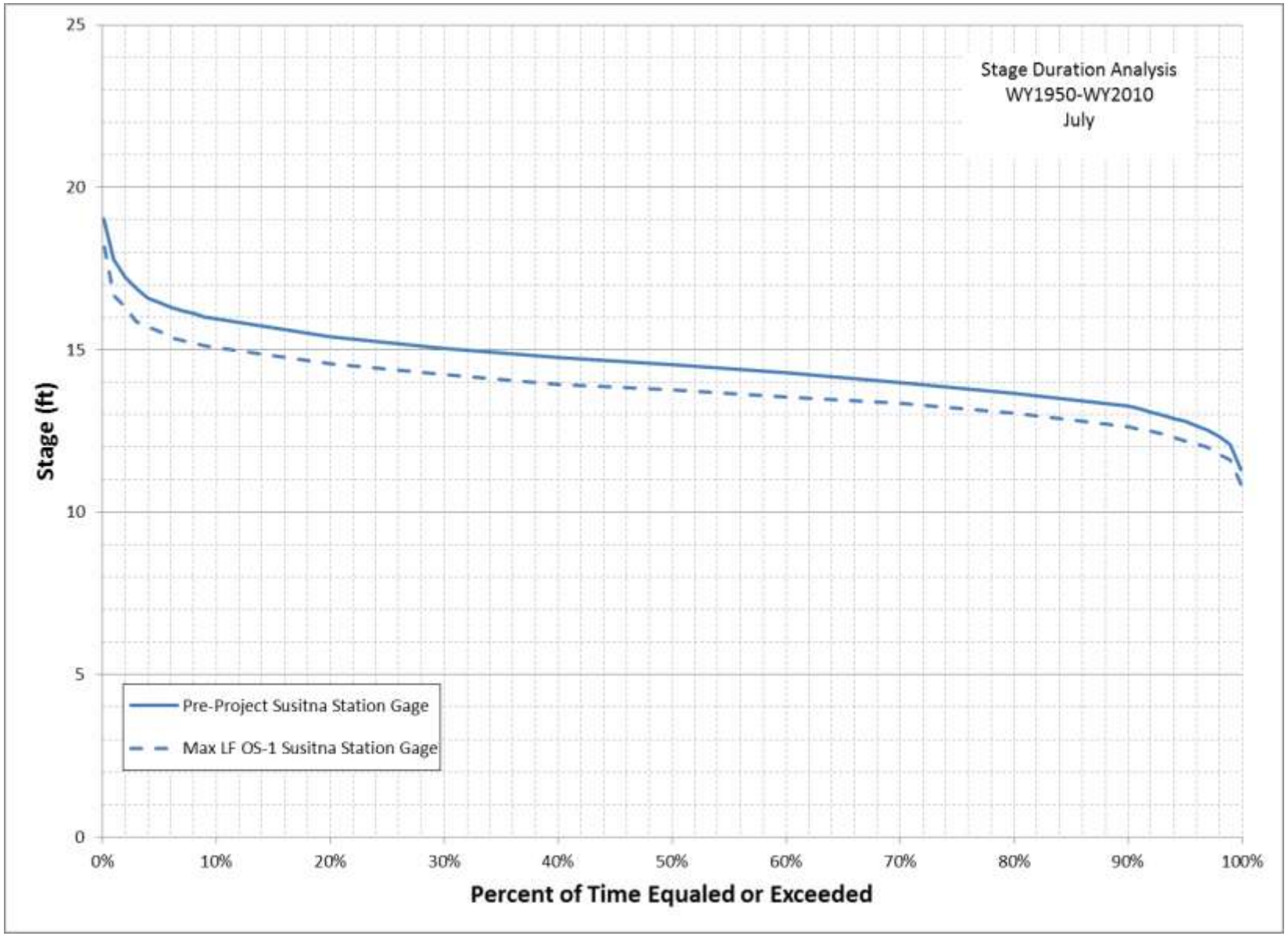

Figure J-24 - Monthly Stage Exceedence Curves for July for pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

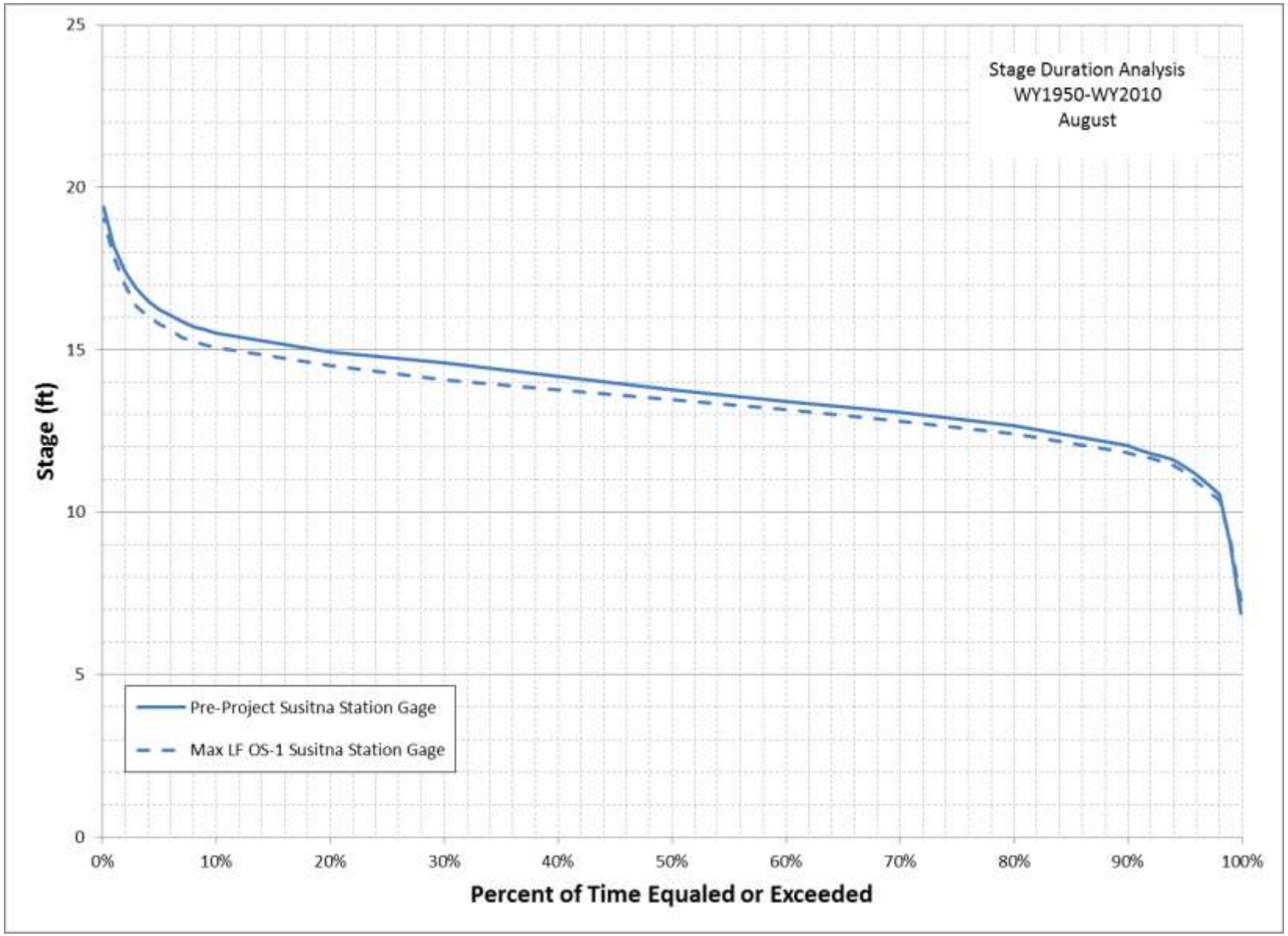

Figure J-25 - Monthly Stage Exceedence Curves for August for pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

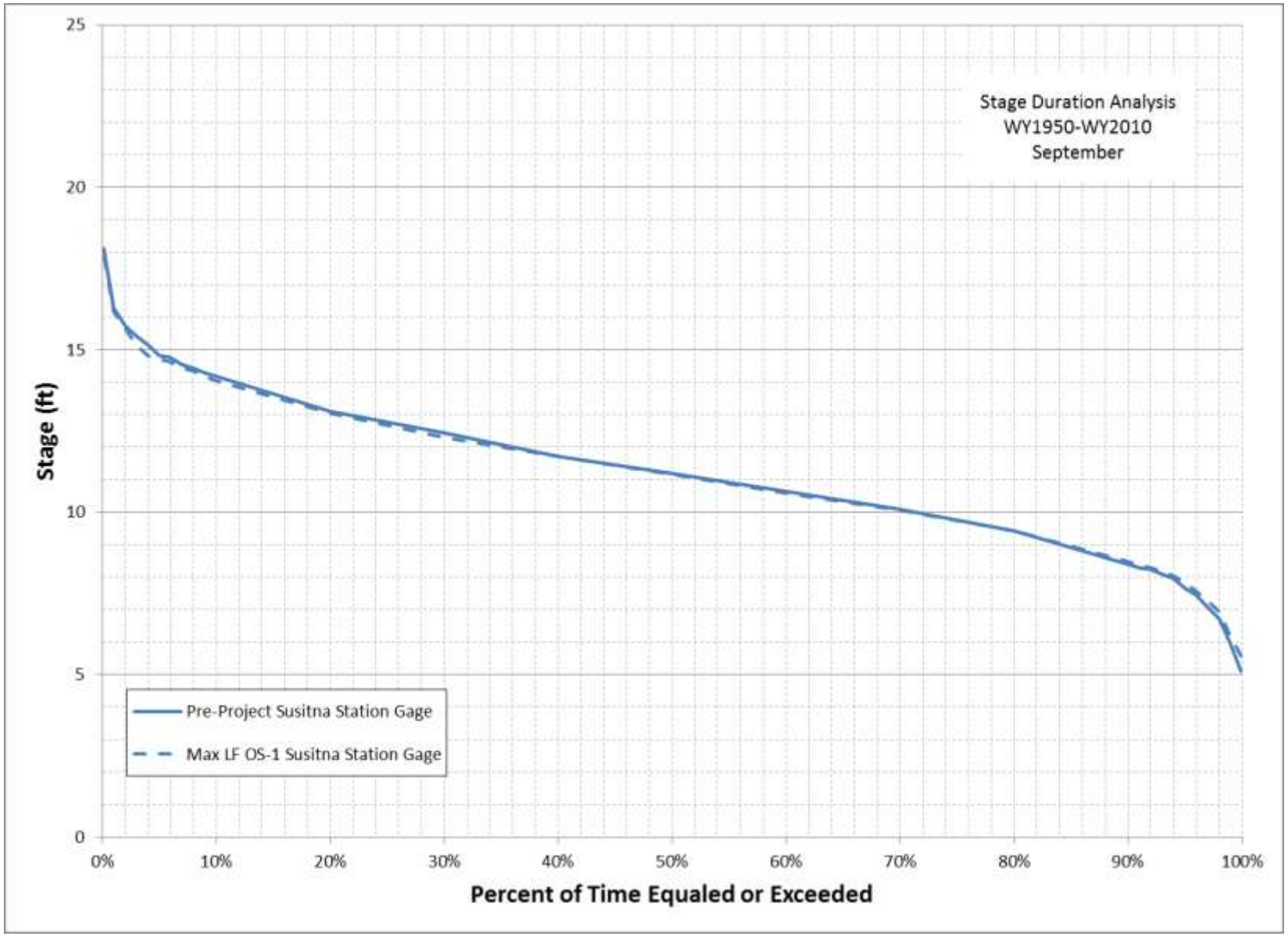

Figure J-26 - Monthly Stage Exceedence Curves for September for pre-Project and Max LF OS-1 Conditions, Susitna Station Gage.

APPENDIX K. PLOTS OF SELECT WATER-SURFACE ELEVATION EXCEEDENCE VALUES (PRE-PROJECT AND MAXIMUM LOAD FOLLOWING OS-1 CONDITIONS) FOR SUNSHINE GAGE AND SUSITNA STATION GAGE CROSS SECTION

Susitna-Watana Hydroelectric Project (FERC No. 14241)

Stream Flow Assessment

Prepared for

Alaska Energy Authority

Prepared by

Tetra Tech

February 2013

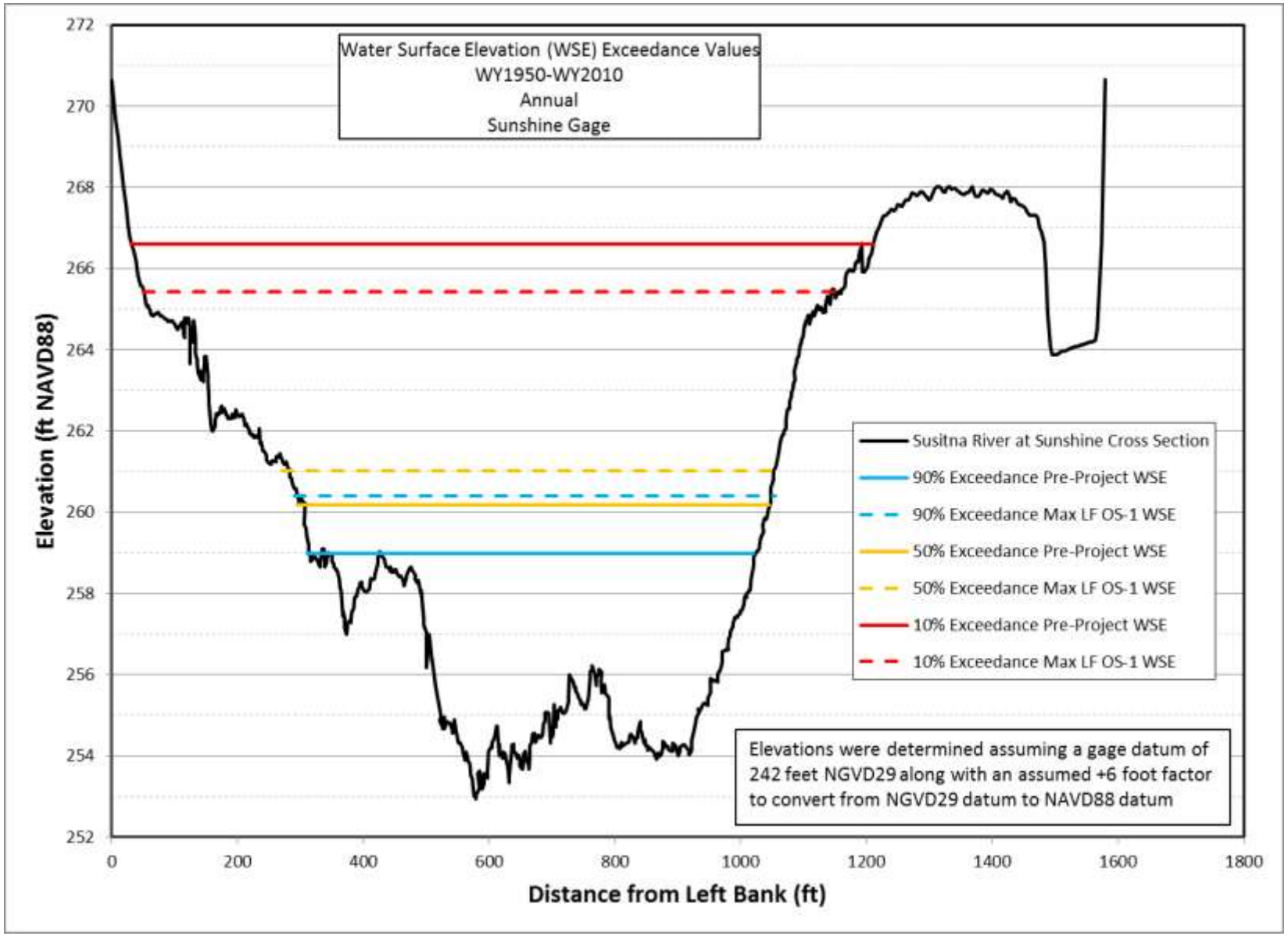

Figure K-1 - Select Annual Water-surface Elevation Exceedence Values, pre-Project and Max LF OS-1 Conditions, Sunshine Gage

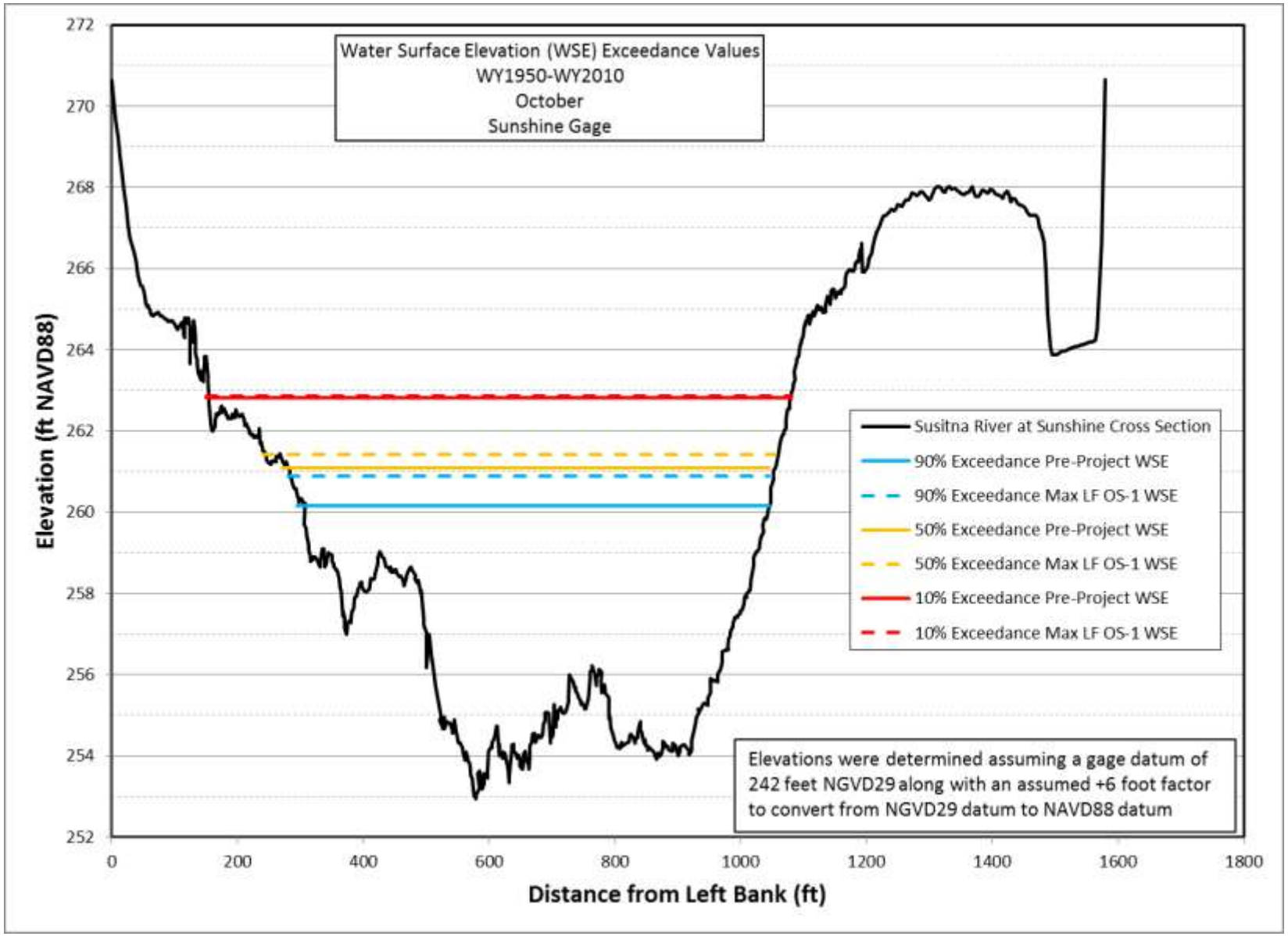

Figure K-2 – Select Water-surface Elevation Exceedence Values for October, pre-Project and Max LF OS-1 Conditions, Sunshine Gage

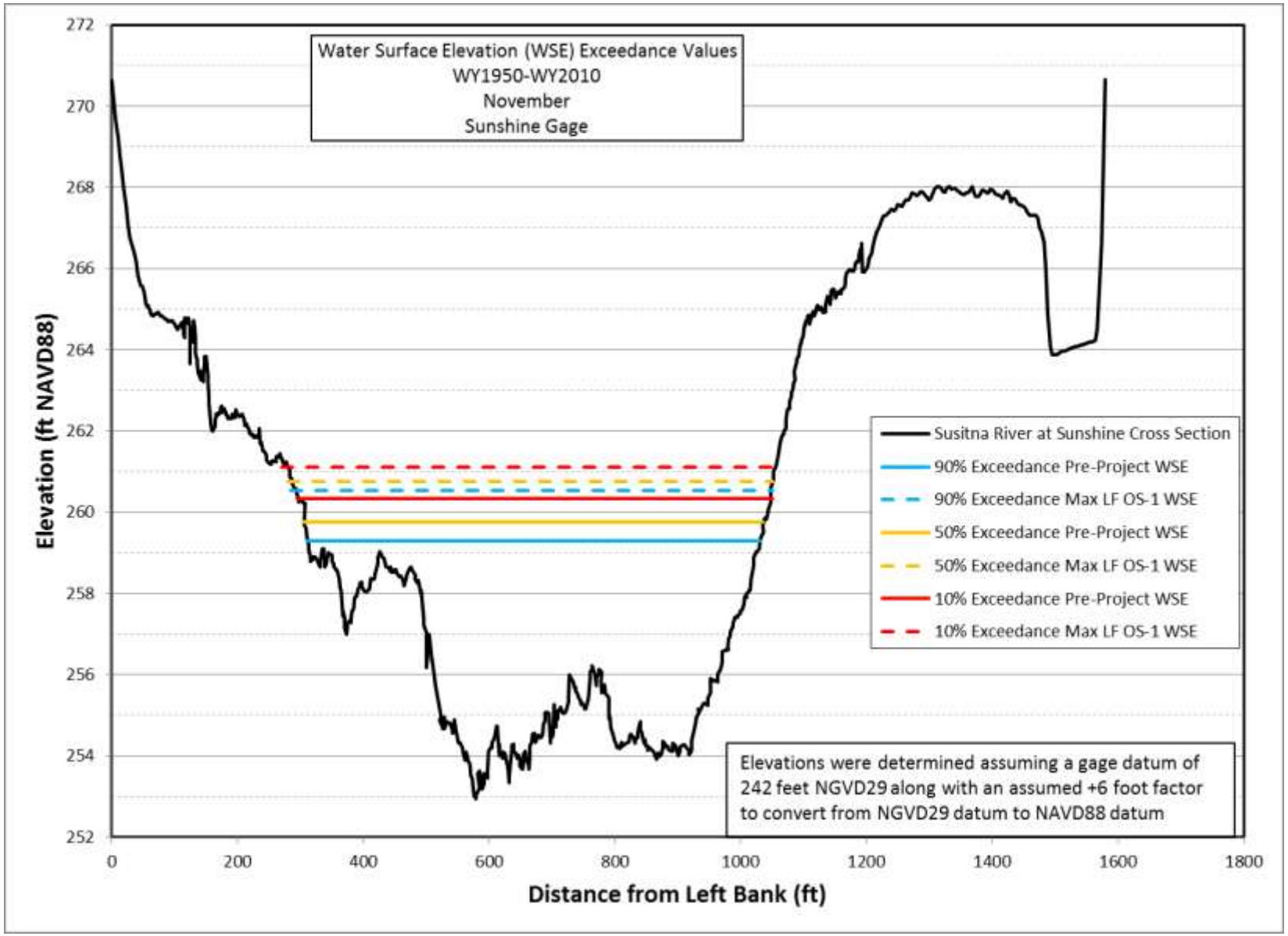

Figure K-3 – Select Water-surface Elevation Exceedence Values for November, pre-Project and Max LF OS-1 Conditions, Sunshine Gage

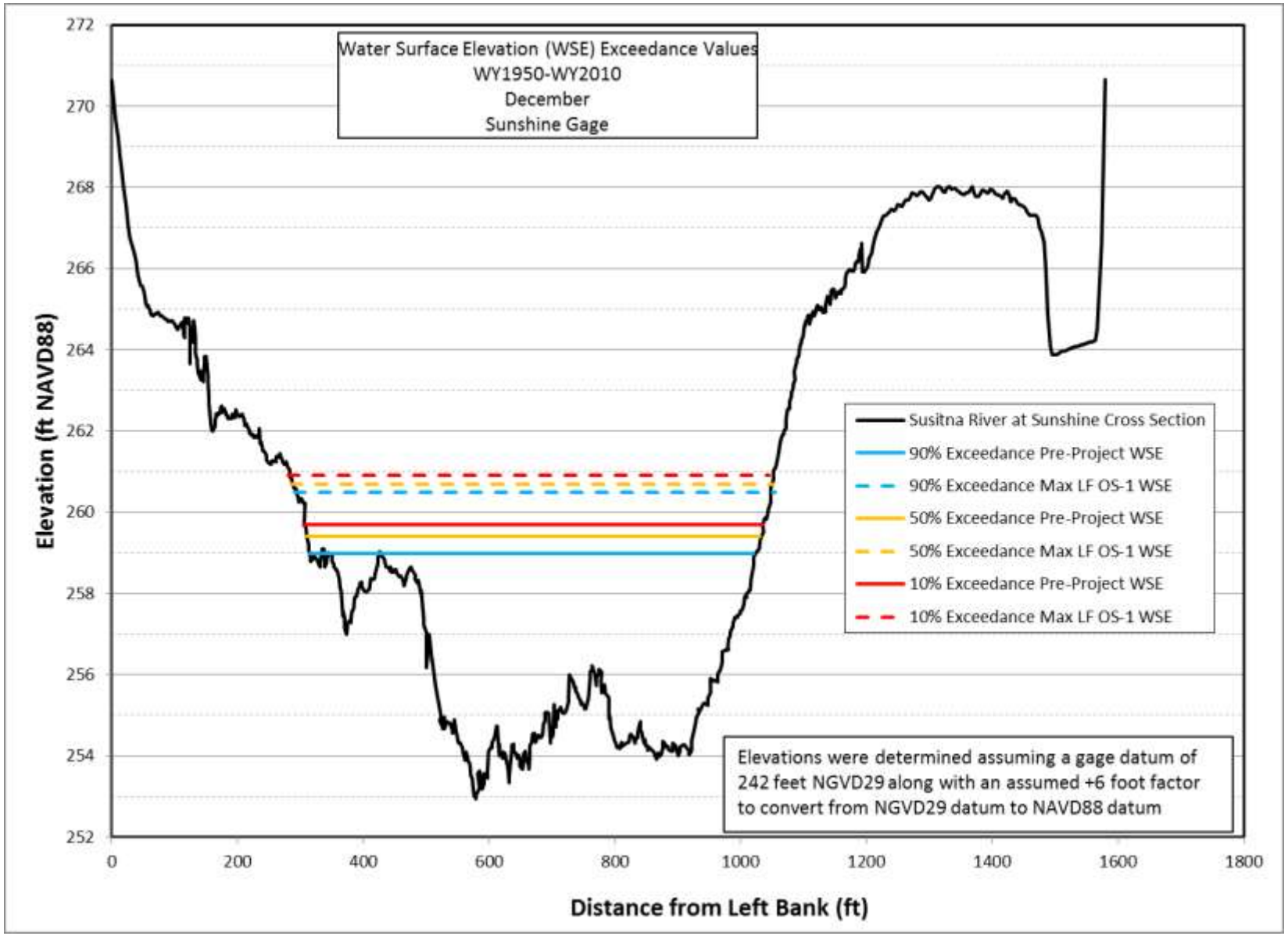

Figure K-4 – Select Water-surface Elevation Exceedance Values for December, pre-Project and Max LF OS-1 Conditions, Sunshine Gage

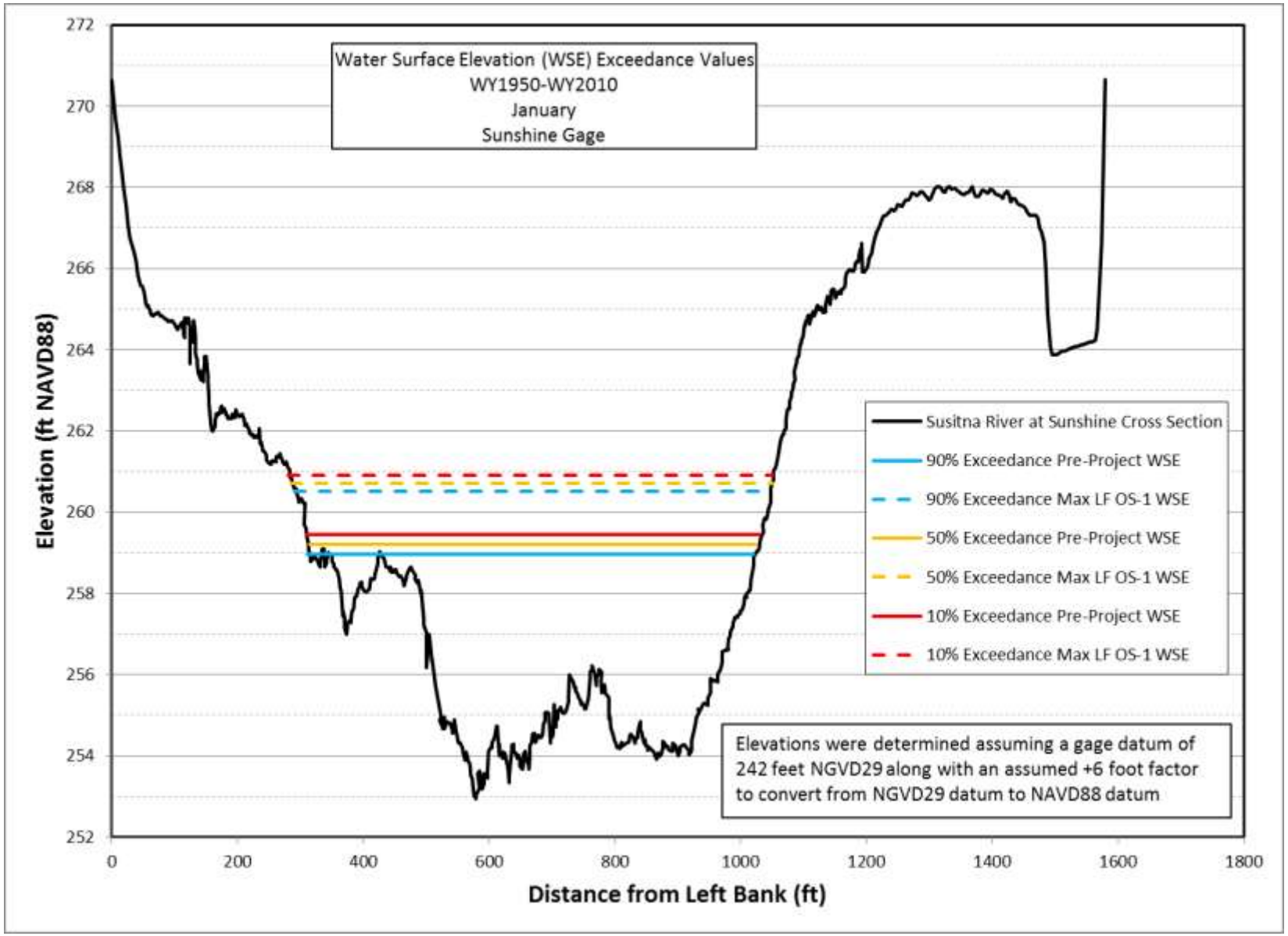

Figure K-5 – Select Water-surface Elevation Exceedence Values for January, pre-Project and Max LF OS-1 Conditions, Sunshine Gage

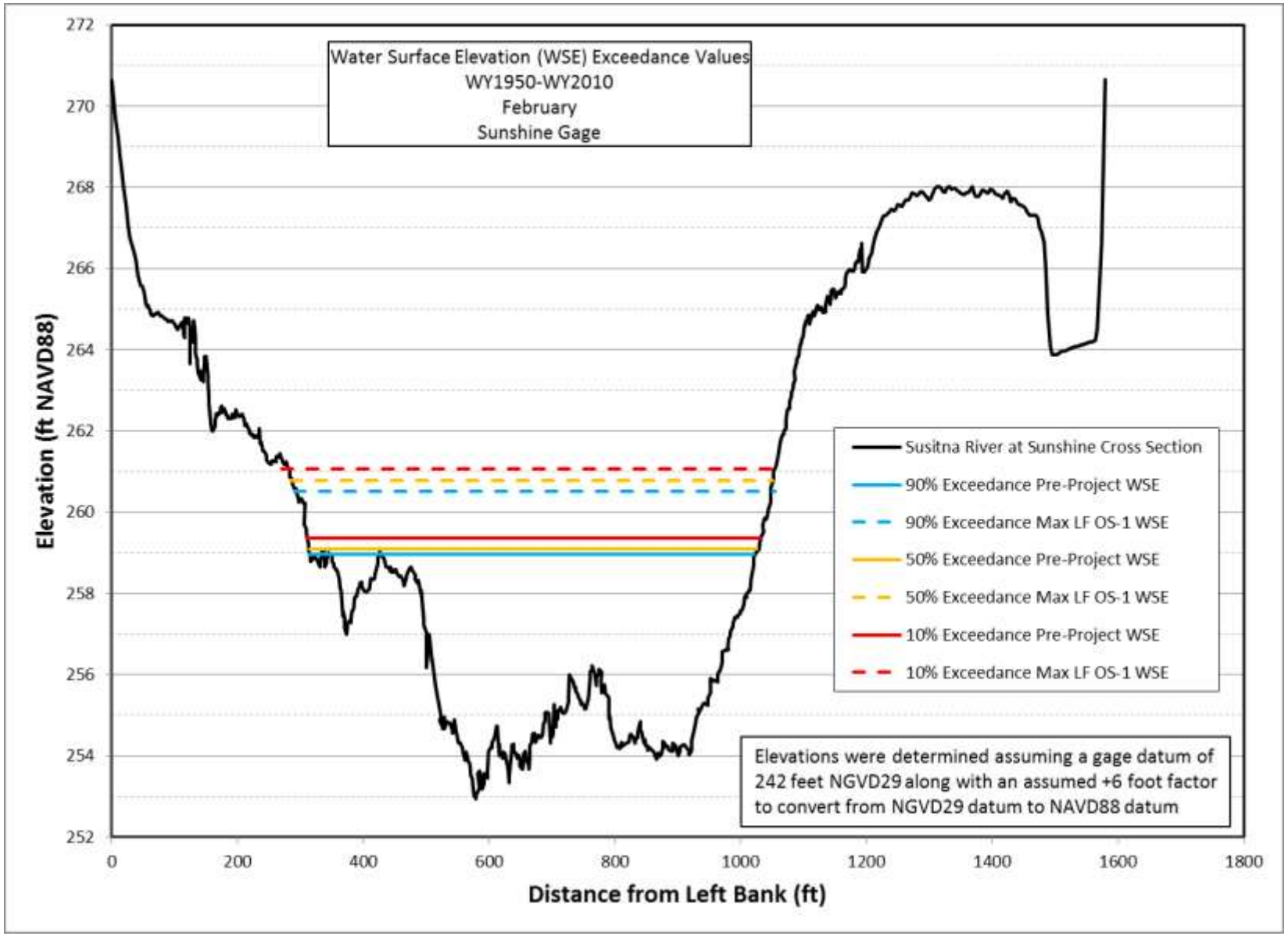

Figure K-6 – Select Water-surface Elevation exceedence Values for February, pre-Project and Max LF OS-1 Conditions, Sunshine Gage

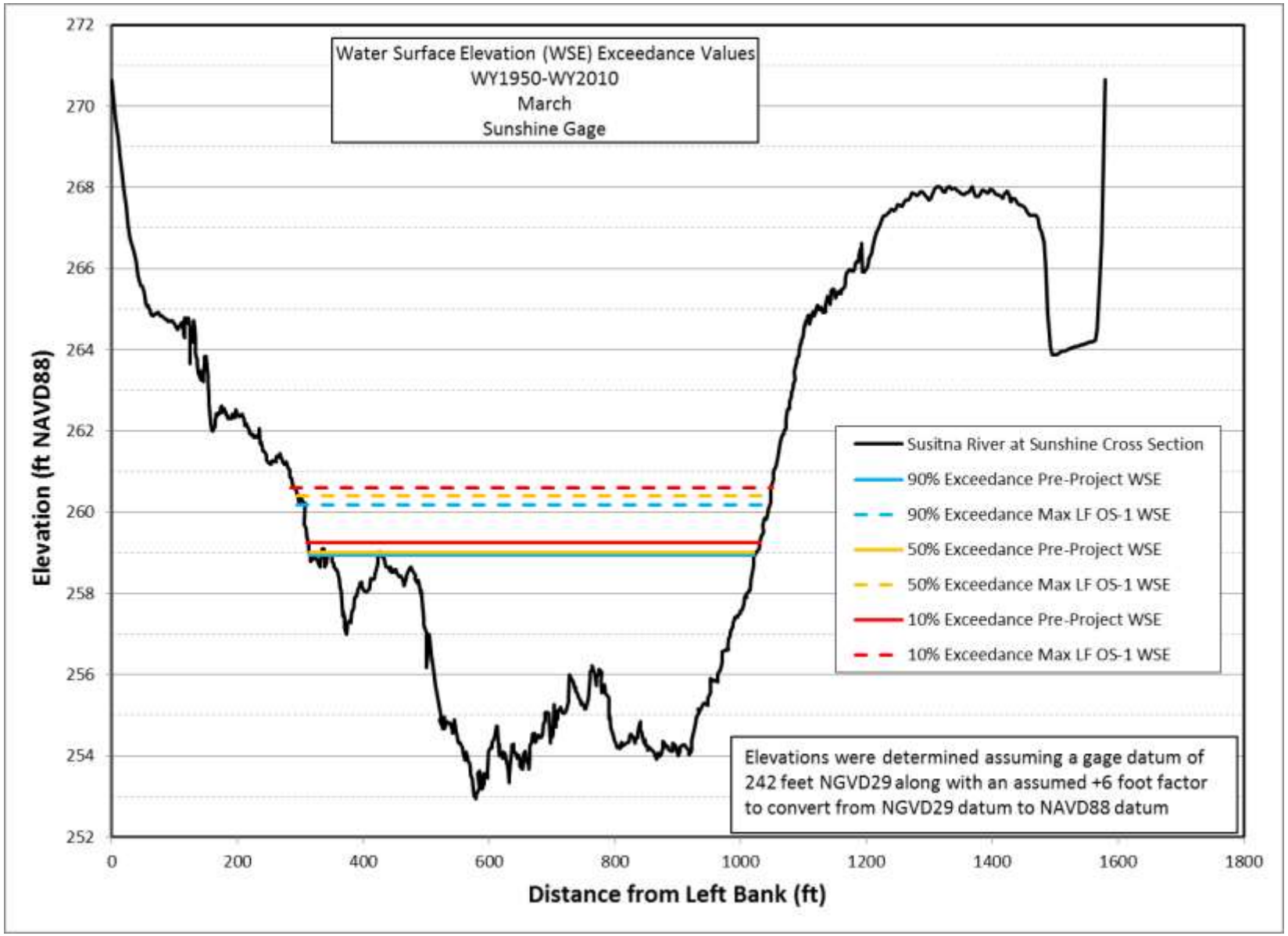

Figure K-7 – Select Water-surface Elevation Exceedence Values for March, pre-Project and Max LF OS-1 Conditions, Sunshine Gage

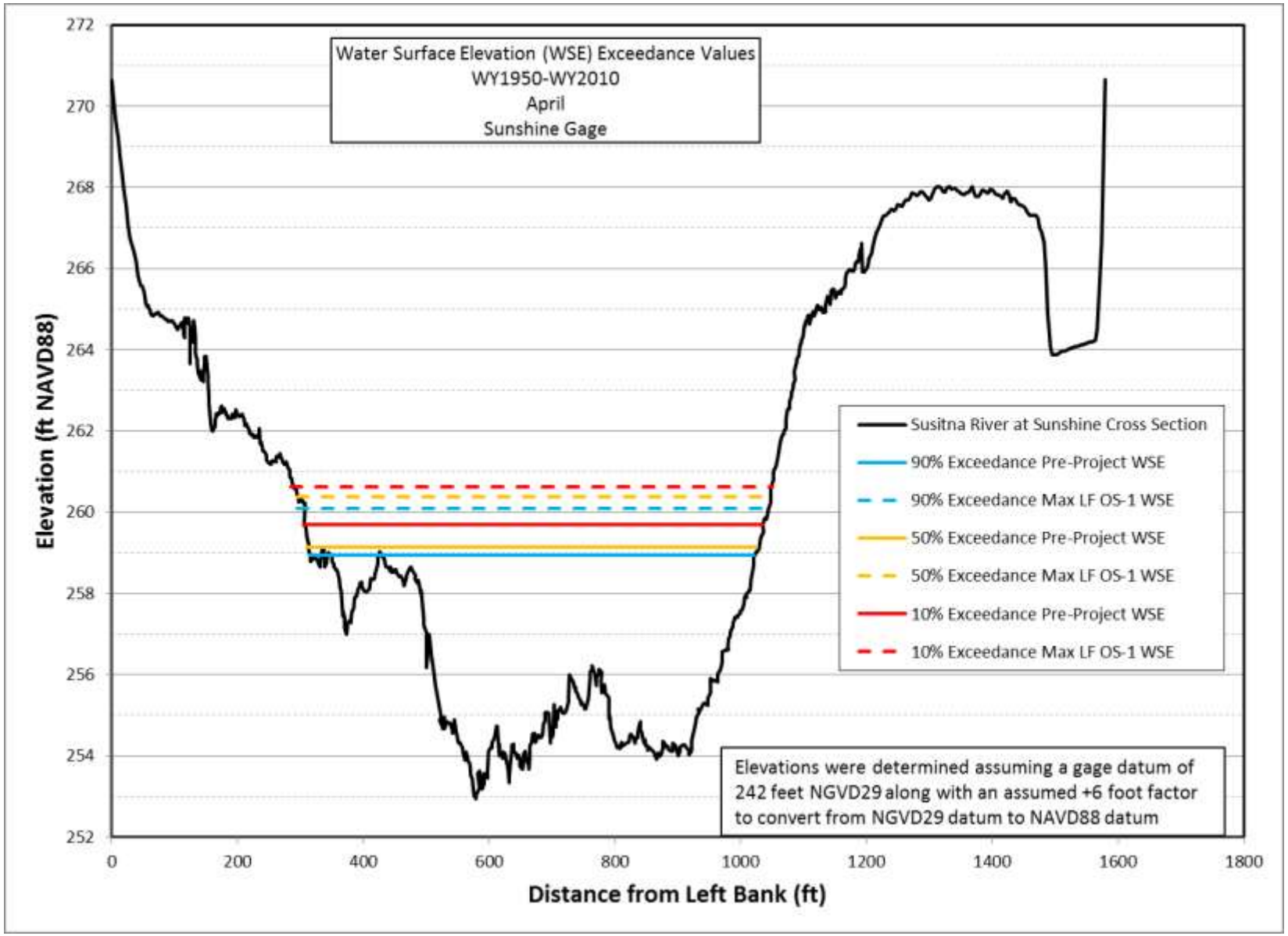

Figure K-8 – Select Water-surface Elevation Exceedence Values for April, pre-Project and Max LF OS-1 Conditions, Sunshine Gage

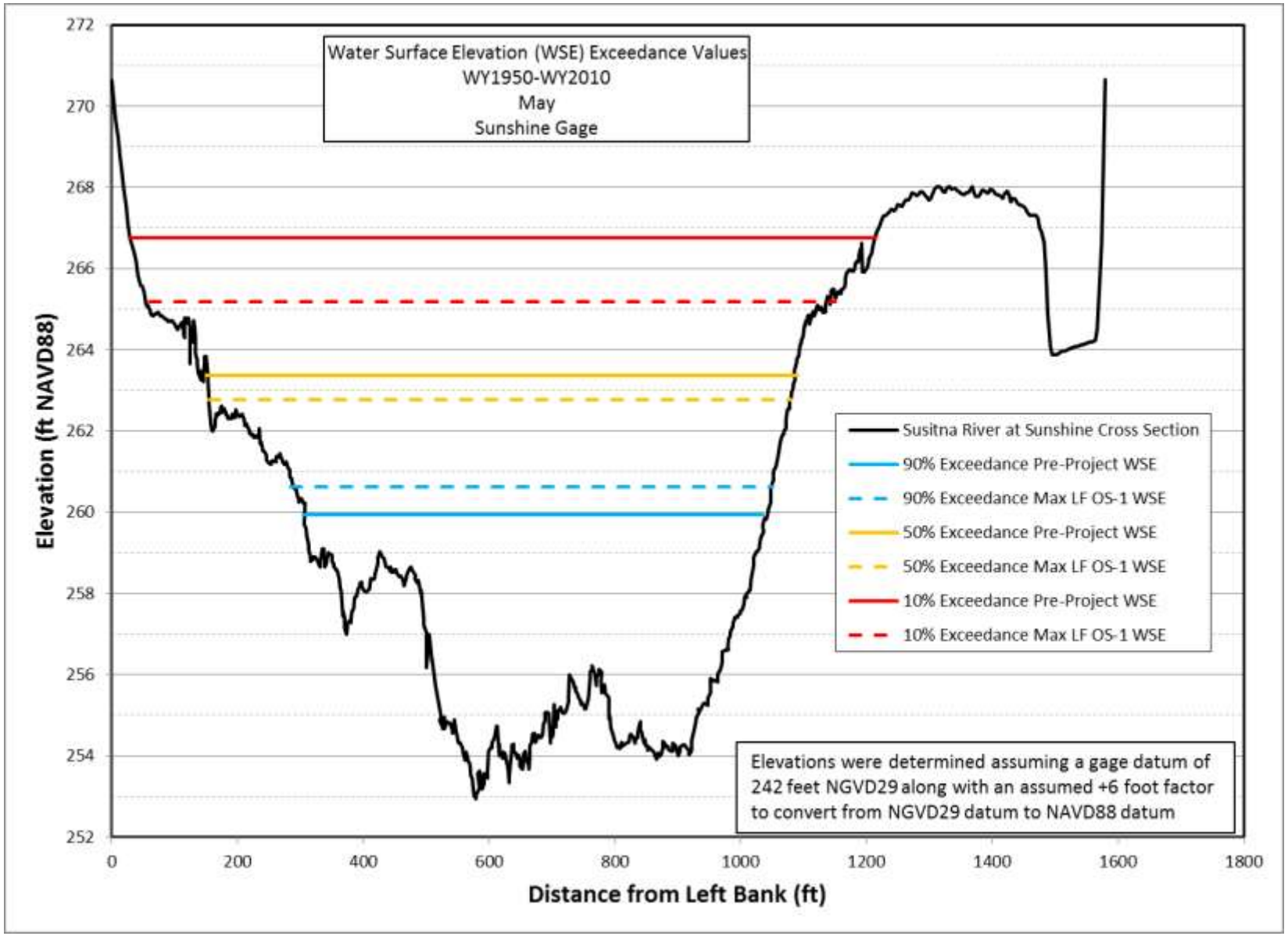

Figure K-9 – Select Water-surface Elevation Exceedence Values for May, pre-Project and Max LF OS-1 Conditions, Sunshine Gage

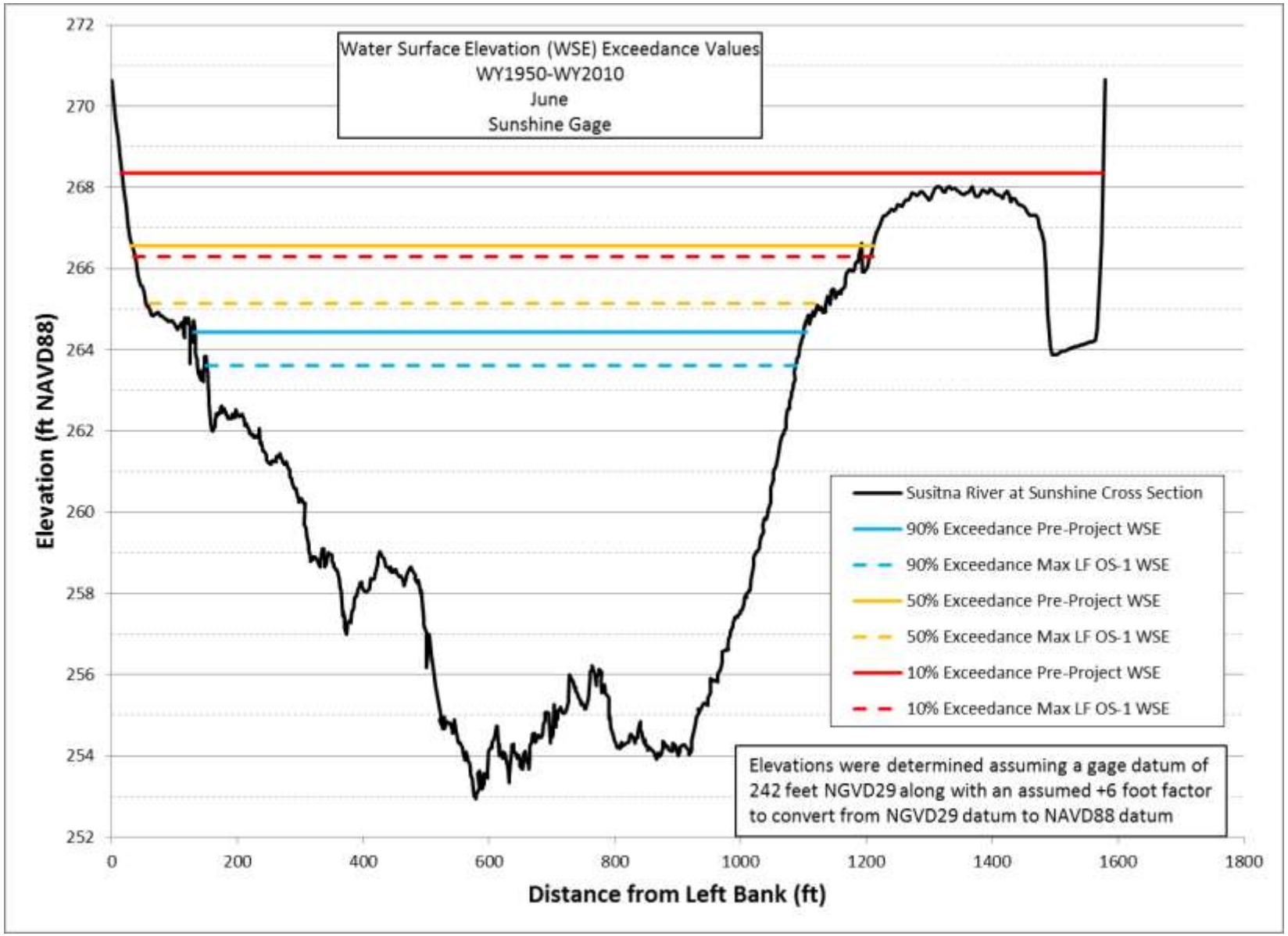

Figure K-10 – Select Water-surface Elevation Exceedence Values for June, pre-Project and Max LF OS-1 Conditions, Sunshine Gage

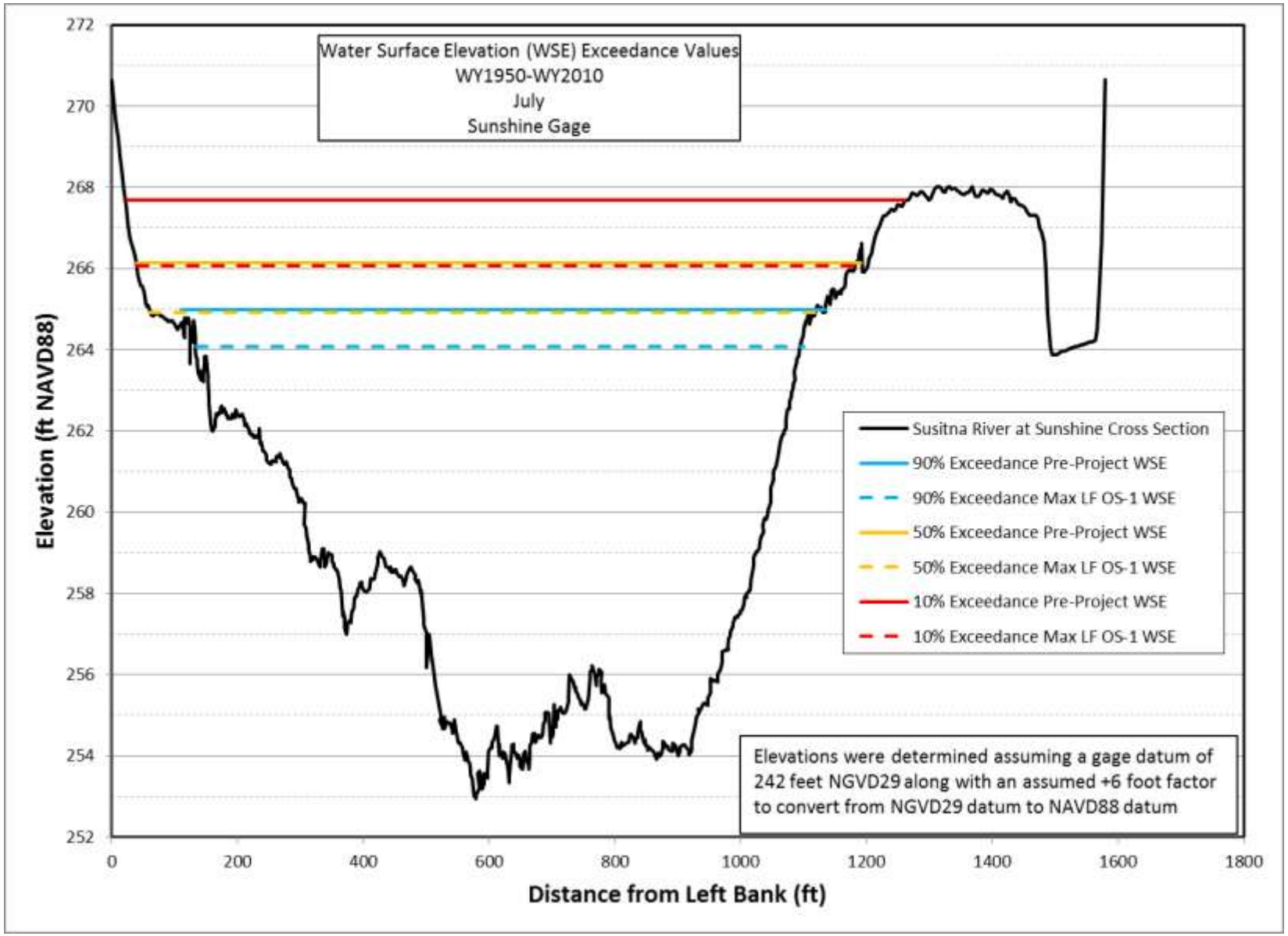

Figure K-11 – Select Water-surface Elevation Exceedence Values for July, pre-Project and Max LF OS-1 Conditions, Sunshine Gage

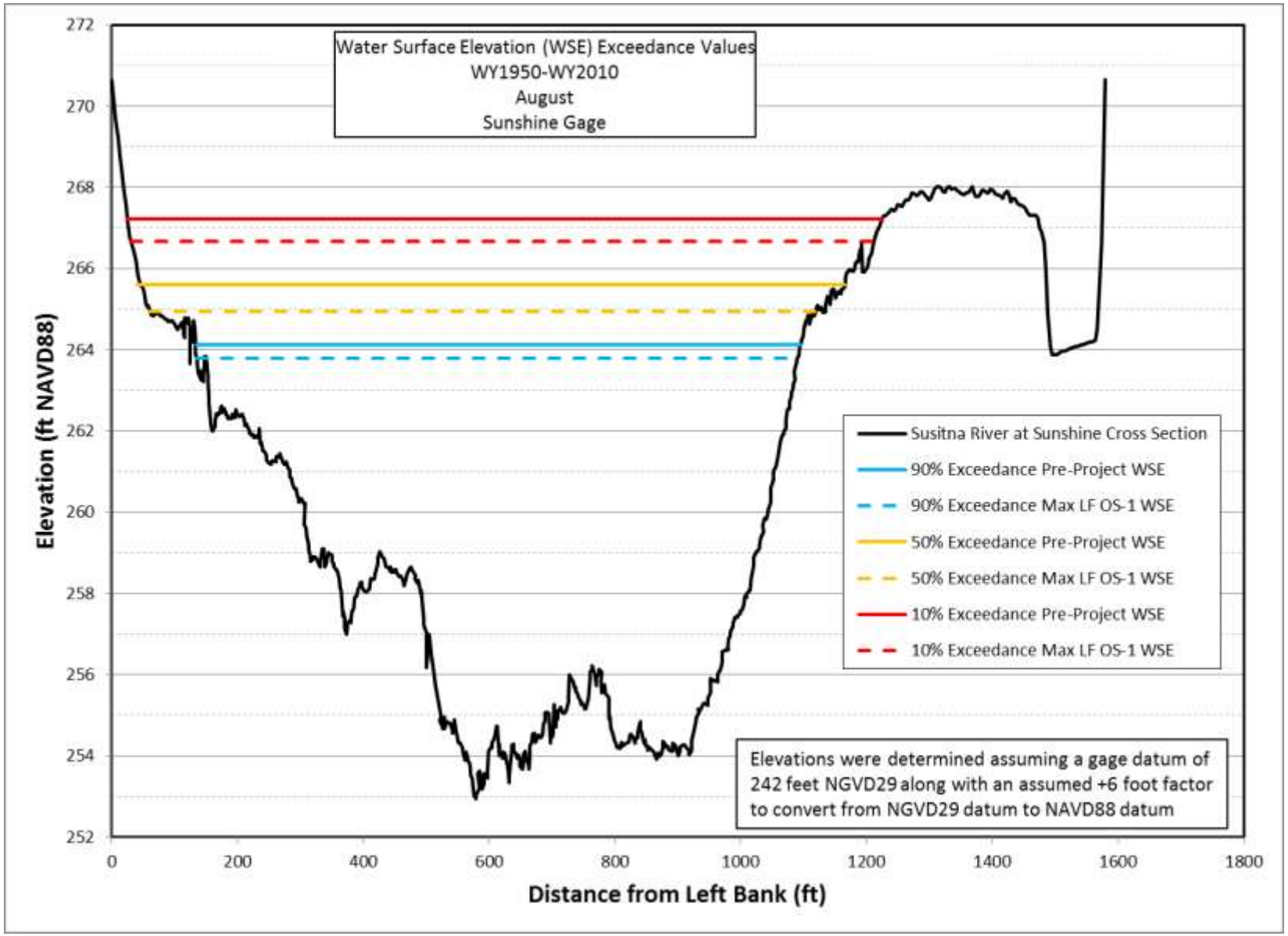

Figure K-12 – Select Water-surface Elevation Exceedence Values for August, pre-Project and Max LF OS-1 Conditions, Sunshine Gage

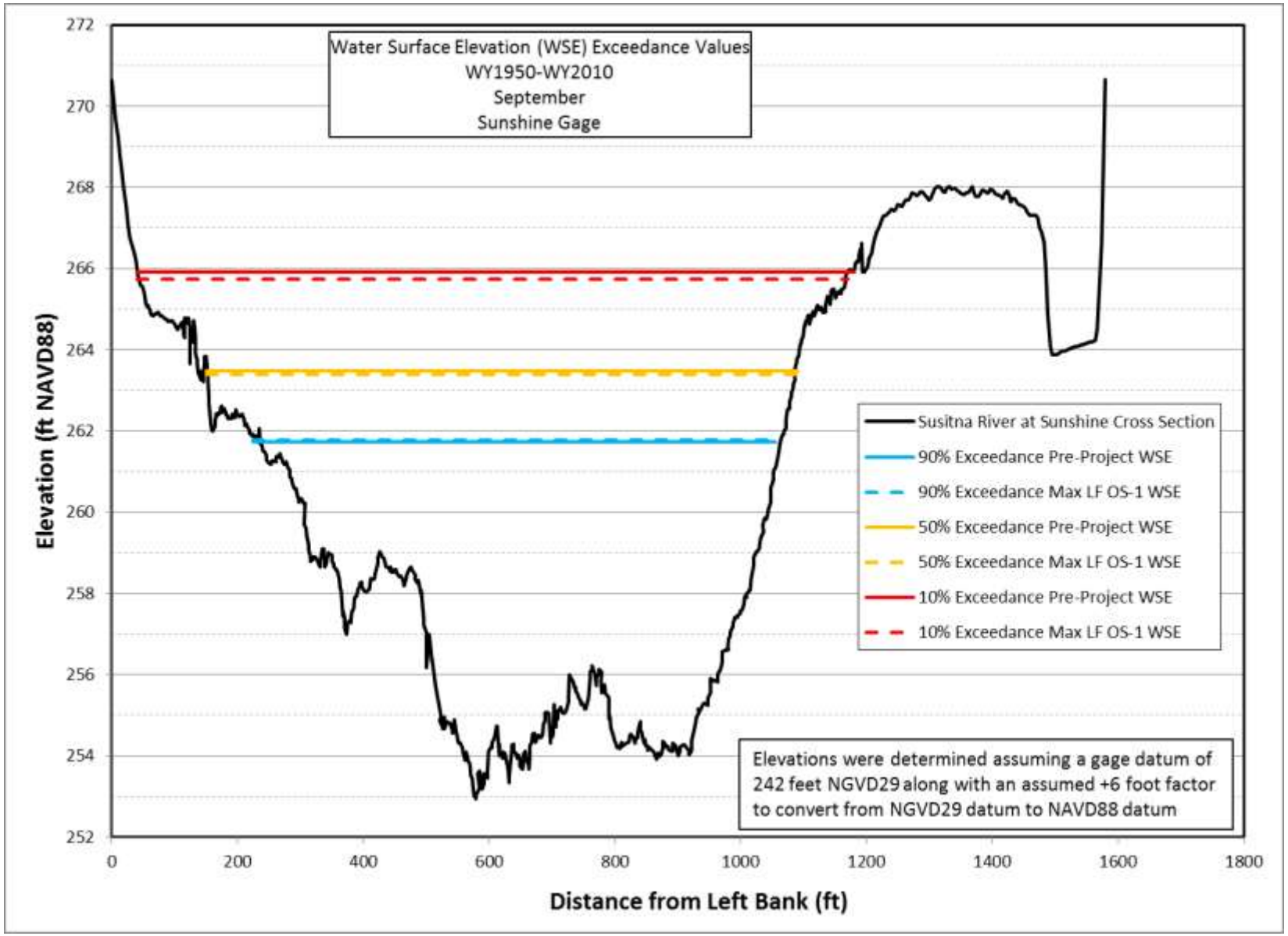

Figure K-13 – Select Water-surface Elevation Exceedence Values for September, pre-Project and Max LF OS-1 Conditions, Sunshine Gage

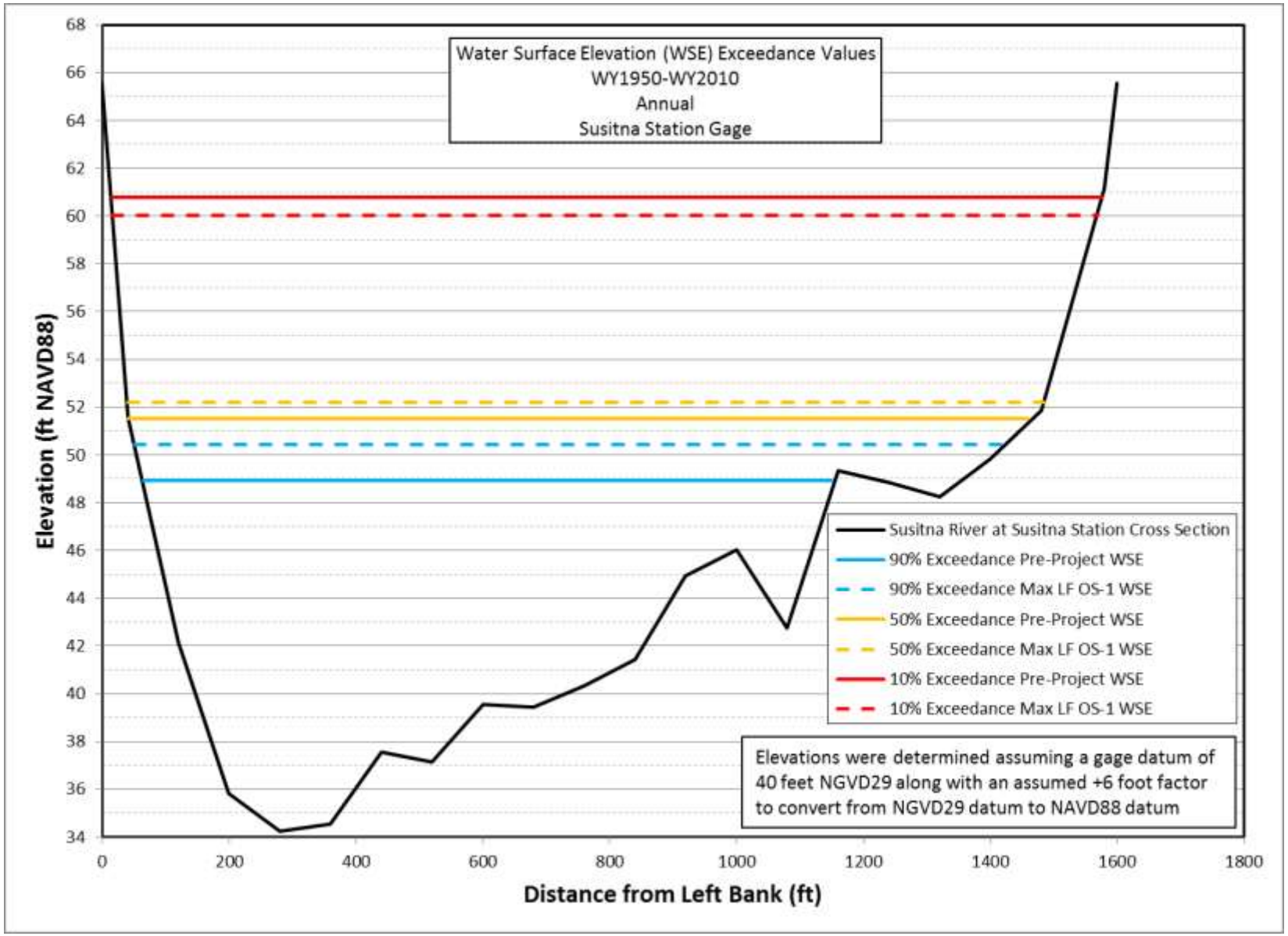

Figure K-14 - Select Annual Water-surface Elevation Exceedence Values, pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

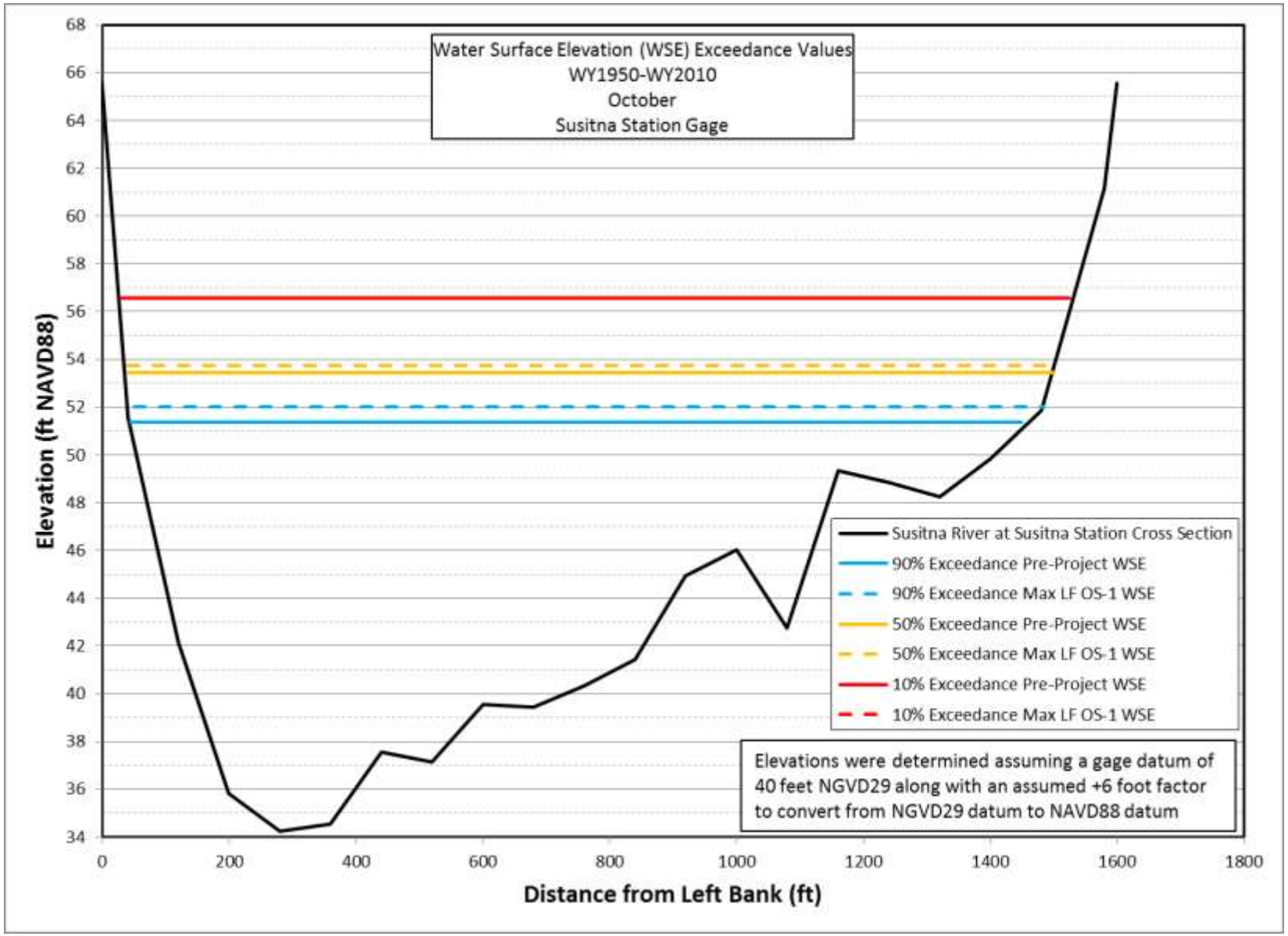

Figure K-15 – Select Water-surface Elevation Exceedence Values for October, pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

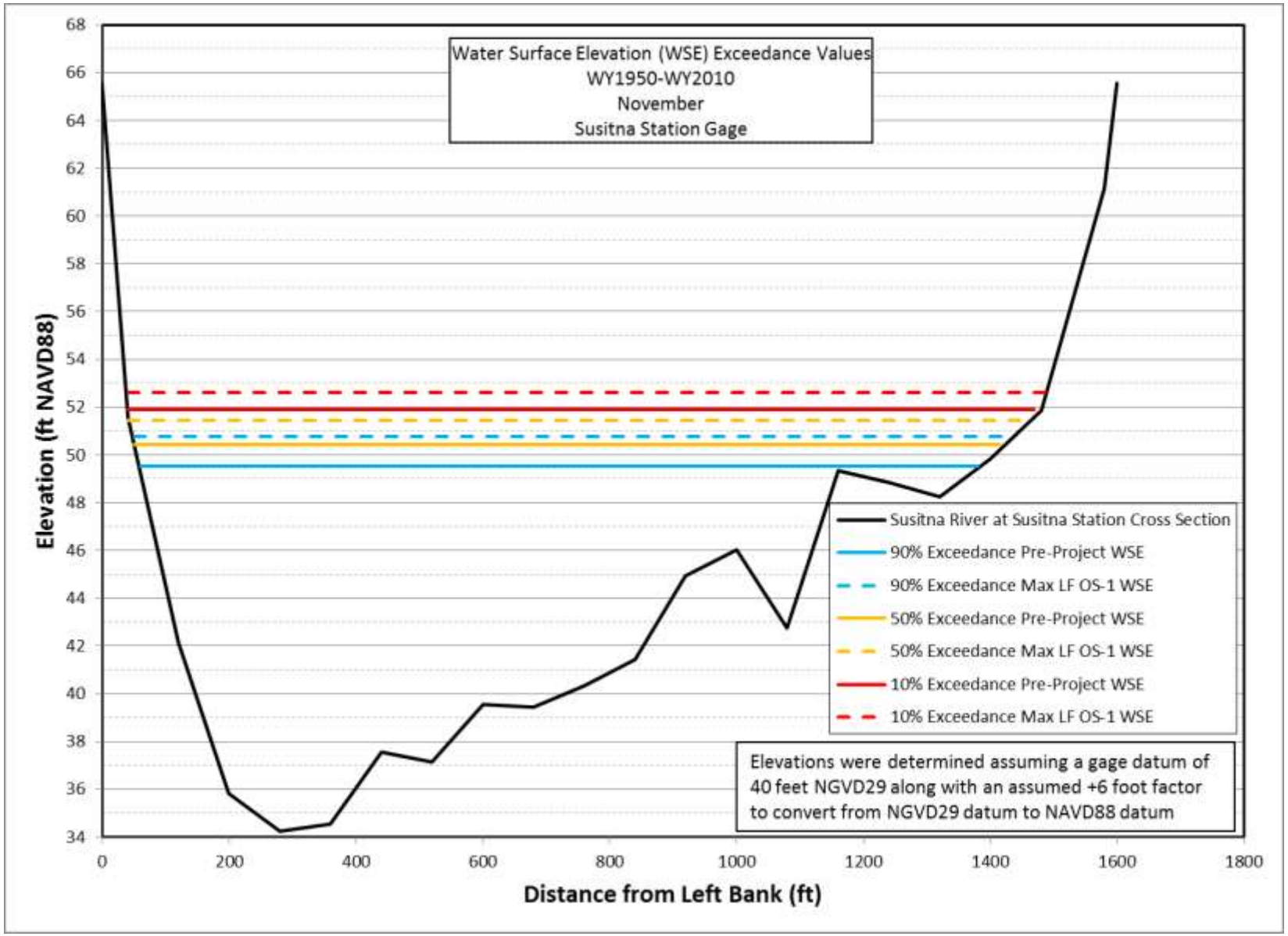

Figure K-16 – Select Water-surface Elevation Exceedence Values for November, pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

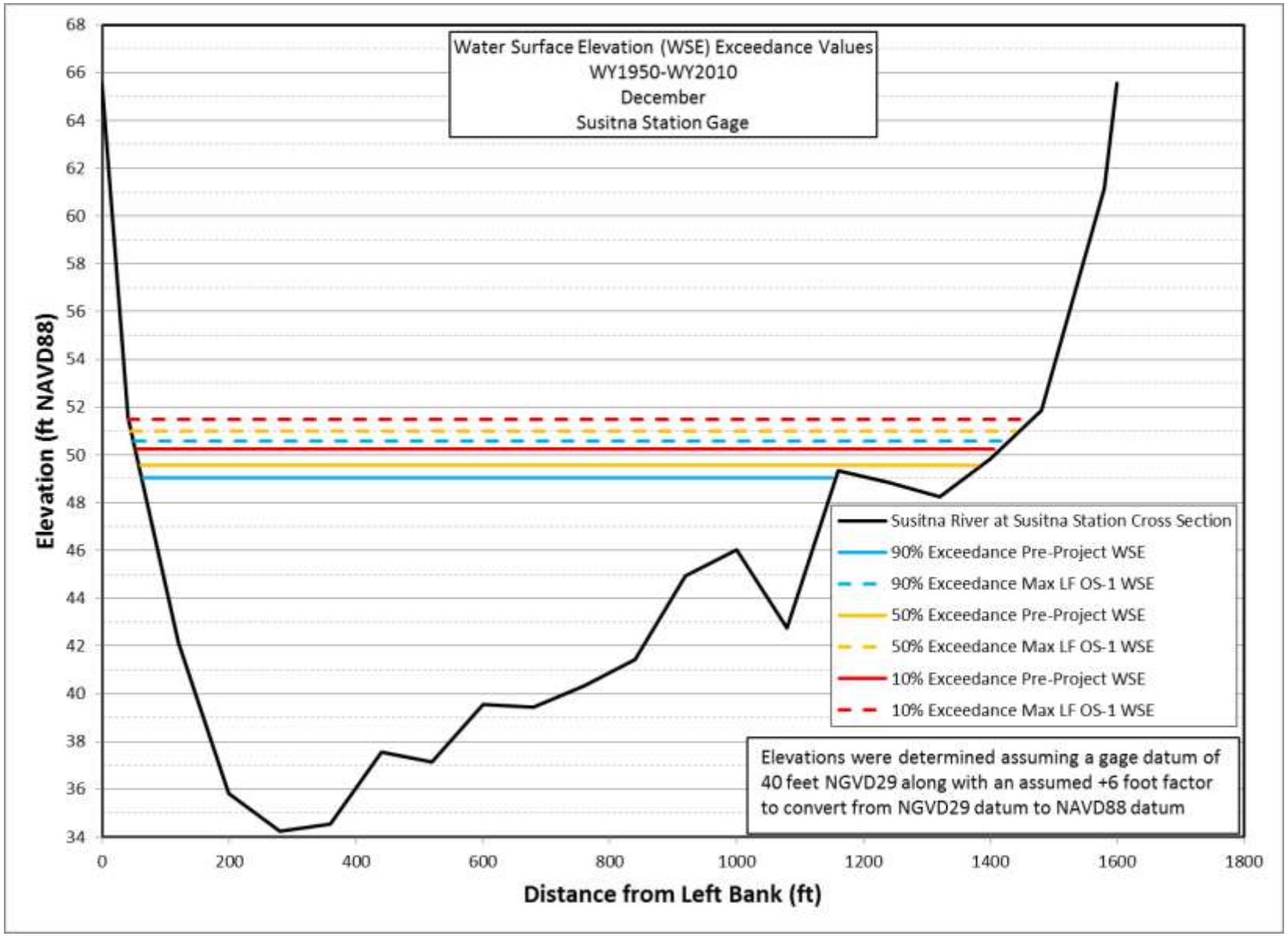

Figure K-17 – Select Water-surface Elevation Exceedence Values for December, pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

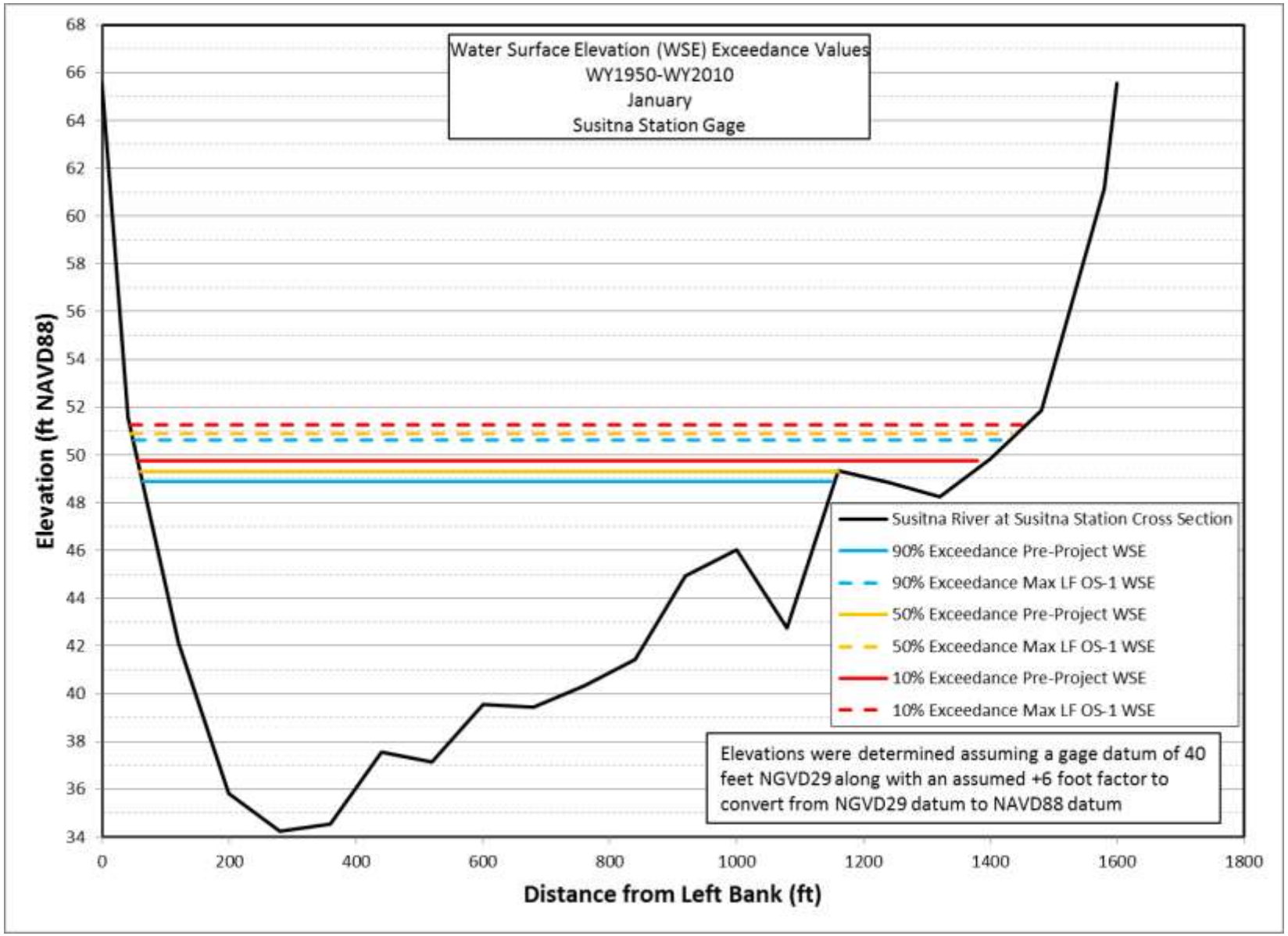

Figure K-18 – Select Water-surface Elevation Exceedence Values for January, pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

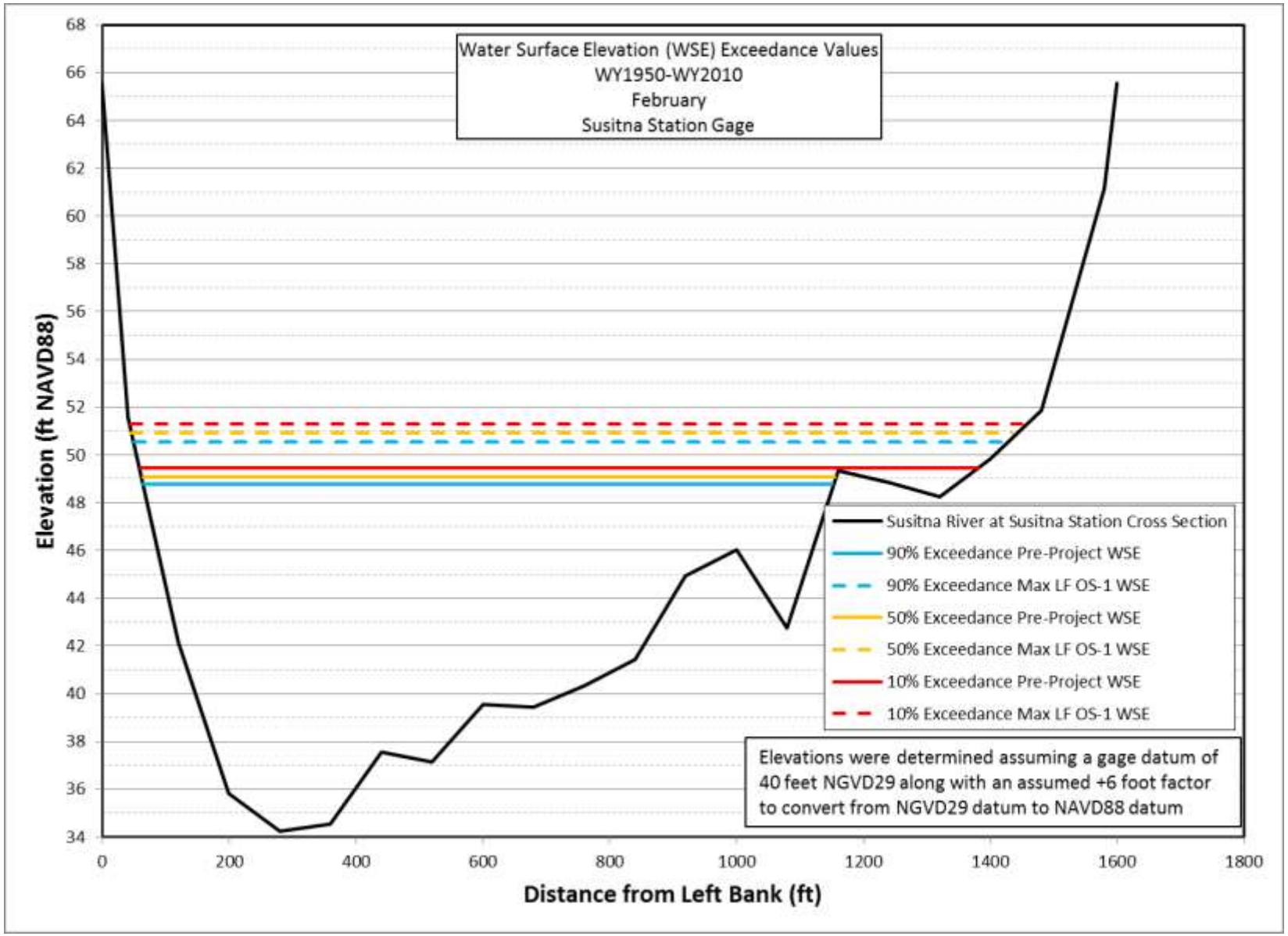

Figure K-19 – Select Water-surface Elevation Exceedence Values for February, pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

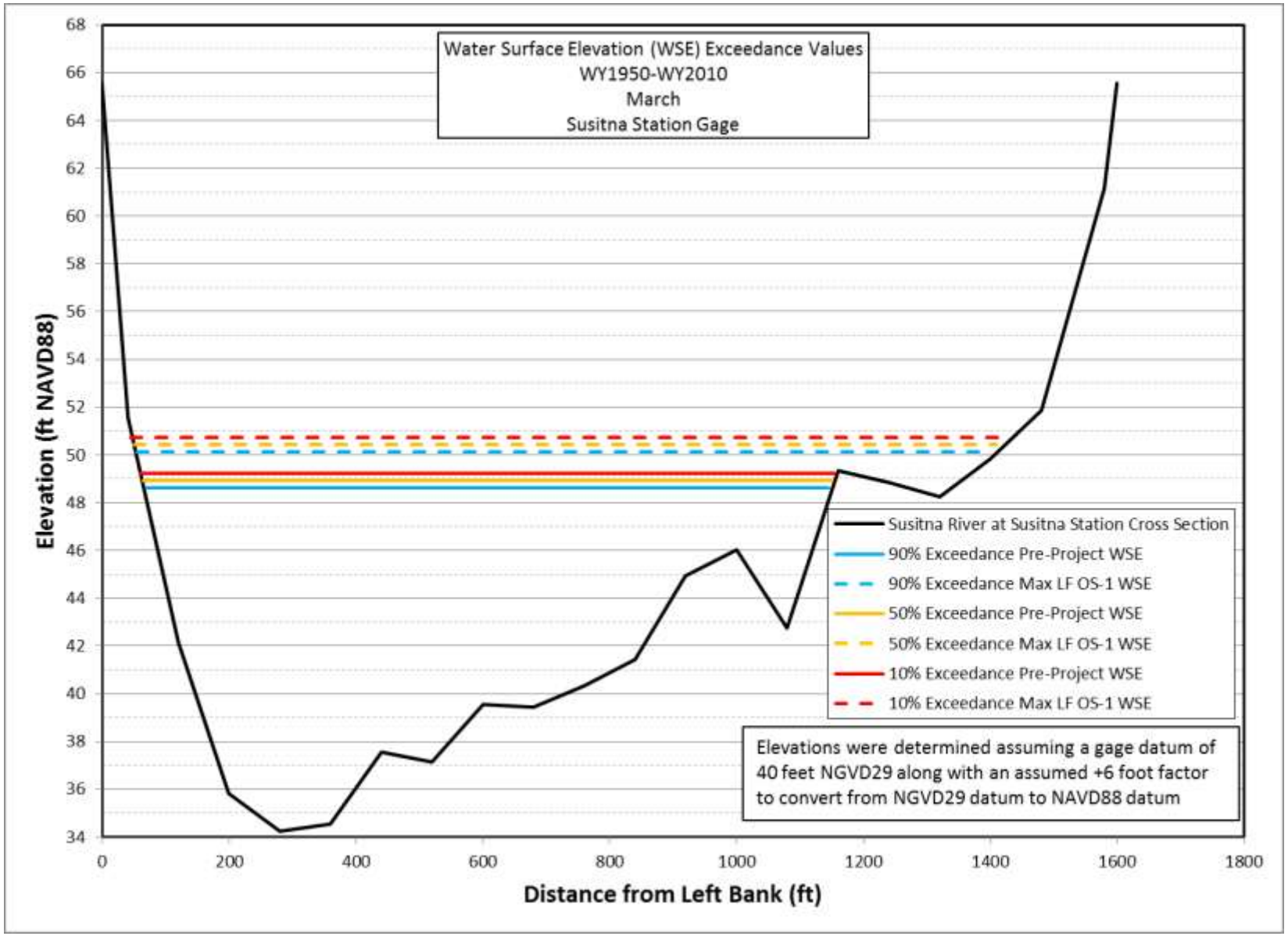

Figure K-20 – Select Water-surface Elevation Exceedence Values for March, pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

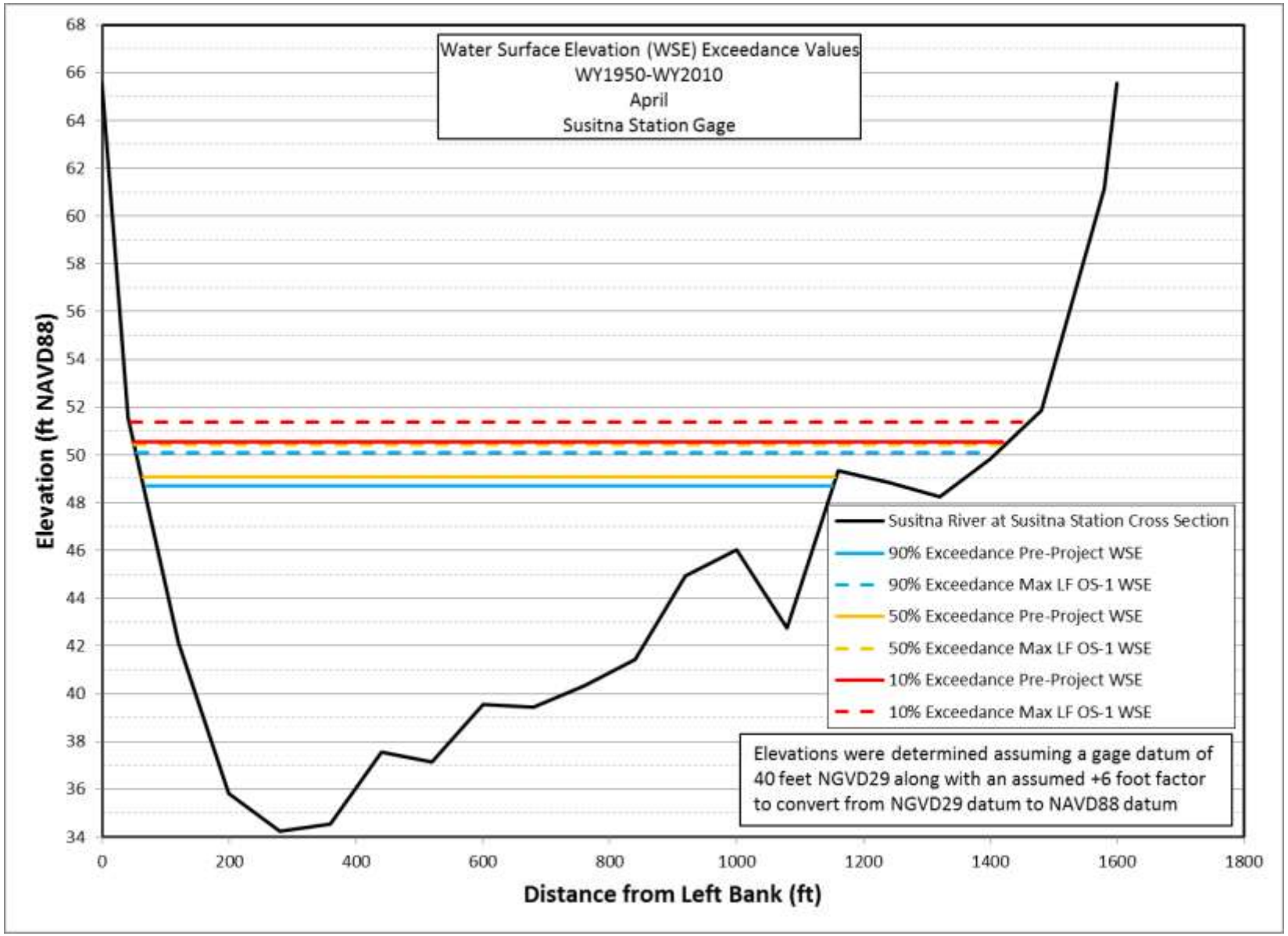

Figure K-21 – Select Water-surface Elevation Exceedence Values for April, pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

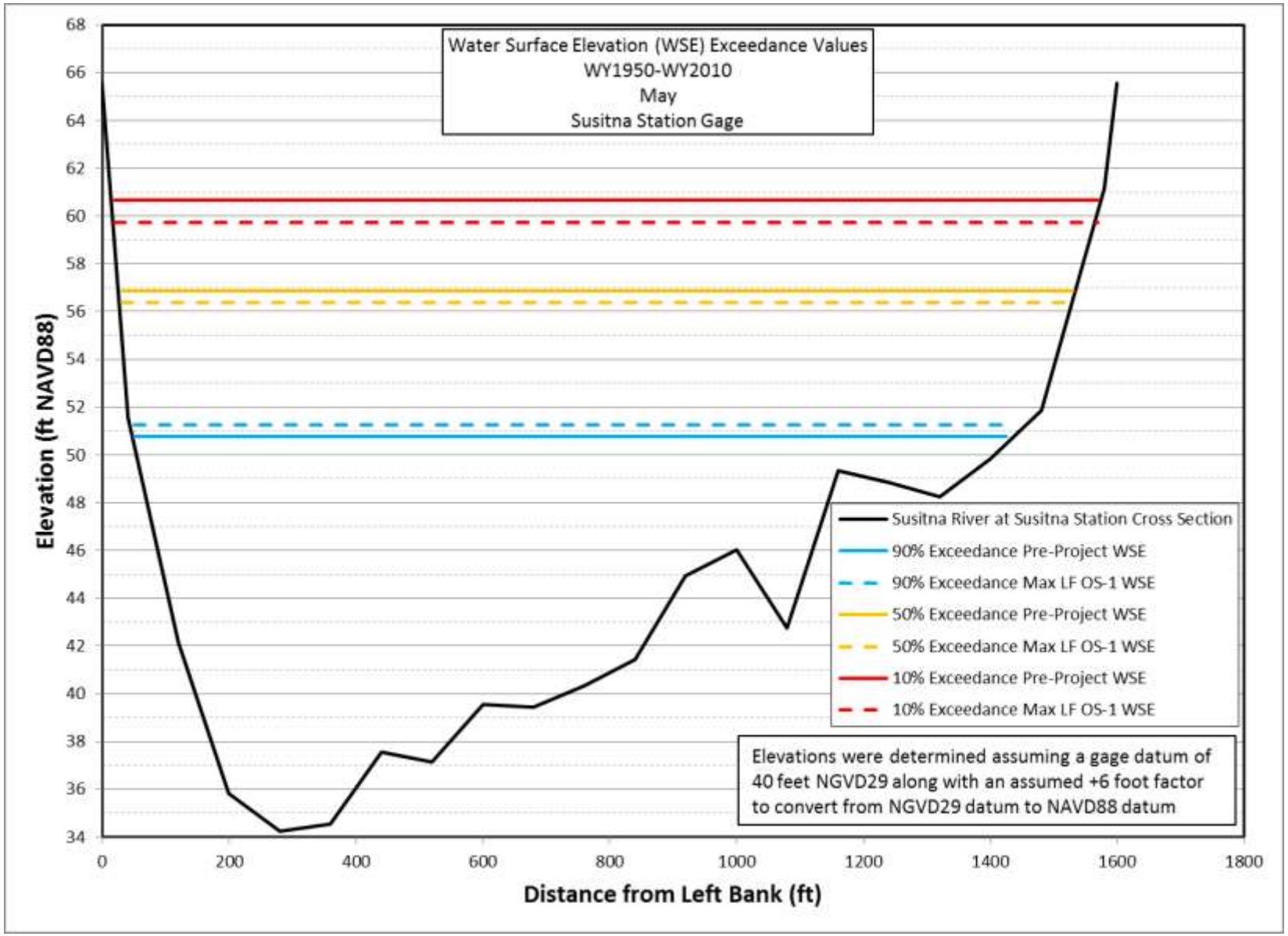

Figure K-22 – Select Water-surface Elevation Exceedence Values for May, pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

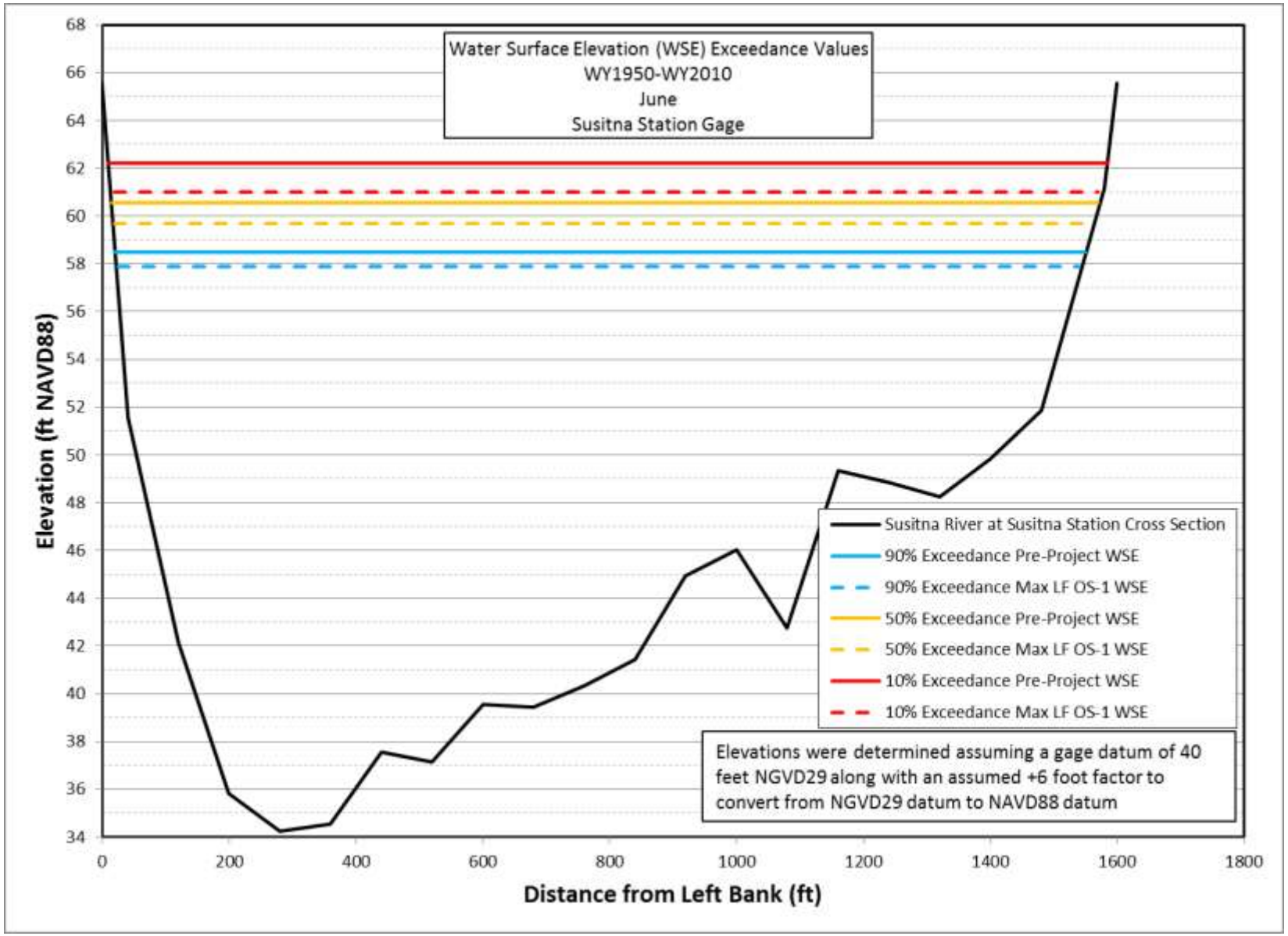

Figure K-23 – Select Water-surface Elevation Exceedence Values for June, pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

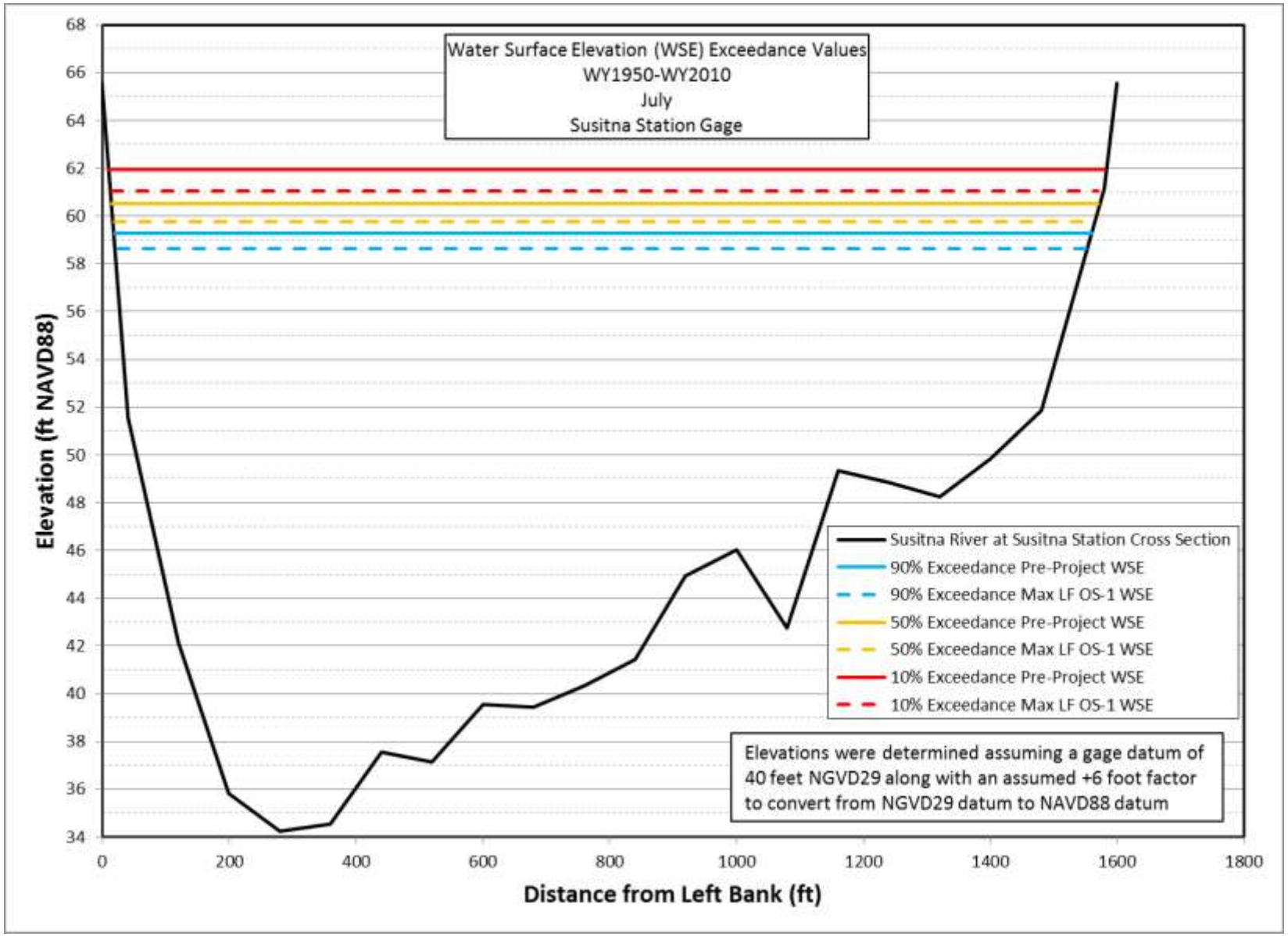

Figure K-24 – Select Water-surface Elevation Exceedence Values for July, pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

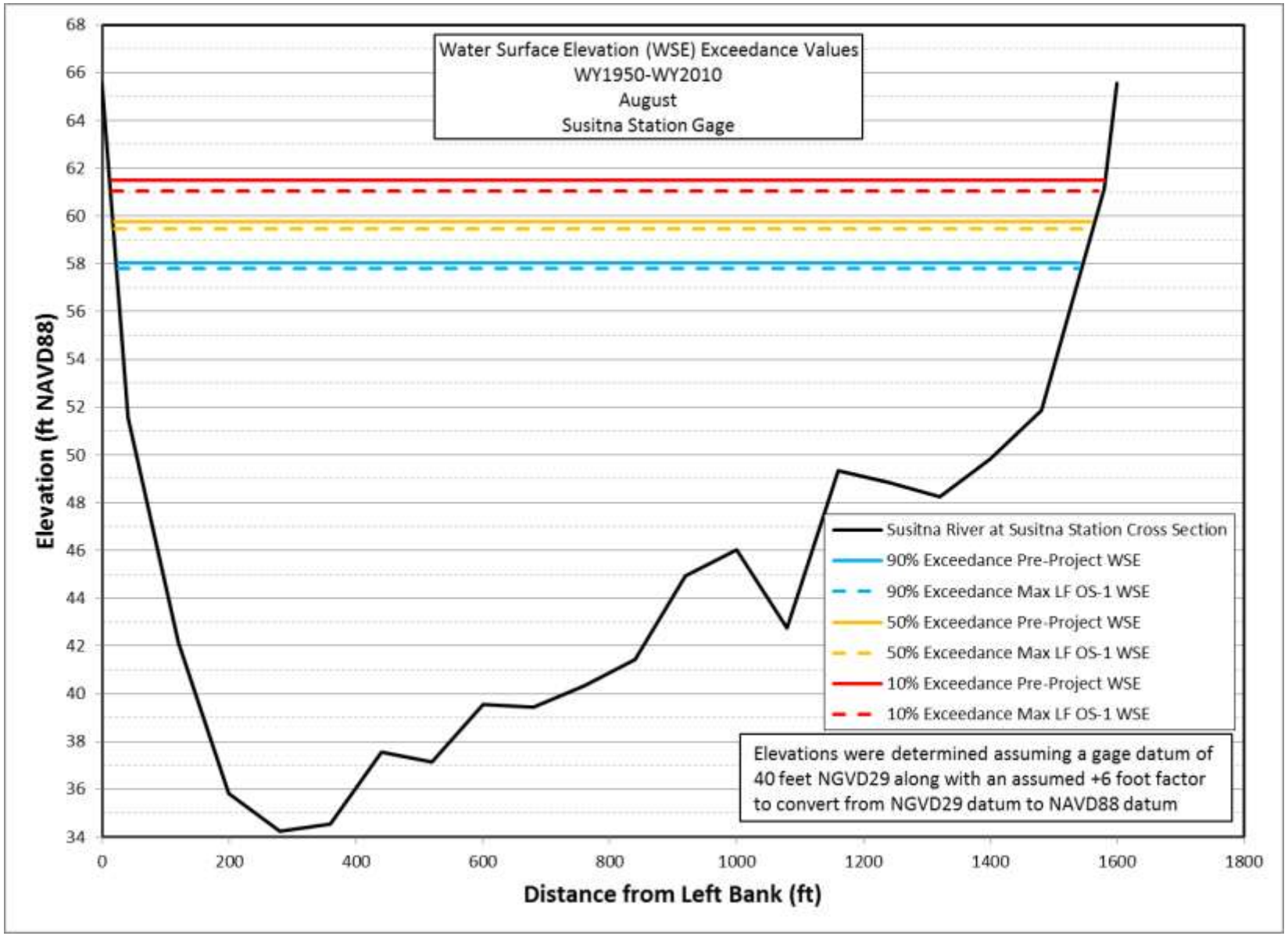

Figure K-25 – Select Water-surface Elevation Exceedence Values for August, pre-Project and Max LF OS-1 Conditions, Susitna Station Gage

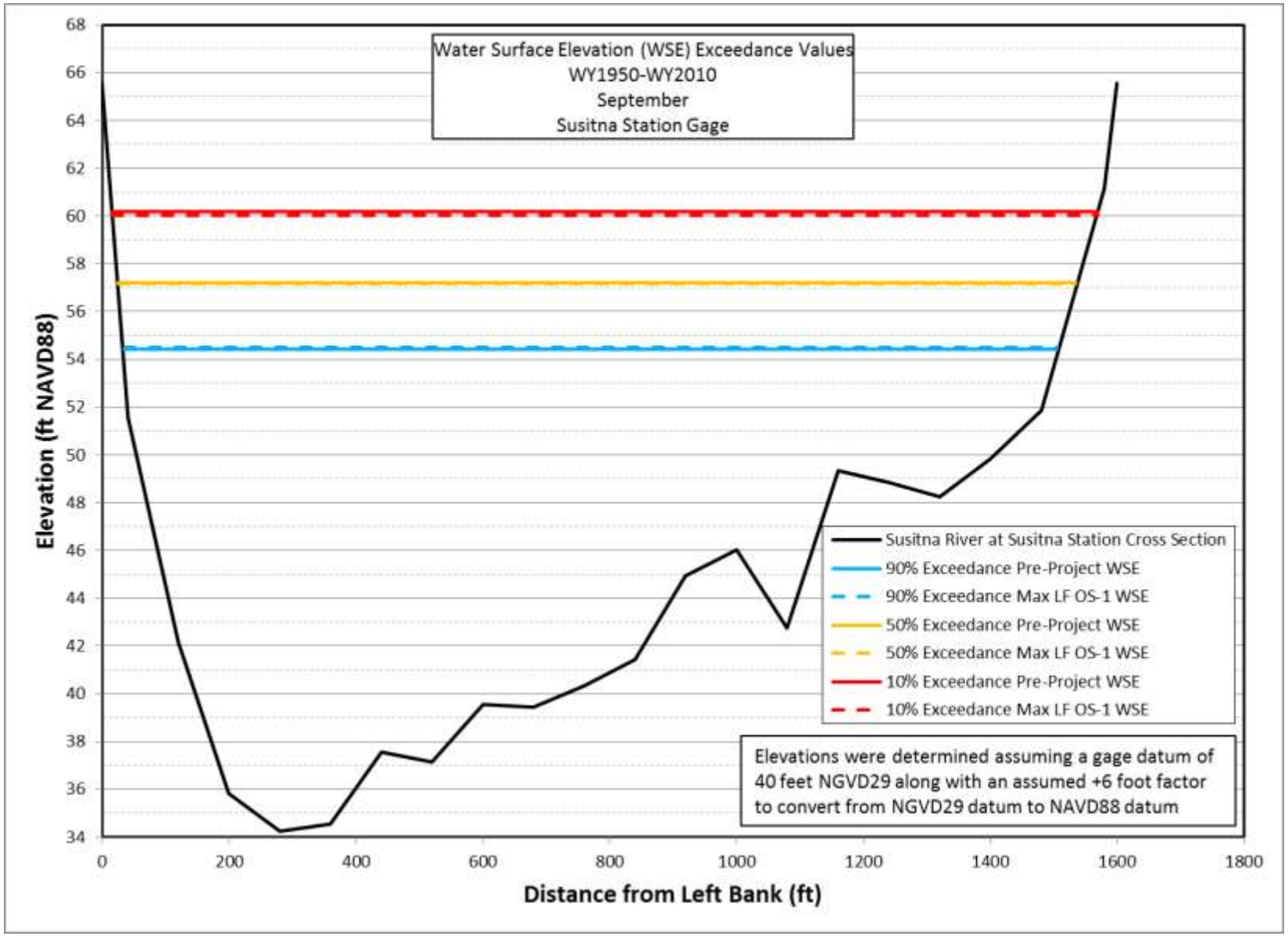

Figure K-26 – Select Water-surface Elevation Exceedence Values for September, pre-Project and Max LF OS-1 Conditions, Susitna Station Gage