Exhibit 8

Probabilities, Frequencies, and Risks to the South Fork Edisto Flow Regime

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Summary

Low-flow probabilities and statistics were derived for the South Fork Edisto using mean daily flow values from the Denmark streamflow gage scaled to the Walther withdrawal site. The Denmark streamflow gauge began collecting data in 1931 and this analysis includes the entire long-term record, although the gauge was not operational from 1972 to 1980.

A flow duration curve derived from the full mean daily discharge data set is presented for the overall probabilities of flow during the year. Monthly probabilities are also presented to show seasonal differences in low flows which may be more meaningful to the questions in this case. They show that flows drop below 200 cfs more than 30% of the time during the months June through October. Comparison of the monthly flow frequencies to safe yields reveals that the regulatory definition of safe yield as a volume leaving 20, 30, and 40% of long-term flows provides little protection to stream flow. Flows less than these safe yield values occur less than 2% of the time, so if safe yield is the only criteria used to limit registrations, most of the time agricultural users will have no restrictions on their use. Seven-day low flows (Q_{7D}) were also calculated for the withdrawal site. The mean annual minimum Q_{7D} for the entire period at the withdrawal sites is 145 cfs, although this average drops to 122 cfs for the period from 1980 to 2014.

As was shown in my earlier Affidavit (Exhibit 3), Exhibit 4 of this supplemental affidavit, and is shown by the frequency analysis in this exhibit, the early period of the streamflow record had higher mean flows, more runoff per unit rainfall, and less frequent low flows than the later period. Since the frequency analysis in this exhibit is based on the entire flow record, which overestimates flows, the flows are likely to inflated and the probabilities of low flows are likely to be underestimated. Further analysis should be conducted on the later period in isolation under the presumption that it is more representative of current conditions and risks of low flows.

Annual Flow-Duration Curve. Plotting flow probabilities against the corresponding discharges generates what hydrologists refer to as a *flow-duration curve*. Based on the entire flow record, including all months from 1931 to 2014, the frequencies of mean daily flows were computed, plotted against discharges, and scaled to show only the low probabilities of lower flows from 0 to 40% (Figure 8-1). This curve shows the percentages of time that flows have occurred on average for the period of record. For example, 10% of the time flows will yield less than 3000 million gallons per month. Percent time on this annual graph can be easily converted to the average

number of days per year by multiplying percentages by 365 days. For example, a flow that occurs 10% of the time in the annual analysis will occur 36.5 days per year on average and a flow that occurs 20% of the time will occur 73 days per year on average.

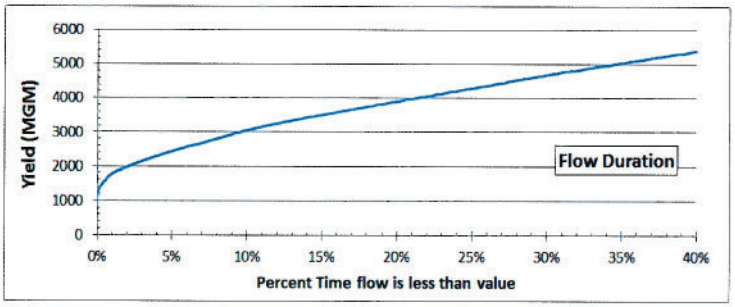

Figure 8-1. Plot of the lower end of the frequency range showing the percent time that a flow in the river at the withdrawal site will be less than the corresponding value. For example, 40% of the time flows will be less than 5377 MGM and 20% of the time flows will be less than 3900 MGM.

Much information is obscured by the use of annual averages, so calculating frequencies for individual months is very important. Monthly flow exceedance probabilities were computed from the mean daily discharge data. Exceedance probabilities are the likelihood that flows will be greater than a given value. For low-flow analysis it is often preferable to refer to the probability of flows that are less than a given discharge, because this better represents the risk. The probability of flows less than a given value are equal to one minus the exceedance probability; i.e., a flow with an 80% exceedance probability has a 20% probability that flows will be less. Percent time on the monthly frequency curves can be converted to the average number of days per month by multiplying percentages by the number of days in that month.

Probabilities on the monthly probability figures clearly show the seasonal difference in the likelihood of severe low flows (Figure 8-2). Winter months (blue colors January to April) plot high in the diagram indicating that flows during those months rarely drop below relatively high discharges. In contrast, the summer months cluster in the lower part of the graph indicating that very low flows are relatively common. For example, there is a 20% chance that flows will be less than 150 cfs in June through Oct, which is approximately equal to an average of 30 days per year. Similarly, flows drop below 200 cfs more than 30% of the time during the months June through October.

Another way to interpret the monthly flow duration curves is to show safe yields on the chart for comparison (Figure 8-3). Depending on the month, safe yields are defined as 80, 70, or 60% of the long-term mean annual daily flow (MADF), which corresponds to leaving 20% (74 cfs), 30% (112 cfs), or 40% (149 cfs) of MADF at the Walther site, respectively. Without the exercise of judgment, safe yields defined in this manner are entirely unprotected from agricultural withdrawals. Only 20%, 30%, or 40% of the MADF would be protected. The flow duration curves show that very little of the flow in the South Fork Edisto would be protected from withdrawals under a non-judgmental definition of safe yield.

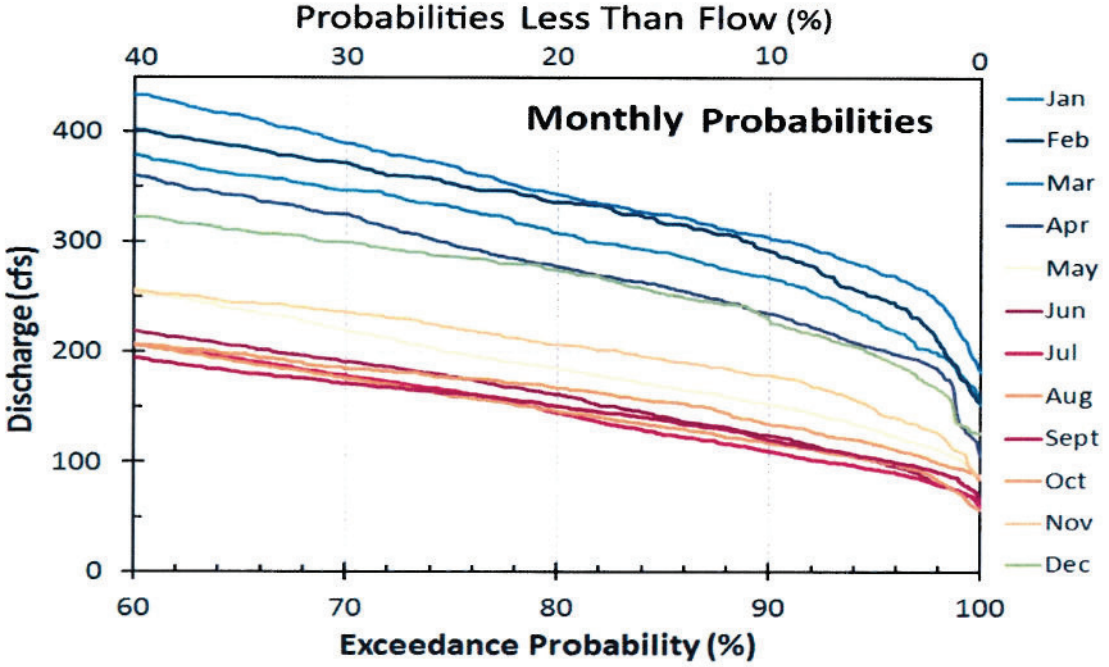

Figure 8-2. Monthly probabilities of low flows. Probabilities in summer months are similar and pose a much greater risk of flows being less than 200 cfs.

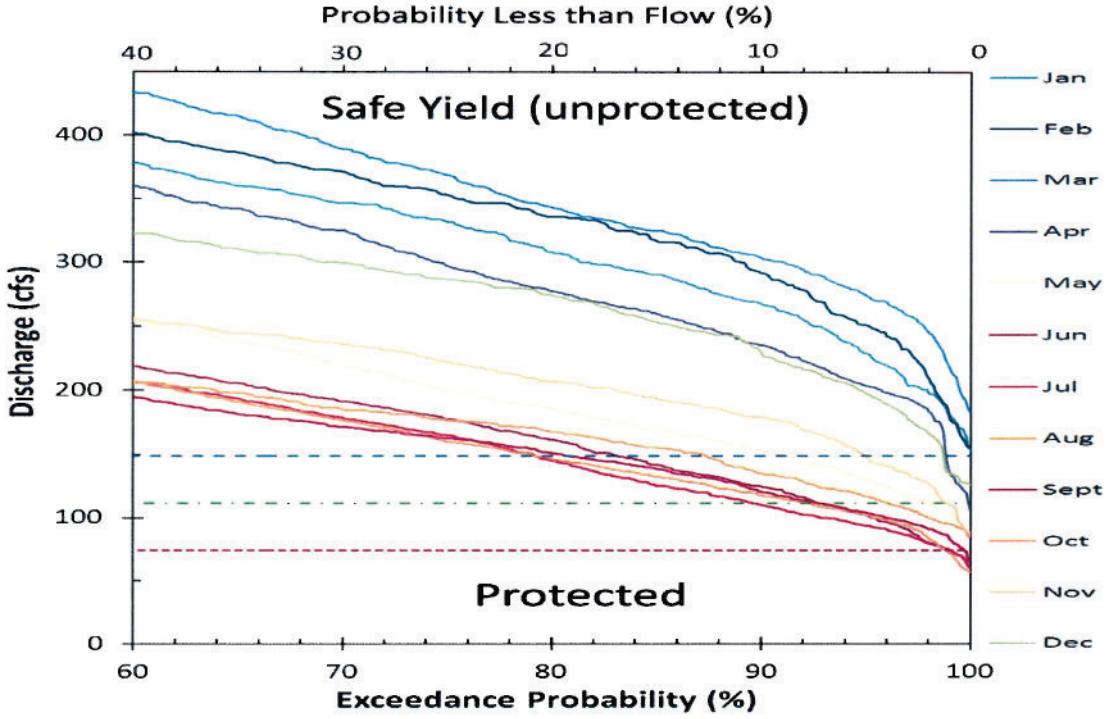

Figure 8-3. Safe yields compared to flow frequencies with safe yields.

Seven-Day Low Flows (Q_{7D}). The seven-day low flow (Q_{7D}) is a standard hydrologic measure of low-flow conditions from a continuous streamflow record. It records the lowest mean flow for seven consecutive days of each year and is commonly used in monitoring water quality, which relies heavily upon dilution. An analysis of low flows at the withdrawal site was based on mean daily flow records at the Denmark gauge for 1931-2014 (missing years 1972-1980). The Indicators of Hydrologic Alteration (*IHA*) hydrologic software package was used to compute annual minimum seven-day low flows (Q_{7D}) from the entire mean daily flow data set. The mean annual Q_{7D} for the entire period at the withdrawal site is 145 cfs; that is, in an average year there will be a period of seven consecutive days with low flows averaging 145 cfs. The time series of the minimum Q_{7D} low flow for each year reveals an increased frequency of low flows since 1980 and especially after 2000 (Figure 8-4). Prior to 1980, seven-day flows less than 100 cfs were relatively infrequent, but after 1980 seven-day periods averaging near or less than 100 cfs have been relatively frequent. The average Q_{7D} low flow since 1980 has been only 121.5 cfs. If the past three decades are representative of the current low-flow, as seems likely, an average year will have a week of flows averaging only 122 cfs.

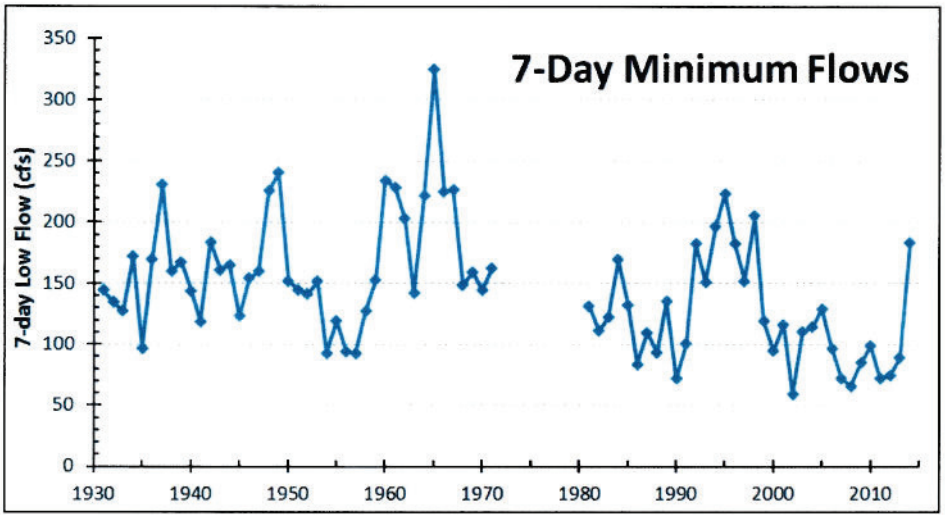

Figure 8-4. Seven-day low flows (Q_{7D}) at the Walther withdrawal site averaged 145 cfs from 1931 to 2014, but after 1980 they averaged only 122 cfs; that is, 23 cfs less. The frequency of seven-day low flows (Q_{7D}) has increased substantially since 1980.

To put this into perspective, the same time series plot of annual Q_{7D} values shown in Figure 8-4 was redrafted with lines indicating safe yields defined to leave 20% (890 cfs), 30% (1,336 cfs), and 40% (1,781 cfs) of long-term mean annual flows at the Walther site (Figure 8-5). This plot shows that even without the Walther Farm withdrawals, flows have been at or below the safe yield limit for at least a week in six of the years since 1990. Subtracting 47 cfs from the South

Fork Edisto River would increase the frequency of these extreme low flows and could have serious repercussions.

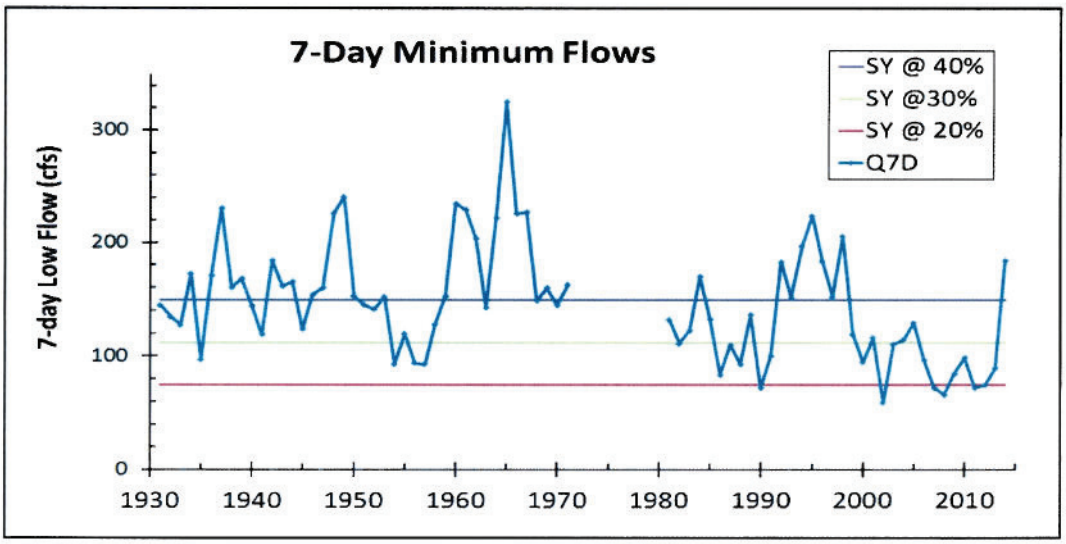

Figure 8-5. Seven-day low flows (Q_{7D}) at the Walther withdrawal site compared to safe yield values. In six of the years since 1990, flows were less than 20% of the long-term mean average flow indicating that withdrawal of the 80% safe yield would have resulted in flows dropping to zero cfs; i.e., the stream would have gone dry.

The probability and statistical analysis presented in this exhibit are based on the entire record of flow at the Denmark stream gage. It is important to keep in mind that the long-term record includes a much wetter period prior to 1990, so probabilities of low flows are underestimated by this analysis. Thus, this study should be considered preliminary to a more comprehensive study focused on the later period.