

Methodology to Classify Water Years

An online data management and reporting platform (ITAS) is being created for the Napa River Watershed to track and communicate progress of actions implemented in an effort to meet the goals of the Napa River sediment TMDL. Progress will be tracked using a series of metrics summarizing priority monitoring data obtained in the watershed over time. A collection of these metrics, including fish community, streambed scour, spawning gravel permeability, and road condition are anticipated to vary annually in response to rainfall and stream flow differences. Providing a climatic context for monitored years will assist future interpretation of the metric results and detection of trends above the variability associated with climatic differences. This memo summarizes the initial steps of classifying water year types (wet, average, dry) using available historic rainfall data from the watershed and recommending rainfall data and water year precipitation totals to classify water year types into the future.

Site Selection: In order to define the water year categories for the Napa River Watershed, a representative location that had a long-term dataset was necessary. The Napa State Hospital (NSH) gage is located in Napa, CA on the valley floor at an elevation of 35 ft (Figure 1), and provides the longest period of record for the Napa River Watershed (104 yrs). However, given the dramatic elevation ranges from the valley floor to the mountain ranges on the western and eastern watershed borders, the NSH data was compared with data from two other rain gages at higher elevations to ensure watershed wide precipitation patterns can be reasonably represented by the NSH dataset. The St. Helena 4WSW (SH4) station is in the northeast part of the county at an elevation of 1780 ft, and the Angwin (ANG) station is located in the north at an elevation of 1815 ft (see Figure 1). The Napa State Hospital (NSH) gage is operated by Napa County, while Angwin (ANG) and St. Helena (SH4) are operated by the Department of Water Resources (DWR). Data can be accessed through the Department of Water Resources California Data Exchanger (<http://cdec.water.ca.gov/selectQuery.html>) using the rain gage codes (NSH, ANG, and SH4, respectively).

Figure 2 presents the comparison of NSH dataset to the SH4 and ANG data. The daily precipitation data for SH4 and ANG had many missing records, and only years in which there were more than 355 days of data were used in this analysis. Fourteen (14) years of water year precipitation data from 1997-2005 and 2008-2011 are compared from the Napa State Hospital to the ANG and SH4 rain gages (see Figures 2a and 2c), and monthly data from NSH and SH4 are compared from 160 data points over the same time period (see Figure 2b). The coefficient of determination (R^2) values for SH4 showed low amounts of variance ($R^2 > 95\%$) for both monthly and annual data for a linear relationship. There was also a strong correlation between the ANG and Napa State Hospital ($R^2 > 90\%$). These results imply that the Napa State Hospital rain gage is a good indicator of relative precipitation throughout Napa Valley, and can be used as a representative location to classify water year types in the watershed. Note, relationships are not 1:1 and therefore, the precipitation totals will not be equal across all sites. The Napa State Hospital (NSH) gage cannot provide the actual the weather conditions experienced at a specific water quality monitoring location within the watershed. However, for purposes of providing the climatic context within which to interpret trends in the ITAS metrics over time, we believe the Napa State Hospital data can be used to represent the regional water year type.

Water Year Designations: A precipitation frequency analysis was conducted on 104 years of NSH precipitation data to determine the water year precipitation thresholds that define 5 water year types (very dry, dry, average, wet, and very wet). The water year type definitions were created using reasonable exceedance probabilities, ensuring the average precipitation totals were bracketed and the extreme (very wet and very dry) categories have less than a 10% probability of occurring (Table 1).

Table 1. Frequency analysis of Napa State Hospital precipitation gage using 104 year of data and classification of water year types based on recurrence interval (RI) breaks.

| Year Type | WY Precipitation (in/yr) | | WY Type Recurrence Interval (years) | Annual PPT Exceedance Probability (%) | n |
|---|--------------------------|---------------|-------------------------------------|---------------------------------------|----|
| | Lower (in/yr) | Upper (in/yr) | | | |
| Very Dry | | 13.8 | 11 | ≥ 91 | 9 |
| Dry | 13.8 | 19.7 | 4 | ≥ 67 | 26 |
| Average | 19.7 | 27.8 | 3 | ≥ 33 | 35 |
| Wet | 27.8 | 36.0 | 4 | ≥ 10 | 25 |
| Very Wet | 36.0 | | 11 | < 10 | 9 |
| Long-Term Average WY Precipitation = 24.3 in/yr | | | | | |
| Water Year Record = 1906 - 2012 *no water year data for 1981-1983 | | | | | |

Using the definitions from Table 1, Figure 3a displays time series of all the existing water year data between 1906 and 2012. Note that there are three missing years of data for WY 1981-1983. Figure 3b shows the probability that the total precipitation for the water year will be exceeded and recurrence intervals for each water year type. Assuming ITAS will be populated with some past data, Table 2 summarizes the total water year precipitation and water year type over the past 5 years.

Table 2. Water year types for WY08-12 based on frequency analysis, WY definitions (see Table 1) and total WY precipitation at Napa State Hospital gage.

| Metric | WY08 | WY09 | WY10 | WY11 | WY12 |
|---|---------|---------|------|------|---------|
| Napa State Hospital WY precipitation (in) | 20.8 | 21.3 | 28.9 | 35.0 | 21.0 |
| Water Year Type | Average | Average | Wet | Wet | Average |