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APPENDIX A: METHODS FOR CALCULATING UNIMPAIRED FLOWS FOR INDIAN CREEK

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1 OBJECTIVE

The objective of this analysis is to develop a hydrograph depicting “unimpaired” flow for Indian Creek, a major tributary to the Navarro River (approximate watershed area 40 mi²), in Mendocino County.

2 DATA SOURCES

We have several sources of data that could be relevant for this analysis:

1. USGS streamflow data from the Navarro River, downstream of the confluence with the North Fork Navarro (approximate watershed area 300 square miles)
2. Full data set of eWRIMS diversions from the Navarro River drainage network
3. Recent streamflow data from the Navarro River and tributaries, including Indian Creek and the Navarro River below Indian Creek (beginning summer 2013)
4. Full data set of human water needs, refined to a daily scale, for the Navarro River and selected tributaries (including Indian Creek). To develop the dataset, we carefully examined aerial imagery of the entire Navarro River watershed in a GIS and identified all human development features as shapefiles. This included each building structure (identified as a residence, residential storage/garage, agricultural storage, greenhouse, winery, school, or other commercial facility) and agricultural field (identified as orchard, vineyard, marijuana, or other crop), throughout the Navarro River watershed. Each identified feature was assigned a water use value based on reported sources of water use (e.g., 350 gallons per day per residence through summer, 0.2 acre-ft per acre for vineyards through the irrigation season) and upstream estimates of water needed for each type were summed at a handful of reference locations in the Navarro watershed. This data set also considers seasonal water use variations. For example, residential water uses are highest in the summer when water is needed for irrigation, and lowest in the winter.

3 METHODS

We used Data Sets 1 and 4 to create unimpaired flow conditions for Indian Creek. This was partly because of limitations of the other two data sets: water rights records (Data Set 2) do not accurately characterize the number of water users or the volume of water used; and streamflow in Indian Creek (Data Set 3) had a short period of record. To estimate unimpaired flows in the Navarro River watershed, we first obtained daily average discharge records measured at the USGS Navarro River (USGS 11468000) gage (Data Set 1) for a recent wet year (WY 2003), normal year (WY 2010) and dry year (WY 2012). We consider these streamflow records to be impaired flow datasets because they reflect flow conditions after human diversions under a recent diversion regime likely to match our estimates of upstream water needs. Using these datasets, we increased daily discharge values by the daily amount of water used for human purposes (Data Set 4). The resulting hydrograph represents our estimated unimpaired flows for the Navarro River watershed at the USGS streamflow gage in WY2003, WY2010 and WY2012 (wet year, normal year and dry year, respectively).

To estimate daily average unimpaired discharge in the Indian Creek watershed, we used a simple drainage basin area-ratio transfer based on our calculated unimpaired flow dataset for the Navarro River. This method for modeling streamflow was chosen because of its clarity and simplicity to calculate, as well as for its regulatory application. This is the method recommended by the State Water Board for scaling discharge from USGS gages to points of diversion or points of analysis in water rights applications. The resulting daily average discharge represents the estimated unimpaired flows in Indian Creek, and reflects streamflow without diversions for human water uses.