Appendix 4: Recommendations for Nutrient Monitoring in the Sacramento-San Joaquin Delta, Suisun Bay, and North San Francisco Bay

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Over the course of this project, several overarching data needs and opportunities for monitoring program adjustments emerged. The following recommendations are based primarily on observations from the nutrient data analysis that was described in Appendix 2, and were additionally shaped by the results and conclusions from the mass balance analysis (Appendix 3) and the review of the isotope data (Appendix 5). These recommendations are not intended to be exhaustive, but rather an initial set of observations upon which further work might build. Additional targeted data analysis may be required to answer specific questions related to trends in water quality, or to determine the necessary spatial and temporal resolution of future data collection to inform nutrient-related management decisions in the Delta, both of which were beyond the objectives of the current study.

1. Add discrete monitoring of nutrients and chlorophyll-a at key locations for calculating mass balances and transformations and tracking status and trends in all subregions of the Delta.

Additional stations are needed to evaluate general conditions and trends in regions of the Delta that do not currently receive sufficiently-regular monitoring. Given the large amount of variability, additional stations will also increase the power for detecting significant larger-scale and longer-term trends. Potential sites to consider include:

- Cache Slough/Yolo Bypass Complex: Additional monitoring in this region is needed to monitor loads of nutrients through the Complex and transformations within the Complex. In the current mass balance, loads from the Yolo Bypass are calculated based on concentrations at C3 (Sacramento River at Hood), which may not be representative of the Yolo Bypass. The available data indicate that the Complex is an important area for nutrient transformations. Additional stations are recommended inside the Cache Slough Complex (e.g., Liberty Island), and in the tributaries to Cache Slough (e.g., Deep Water Ship Channel, Toe Drain). USGS currently maintains high-frequency monitoring stations at or near some of these locations, which may address some of these data needs
- Sacramento River at Isleton: Isleton is a suitable site for providing temporal data on the total flow of the Sacramento River. Chemical and isotopic data from Isleton can be used as a substitute for the temporal and spatial variation in waters flowing down Miner and Steamboat Sloughs into the Cache Slough/Yolo Bypass Complex. Data from Isleton can be reliably used, combined with data from Rio Vista (or an adjacent site), to estimate transformations of nutrients in Cache Slough. Nutrient measurements at Rio Vista can be obtained from station S657 which is monitored by the USGS Polaris cruises.
- South Delta: No monitoring is currently conducted in the DSM2 South Delta region. It is recommended that stations be added in the Old River and Middle river to fill this data gap. In addition, monitoring for NH3 should be added to the station in Clifton Court Forebay (MWQI does monthly sampling for NO3 and Chl-a already).
- Eastside Tributaries: There is currently limited data for estimating mass loads from Eastside tributaries. Initial calculations suggest these loads are small at the whole Delta scale. However, their local importance is difficult to assess. To improve mass balances

for nutrients in the Delta, especially at the regional/sub-regional scale, stations could be added in the Eastside tributaries (Calaveras, Cosumnes, and Mokelumne Rivers).

- San Joaquin River: In order to better understand nitrogen dynamics in Stockton Deep Water Ship Channel additional monitoring stations should be added both between Mossdale and the effluent discharge and in the upper Channel below the discharge point. It may be possible to use existing stations monitored by the City of Stockton and the City of Tracy to fill this gap.
- San Pablo Bay: The USGS Polaris cruises currently monitor total and dissolved nutrients at station S13 (middle of San Pablo Bay) and dissolved nutrients at stations S9 (at Martinez) and S15 (Pt. San Pablo). In order to provide complete information on fluxes into and out of San Pablo Bay, total nutrients should be monitored at stations S9 and S15. Although San Pablo Bay is not within the Delta, during certain times of the year conditions within San Pablo Bay are strongly influenced by flows and nutrient inputs from the Delta.

2. Consider reducing the number of stations monitoring monthly for nutrients in Suisun Bay.

Ideally, any new nutrient-related monitoring in the Delta would augment the current program. However, funding constraints for monitoring are a likely reality. If monitoring at some stations needs to be curtailed to support adding stations elsewhere, stations D6, D7, or D8 could be considered as reasonable candidates. Data analysis indicated that nutrient concentrations at D6, D7, and D8 in Suisun Bay followed very similar patterns.

At the same time, any cuts to the current DWR-EMP network need to be carefully considered. Such consideration should include the detailed comparison of stations for all of the regularly-sampled biological, chemical, and physical parameters. All three of these stations have been sampled monthly for the past ~40 years and represent important records of ecological condition. In addition, Suisun Marsh is not currently monitored for nutrients and stations in Montezuma Slough and Suisun Slough may be needed in the future, as the TMDL for nutrient and DO proceeds. Lastly, D7 is a relatively shallow site, and conditions there have differed substantially from other sites in Suisun Bay (e.g., chlorophyll-a pre-1987). Therefore, this is not presented as a true recommendation, but rather, pragmatically, as a possible least-bad option should cost-savings become necessary.

3. Expand the network of continuous monitoring stations for nutrients and ancillary parameters to capture system variability and calculate loads more accurately.

While sensor data was not the focus of this report, the review of the discrete samples in this report highlighted the need for more stations with continuous monitoring sensors for water temperature, flow, and nutrient parameters. System variability in flows and temperature are key drivers in

controlling nutrient variability and primary productivity. If information on these factors is lacking interpretation of discrete sample monitoring data can be limited. Moreover, continuous measurements of flow at key locations would improve loading and mass balance calculations. There is already an existing network of continuous monitoring sensors in the Delta. In January 2016, the USGS will complete a synthesis report of existing nutrient sensor data in the Delta. The USGS report will have specific recommendations for expanding the network of moored sensors.

4. Include measurement of isotopic composition of nitrate at key locations in the Delta.

Nitrate derived from the San Joaquin River has a very distinct isotopic composition compared to nitrate derived from the Sacramento River. Studies designed to examine nutrient sources and movement through the Delta would greatly benefit from making isotopic measurements in addition to concentration measurements. The collection of suitable isotope samples could be added at IEP monitoring sites. For isotope samples, 2-3 additional liters of water need to be collected. The samples could be archived for future isotope analysis.

5. Monitoring program designs should be informed by data needs for water quality models of the Delta.

In 2015, the Central Valley Regional Water Quality Control Board convened a Modeling Science Workgroup, which was tasked with advising on the development and use of water quality models as one component of the Delta Nutrient Research Plan. One of the recommendations of this Workgroup was to better integrate modeling and monitoring. The interaction between modeling and monitoring should be reciprocal, with the monitoring program highlighting priority data gaps to be refined through monitoring (locations, frequency, parameters), and the monitoring programs providing field measurements in the Delta to further ground truth the models.

This current report represents a small first step toward integrating monitoring and modeling. Results from the DSM2 model were combined with EMP monitoring data to calculate mass balances. Some of the recommendations for enhanced monitoring were based on input data needed for DSM2. As more sophisticated water quality models for the Delta are developed, this type of integration between monitoring and modeling should continue.

6. General Recommendations

6.a Include the measurement of NO2 concentrations. Although often a minor form of N in natural systems, NO2 nonetheless provides valuable information about sites of active nitrification and the seasonality of nitrification, and the lack of such data at most sites and dates took away important complementary data that would have aided interpretation.

6.b Coordinate efforts with the USGS to use the nutrient data from adjacent USGS sites as part of the IEP monitoring program. The USGS Bay Water Quality program already has sites in many of the locations where new sites (or reactivation of old sites or different measurements at existing sites) are recommended. The USGS has been monitoring these sites approximately monthly since the 1970s, although some of these sites are not as intensively monitored currently because of limited funding.