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MEMORANDUM

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Subject:	Laguna de Santa Rosa Monitoring Recommendations (Revised)
Project Number:	100-IWM-T39645

Task 7: Develop Monitoring Recommendations to Support Adaptive Management

The Contractor shall develop monitoring recommendations to complete the development and move into implementation of the Laguna de Santa Rosa TMDLs. Two types of monitoring recommendations will be needed. First, monitoring recommendations must address needs for additional data to fill critical information gaps and to support future updates to existing analyses, including those completed under Tasks 2 through 6. These recommendations may include traditional monitoring of flow and pollutants along with special studies to answer specific science questions. The second type of monitoring recommendations must be designed to track and account for the benefits of future implementation actions and provide a basis for future water quality credit trading. The second set of monitoring recommendations will likely focus on surrogate measures of pollutant loads combined with measures that can indicate the state of health of the waterbody. The Contractor shall submit all recommendations to the Water Boards Contract Manager in an internal (deliberative) memorandum.

This memorandum on monitoring recommendations for the Laguna de Santa Rosa is developed consistent with the requirements of Task 7 of the contract, described above. The recommendations are based on technical analyses and anticipated potential needs for future adaptive management. The recommendations do not take cost or funding sources into account except insofar as the suggested items are believed to be reasonable and appropriate, given our experience with other regional TMDLs. In addition, there are several pending decisions that may affect monitoring needs and introduce uncertainty into these recommendations. Most importantly, the ultimate form of the TMDL or TMDL alternative and associated requirements of the accompanying Implementation Plan have not yet been determined. In addition, it is not yet clear whether certain components of the monitoring and associated data management will be integrated into the Russian River Regional Monitoring Program or pursued independently.

1.0 Information Gaps and Future Updates

It is anticipated that, regardless of the exact regulatory framework, reconciliation of beneficial uses in the Laguna will require continuing adaptive management. Work to date has established a strong technical basis for a conceptual model of impairments in the Laguna related to sediments and nutrients; however, there is also inevitable uncertainty in these estimates as well as topics where additional information is needed. The TMDL implementation plan for the Laguna will need to be a living document that is periodically adjusted and updated as more information is obtained. To do this effectively it will be important to maintain a regular program of monitoring that can track conditions over time as well as detect changes in conditions and responses. At the same time, special studies are needed to improve understanding and reduce uncertainty in specific aspects of the sediment and nutrient mass balances and responses in the Laguna.

1.1 Standard Monitoring

To date, data collection in the Laguna has been somewhat sporadic due to funding availability and the absence of an established monitoring framework. Development of a standard monitoring program that can be maintained over the long term will be important to the success of restoration for the Laguna.

1.1.1 FLOW GAGING

Sediment transport capacity in streams is directly linked to streamflow velocity (not just total flow volume), and time series of daily or sub-daily flow measurements are needed for computing sediment loads and associated nutrient loads in the Laguna watershed. USGS in cooperation with SCWA currently operates three gages along the Laguna mainstem (11465750 Laguna de Santa Rosa nr Sebastopol, 11466800 Mark West Cr. nr Mirabel Heights, and 11465680 Laguna de Santa Rosa at Stony Creek Rd.) plus tributary gages on Santa Rosa Creek (11466320 Santa Rosa Cr. at Willowside Rd.), Copeland Creek (11465660 Copeland Cr. at Rohnert Park), and Colgan Creek (11465690 Colgan Cr. near Santa Rosa and 11465700 Colgan Cr. near Sebastopol). It is important to continue to operate and maintain these flow stations. The long-term record so developed will be helpful for understanding the past variations in annual, seasonal, and peak flows, and in tracking future changes on account of climate change.

Additional flow gaging stations are not recommended at this time, and it is important that resources be devoted to water chemistry monitoring, described below.

1.1.2 WATER CHEMISTRY

Sampling for nutrients in the Laguna dates back to the 1970s, but has not been performed continuously. As a result of the 1995 Waste Reduction Strategy, regular sampling was established at five compliance stations (Laguna at Stony Point Road (LSP), Laguna at Occidental Road (LOR), Laguna at Guerneville Road (LGR), and Mark West Creek at Trenton-Healdsburg Road (LTH), as well as a station on Santa Rosa Creek at Willowside Road (SRCWR)). Except for LGR these stations are approximately collocated with USGS gages that report flow. Regular sampling by Water Board staff continued through 2001, then was revisited in 2008 and 2013. The City of Santa Rosa collected additional samples at essentially the same locations in 2016-2017. Scattered additional samples also appear in CEDEN; however, the bulk of more recent samples have included only limited numbers at fixed locations.

To track progress over time it is important to collect samples at fixed locations on a regular basis. The water chemistry monitoring should be reinstated on a regular basis (at least monthly, every year) at the historic compliance stations. Samples should be analyzed for nitrogen species (ammonia, nitrite + nitrate, TKN), phosphorus species (total P and orthophosphate), total suspended solids, 5-day biochemical oxygen demand (BOD5), total organic carbon, and chlorophyll *a*, together with field measurements of dissolved oxygen (DO), temperature, and turbidity.

DO is a key impairment in the Laguna; however, instantaneous grab measurements of DO are of minimal use due to diel cycles caused by plant growth and respiration along with water temperature changes that affect DO saturation concentrations. Continuous measurements of DO with sondes are necessary if useful DO data is to be collected. While the sondes are relatively expensive and require a certain amount of labor for maintenance, they are becoming more dependable and are commonplace in many DO-impaired waters in the region. Although a long-term record is preferable, particularly over the summer months, if costs are a constraint, a possible compromise would be to undertake monitoring for a two-week late summer period at a critical location such as Lake Jonive. This could be done annually or every second year to establish a long-term record of DO fluctuations in the Laguna as well as to support potential future DO response modeling.

1.1.3 *LUDWIGIA* COVERAGE

The invasive macrophyte *Ludwigia* plays a key role in the impairment of the Laguna by slowing flow and enhancing sedimentation, reducing reaeration capacity, creating detrital organic matter that depletes dissolved oxygen, and pumping nutrients from sediment back into the water column. Despite its fundamental role in water quality and habitat degradation, there has been no consistent effort to map the extent of *Ludwigia* coverage or its changes over time. This has likely been due in part to the costs and level of effort associated with manual surveys; however, the advent of low-cost drone technology may change this. Drone-based aerial photography during the *Ludwigia* bloom season should be able to rapidly identify areas and density of coverage.

The Sonoma State University Center for Environmental Inquiry is already using a drone to collect aerial images of *Ludwigia* coverage at channel restoration sites in the Laguna near Stony Point Road (http://cei.sonoma.edu/projects/search/modifying-stream-channels-control-invasive-species) and the Prequalified Practice Standards for Channel Restoration under the existing Water Quality Trading Framework specify “low elevation aerial photographs collected by a drone will be used to annually verify the area of *Ludwigia* contributing to internal loading. A series of overlapping aerial photographs collected by the drone will be processed into a single high-resolution, distortion-free orthophotograph from which it is possible to distinguish and map *Ludwigia*, riparian vegetation, bank vegetation, and open water.” (https://www.waterboards.ca.gov/northcoast/water_issues/programs/nutrient_offset_program/pdf/2020/WQTF_PQP_SedRemove_RipRestore.pdf.) It seems likely that automated image processing methods could be trained to estimate coverage.

Drone-based surveys for *Ludwigia* could be extended to the whole length of the Laguna. If such surveys were conducted annually or biannually, they would provide a long-term record to help evaluate success in restoring the Laguna. While it may be necessary to ground truth some areas, such as those partially obscured by canopy cover, the use of drone technology would greatly reduce the labor costs associated with surveys of *Ludwigia* extent.

1.1.4 BIOTIC INTEGRITY

The State's emerging strategy for addressing biostimulatory substances is strongly tied to estimates of biointegrity using the California Stream Condition Index (CSCI; for benthic macroinvertebrates) and Algal Stream Condition Index (ASCI). Quantitative data on benthic macroinvertebrates and benthic algae are largely lacking for the Laguna and its tributaries. A program should be established to build up a database of such information and track it over time. Thresholds in the CSCI and ASCI indices may not be fully applicable to the Laguna due to its unique characteristics and position on the borderline between lentic and lotic systems; however, relative trends could be informative. The indices and their thresholds should be fully applicable to tributary streams in the Laguna watershed.

1.1.5 SEDIMENTATION RATES AND SEDIMENT QUALITY

Retention of sediment and associated nutrients within the Laguna and its floodplain is an important component of the overall mass balance but difficult to measure. To improve this situation a series of fixed transects (with permanent monuments) could be established and resurveyed periodically. Additionally, sediment cores may be collected at key locations within the Laguna to estimate the rates of sediment accretion over time. Sediment quality, including metrics such as total phosphorus and sediment oxygen demand, may be collected at a limited frequency, such as every 5 years. Depending on funding availability, this sample collection may be done over 4-10 locations across the Laguna. These data will help to better quantify the storage and overall mass balance of sediments and phosphorus within the Laguna.

1.2 SPECIAL STUDIES

1.2.1 WATERSHED MODEL CALIBRATION SUPPORT

The existing sediment and nutrient mass balance estimates rely to a large extent on the Land Cover Loading Model (LCLM) developed by Water Board staff. While this tool has proved to be robust, it is based on a limited amount of data collection for dry and wet weather concentrations for different land use types and is not incorporated into a full watershed model.

Current proposals suggest the need for a rainfall-runoff and pollutant loading model of the entire Laguna watershed. The value of such a model increases with the amount of information incorporated into the calibration, especially in regard to differential runoff and loading amounts from different land use types. Data collected for the LCLM will be useful for the calibration of such a model; however, additional data collection over a longer period of time is recommended. A detailed plan for such a special study could begin from the monitoring plan developed for the LCLM. However, additional sites may be needed to develop estimates for significant land use types not included in the earlier sampling. In addition, the specification and identification of land uses should be made consistent with the most recent land use analysis produced by the Sonoma VegMap program.

1.2.2 TURBIDITY – TSS/SSC CORRELATION

The Laguna and tributaries have a shortage of monitoring for total suspended solids (TSS) or suspended solids concentration (SSC), which complicates estimation of sediment loads. Of the two methods, SSC (which involves filtering and measuring solids after volatilization from a whole volume of water) has better accuracy and less tendency to bias than the more common TSS (which filters and measures solid weight

on a subsample drawn by pipette). At many sites it is possible to establish a good correlation between turbidity (a measure of light scattering) and SSC or TSS. Turbidity is readily measured by recording sondes or field test equipment. Therefore, establishing a strong correlation between turbidity and SSC provides a means for inexpensive long-term estimates of SSC concentrations. This issue was explored in the sediment linkage analysis, where it was found that, while both turbidity and SSC or TSS measurements have been taken, only a small subsample of data contain paired measurements. Development of site-specific correlations between turbidity and SSC (as was done for Sonoma Creek) would provide a means for inexpensive, and potentially continuous, monitoring of solids loads at USGS gages.

1.2.3 SEDIMENT NUTRIENT CHARACTERIZATION

The conceptual model of nutrient cycling in the Laguna holds that the sediments contain a substantial store of phosphorus (due to past discharges from WWTPs, dairies, and other land uses), which is supported by somewhat limited sampling of sediment phosphorus concentrations. Some of the most extensive sampling of nutrients in sediment has been undertaken in support of the generation of credits for sediment removal under the current Water Quality Trading Framework; however, as of this writing, there is limited characterization for many portions of the Laguna and systematic sampling to establish trends over time is recommended. In addition, Regional Board staff have recently been made aware of the potential for an extensive and relevant dataset from Sonoma Water. It is recommended that the Regional Board staff follow up on this and work with Sonoma Water to incorporate the monitoring that produces these data into the Regional Board's adaptive management program.

1.2.4 PHYSICAL CONTROLS ON *LUDWIGIA* DOMINANCE

What are the best strategies for addressing the adverse effects of *Ludwigia* infestation? Although high nutrient levels may have facilitated invasion, it is clear that reducing nutrient loads will not by itself eliminate *Ludwigia*. Persistence of established *Ludwigia* populations is driven by hydrologic and geomorphic conditions. Better understanding of these physical controls is a prerequisite to successful restoration and improved assimilative capacity. The Laguna Foundation and the USDA have preliminary efforts currently underway to investigate these controls on *Ludwigia* growth that could lead to important insights on optimal management strategies. These efforts are in need of further funding.

2.0 TRACK AND ACCOUNT BENEFITS OF FUTURE IMPLEMENTATION

TMDLs for the Laguna de Santa Rosa are being developed for sediment and phosphorus. The proposed reductions in sediment and phosphorus loads are, however, intermediate steps toward the ultimate goal of maximizing support of beneficial uses including aquatic life, wildlife habitat, and recreation. Achieving these uses will require limiting low DO events, restoring more natural hydrology and habitat, suppressing excess growth of *Ludwigia*, and preventing nuisance blooms of planktonic algae. From a broad-based perspective, trends revealed by the monitoring program described in Section 1.1 will provide the best indication of progress toward achieving ultimate management goals.

In the interim, other methods are needed to track and account benefits of individual implementation actions. It is important that such tracking be set up and maintained from an early stage to evaluate progress even before results are seen in the responses described above. Benefits at the site or project

scale also need to be tracked to separate the effects of implementation from other evolving stressors, such as climate and land use changes.

For tracking and accounting, a surrogate approach has been proposed. The surrogate is the excess runoff from anthropogenic land uses relative to natural conditions from the 1-year, 24-hour storm. Controlling this excess runoff will help move the watershed back toward natural conditions by reducing upland loads of sediment and nutrients and limiting degradation of stream channels. The surrogate measure will also help provide a basis for trading that can encourage support for instream restoration projects. However, like most surrogates, it is an indicator to track progress within an adaptive management approach and not an absolute measure of what needs to be achieved.

It is recommended that the Board (1) sponsor a watershed-wide analysis of curve number-based runoff from the 1-year, 24-hour event, and (2) establish a tracking system to track changes in curve number, stormwater control measures, and estimated runoff from the 1-year, 24-hour event, as described below in Section 2.2.1. The surrogate is not intended to be directly monitored at all sites. However, some site-scale monitoring to validate literature-based curve number choices and, in particular, to describe appropriate changes in curve numbers to account for various onsite stormwater control measures would be useful.

2.1 Standard Monitoring

The standard monitoring program described in Section 1.1 is also largely applicable to tracking and accounting benefits of implementation. To optimize the value for this purpose it will be important to maintain a geographic coverage and database of the extent to which stormwater control measures are implemented. Standardized reporting and data sharing could be specified for land uses where the Board has appropriate regulatory authority.

2.2 Special Studies

2.2.1 ESTABLISHING THE SURROGATE MEASURE BASELINE

The surrogate measures proposal lays out a calculation approach to establish the excess storm flow associated with anthropogenic land uses. The approach combines estimates of runoff from the 1-year 24-hour storm using TR-55 (a curve number-based approach) with spatial coverages of current and natural (pre-European settlement) vegetation and land use. It is anticipated that initial GIS-based analyses will be undertaken to estimate the amount and distribution of the surrogate measure across the landscape.

These initial estimates will be somewhat subjective as they depend on the selection of a curve number (which in turn depends on estimates of the directly connected fraction of impervious area), initial abstractions (often fixed at 0.2 in TR-55 applications), and adjustments to account for existing management activities such as rain barrels or bioretention areas. Special studies could be pursued to further refine the method and associated baseline estimates by monitoring of surface runoff from larger storms at the individual lot or neighborhood level. These could include detailed mapping of runoff connectivity. Over time, these studies (which could be done in conjunction with the studies described in Section 1.2.1) could be used to address the following topics:

- What are appropriate local relationships between total and connected impervious area? Various literature equations exist, but there are typically significant regional differences and developing a local equation would be valuable.

- Optimize curve number (and initial abstraction) estimates. Tables of curve numbers are widely available as a function of land use, cover condition, and connected imperviousness. However, these estimates are subjective without local calibration.
- Verify runoff reduction estimates associated with specific designs of stormwater control measures.

2.2.2 LINKING SEDIMENT AND PHOSPHORUS

The nutrient linkage analysis demonstrated that total phosphorus loads calculated based on sediment potency (phosphorus mass per sediment mass) were similar to total phosphorus loads calculated from the Land Cover Loading Model. Further, phosphorus loading from diffuse sources occurs primarily in sediment-associated forms. The surrogate approach implicitly assumes that the relationship between sediment and phosphorus (i.e., the phosphorus potency) is approximately stable and consistent in surface runoff. However, the phosphorus:sediment ratio is likely to vary with geology and may be elevated for certain land uses (e.g., dairies, vineyards). Obtaining additional information on this topic will be useful for future adaptive management. Some information on this topic for individual land uses will likely be obtained as part of item 1.2.1. A cost-effective way to evaluate potency on broader spatial/geographic scales might be to analyze samples associated with SCWA sediment removal activities from the floodways.