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MEMORANDUM

To:	Emily Cira, Kelsey Cody, Lisa Bernard	**Date:**	03/09/2021
Cc:	Aileen Molloy	**Subject:**	Laguna de Santa Rosa, Task 1.2
From:	Jon Butcher	**Project Number:**	100-WTR-T94508.2-13

Task 1.2 is "Document Restoration Plan Opportunities for Crediting." This task in general is to "review the restoration concepts and project types identified in the Laguna de Santa Rosa Master Restoration Plan and propose opportunities where credits can be quantified relative to the nutrient and sediment TMDLs." The deliverable memorandum should describe "how restoration priorities identified in the Vision Plan and Sonoma Water 2012 may be used to establish quantitative measures of change in assimilative capacity for sediment, phosphorus, nitrogen, indicators, and surrogate measures in the proposed TMDLs for the Laguna", accompanied by GIS-based mapping of engineered and ecologically based restoration opportunities.

The task has a fairly limited budget and short schedule, so it is important to be judicious in choosing which components to focus on. It is also important to recognize what work has already been accomplished by others and not unnecessarily duplicate efforts. Finally, it is important to note that the SFEI Master Restoration Plan – which will include information on prioritization, ranking, and sequencing of restoration opportunities – has not yet been released even in internal review draft form, and so is not timely for supporting this task. However, the SFEI Restoration Vision[1] has been finalized and provides the general concepts that will inform the final Restoration Plan.

[1] San Francisco Estuary Institute-Aquatic Science Center. 2020. Restoration Vision for the Laguna de Santa Rosa. An SFEI-ASC Resilient Landscapes Program report developed in cooperation with Sonoma Water, the Laguna de Santa Rosa Foundation, a Technical Advisory Committee, and a Management Advisory Committee. Publication # 983. San Francisco Estuary Institute-Aquatic Science Center, Richmond, CA.

The SFEI Restoration Vision and forthcoming Restoration Plan are focused on work within the 100-year floodplain of the Laguna de Santa Rosa and is not focused on identifying opportunities within the larger watershed. It also has a primary focus on wetland and aquatic habitat restoration opportunities, not all of which are directly associated with increasing assimilative capacity for sediment and nutrients. However, SFEI has recognized that the success of floodplain restoration activities will be affected by the state of and pollutant loading from the upstream watershed and provides a discussion of watershed-scale management needs for supporting the Vision. The Task Order also cites the work done for Sonoma County Water Agency (SCWA) in 2012 by Winzler & Kelly – GHD[2]. Like the SFEI Vision, this work had a multi-objective focus, but is primarily aimed at opportunities to increase flood protection by identifying and encouraging groundwater recharge projects. Unlike the SFEI work, this study addresses only areas outside the 100-year floodplain. Both the SFEI and SCWA reports cite a variety of associated studies on specific aspects.

The Vision discussion of watershed-scale management addresses the following concepts (numbered here for ease of reference):

Table 1. Watershed-Scale Management Components in the Laguna Vision Document

1. Flow Management and Groundwater Recharge
    - 1.1. Intercept precipitation for moderate events with less than a 5-year recurrence
        - 1.1.1. Enhance native woody vegetation in undeveloped areas
        - 1.1.2. Implement low-impact design and green infrastructure (LID/GI) practices in developed areas.
    - 1.2. Capture, Store, and Recharge Flood Flows
        - 1.2.1. Develop groundwater recharge opportunities in less developed areas with high recharge capacity, following the recommendations in Winzler & Kelly – GHD.
        - 1.2.2. Increase channel-floodplain connectivity and maintain/enhance floodplain depressional wetlands.
2. Sediment Management
    - 2.1. Sediment Source Control
        - 2.1.1. Reestablish vegetation on eroding slopes and steep headwater channel banks
        - 2.1.2. Increase vegetative cover on uplands
        - 2.1.3. Stabilize eroding channels using bank setbacks, large woody debris, etc.
    - 2.2. Sediment Capture and Storage
        - 2.2.1. [Mostly congruent with flow capture and storage under 1.1. and 1.2]
        - 2.2.2. Direct removal of excess sediment from channels on the Santa Rosa Plain
3. Nutrient Management
    - 3.1. Nutrient Source Control
        - 3.1.1. Reduce upland erosion using techniques described for sediment in 2.1.
        - 3.1.2. Address loads from onsite wastewater system
        - 3.1.3. Support urban and agricultural nutrient best management practices (BMPs).
    - 3.2. Interception of Nutrient Loads

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[2] Winzler & Kelly – GHD. 2012. Laguna ‐ Mark West Creek Watershed Planning Scoping Study, Screening Technical Memorandum. Prepared for Sonoma County Water Agency. https://evogov.s3.amazonaws.com/185/media/165584.pdf, accessed 2/12/2021.

  - 3.2.1. Promote detention and retention of nutrients via LID and stormwater control measures (as in 1.1 and 1.2)
  - 3.2.2. Encourage increased infiltration and decreased surface runoff on agricultural lands
- 3.3. Processing and Removal of Nutrients
  - 3.3.1. Encourage wetland denitrification
  - 3.3.2. Encourage increased nutrient storage in healthy soils.

Existing studies address some of these components in detail. I suggest that we place less focus on these aspects that have already been documented:

- Winzler & Kelly – GHD (2012) focus on groundwater recharge opportunities (topic 1.2.1) and identified over 100 potential project sites, of which eight were recommended as priorities. The screening is largely based on a 2011 memorandum prepared by Todd Engineers for the Sonoma Ecology Center and SCWA, *Santa Rosa Plain Groundwater Recharge Potential Mapping*, which is attached as an appendix to the Winzler & Kelly – GHD report.
- Floodplain depressional wetlands (1.2.2) were the subject of a 2017 report by SFEI[3]. This report identified all potential depressional wetland restoration areas within the Lower Santa Rosa Creek study area. SFEI used their GreenPlan-IT tool to model feasibility of restoration, potential associated load reductions, condition and habitat value, and factors such as ownership to develop priority rankings.

Evaluation of restoration opportunities for crediting for the TMDLs requires consideration of both feasibility and need. Feasibility involves identifying suitable locations and associated barriers and incentives to implementation. The need side of the equation addresses the amount of excess pollutant load that can be mitigated by a given project. To date, the studies mentioned above have mostly focused on feasibility.

Assimilative capacity is increased only when a project is both feasible and results in a reduction in excess loads. Estimation of avoided loads is difficult, especially in the absence of a detailed watershed model. To address this issue Tetra Tech has proposed and Board staff have accepted a surrogate measure that can stand in for the risk of loads elevated above natural background (*Laguna de Santa Rosa: Surrogate Measures (Revised)*, 12/23/2020). The general concept of the surrogate is that increases in surface runoff above natural background conditions provide an index to both excess pollutant loading and increased flow that causes channel degradation. To make the surrogate easy to calculate and apply the approach does not involve continuous flow simulation, but rather compares current and natural conditions for a specified design storm. Further development and testing of the surrogate measure is the most immediate need for documenting restoration plan opportunities for crediting within the available budget and using available data.

The concept of calculating the contribution of a site or area to increases above natural, undeveloped storm event runoff has aspects in common with Maryland's Environmental Site Design (ESD), although ESD is applied only to new development and redevelopment in Maryland. Maryland's Stormwater Design Manual[4] provides the following summary of the ESD concept: "The criteria for sizing ESD practices are

[3] SFEI. 2017. Demonstration of a Watershed Approach to Wetland Restoration Planning Using GreenPlan-IT. Technical Memorandum

[4] MDE. 2009. 2000 Maryland Stormwater Design Manual, Volumes I and II (Revised May 2009). Maryland Dept. of the Environment (MDE).

based on capturing and retaining enough rainfall so that the runoff leaving a site is reduced to a level equivalent to a wooded site in good condition as determined using United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) methods (e.g., TR-55)." The evaluation is made on the basis of the 1-year 24-hour storm event, eliminating the need for continuous simulation or total runoff volume calculations. The 1-year 24-hour event is selected because channel-forming flows in evolving urban streams are typically found to be in the 1 to 1.5-year recurrence range. The channel forming flow or dominant discharge is the flow that does the greatest work on the channel by integrating a moderately high shear stress with a high frequency of occurrence. Larger flows will do more work on the channel in an individual event but occur less often. Bledsoe and Watson (2001) also recommend using the 1-year 24-hour event for stream stability analysis[5].

The NRCS TR-55 method is based on runoff curve numbers (CNs), which are a function of hydrologic soil group, impervious cover fraction, and condition of the land cover. Tables are widely available. The MDE ESD guidance lays out the calculation methods and also provides reduced curve numbers (RCNs) to be used to account for BMPs that reduce runoff from impervious surfaces. Evaluations can be made at the site, development, or larger scale through the calculation of area weighted CNs; however, for simplicity it is recommended that the analysis be conducted at the site or parcel level, removing the need to simulate downstream routing. CNs can also be modified to account for the presence of stormwater control measures.

The ESD calculation approach simplifies the analysis by focusing on a single design storm, which greatly increases ease of applicability and avoids the need for continuous simulation. Application to the Laguna watershed does require modification to local conditions for the design storm event, land use, and soils, but the necessary sources are readily available.

Design Storm: The 1-year, 24-hour storm for Santa Rosa is 2.87 inches as estimated in NOAA Atlas 14 but varies across the watershed. Interpolated grids for this event covering the whole watershed are available from the NOAA PFDS server (https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_gis.html). Methods are also available to estimate how the design storm is likely to change under future climate[6].

Land Use/Land Cover: High resolution LiDAR based spatial coverages of current land use and land cover, including impervious surface areas, have already been assembled for the Laguna watershed, as described in Tetra Tech (2020a) and can be used as the default basis for defining current condition CNs. Individual jurisdictions could be given the opportunity to revise these CNs based on factors such as presence of stormwater management controls. MDE (2009) provides techniques for accounting for such controls. The MDE ESD method assumes that the natural condition is woods in good condition. For application to the Laguna watershed we would instead use the pre-development land cover map

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[5] Bledsoe, B.P., and C.C. Watson. 2001. Logistic analysis of channel pattern thresholds: meandering, braiding, and incising. *Geomorphology*, 38:281-300.
[6] Butcher, J.B., T. Zi, B. Pickard, S. Job, T.E. Johnson, and B. Groza. 2021. https://doi.org/10.1007/s10584-021-02963-y. IDF Curves for precipitation and runoff under future climate: Efficient statistical generation approach. *Climatic Change*, 164, 3. DOI:10.1007/s10584-021-02963-y. https://rdcu.be/cd0qS.

developed by the Water Board[7]. This identifies six classes of pre-development land cover: Open Water, Perennial Wetland, Riverine Wetland, Rangeland, Oak Savanna, and Forest.

Soils: For the CN approach the primary need is for Hydrologic Soil Group (HSG), which is a measure of infiltration capacity that is incorporated into the CN lookup tables. A gridded map of HSG has already been developed from soil survey data as part Tetra Tech' previous work.

In sum, the analysis of the surrogate measure would assume that the natural condition runoff is calculated using the 1-year, 24-hour storm and the CN for the appropriate pre-development soil group and land cover in good condition. The corresponding post-development runoff is then calculated with the CN appropriate to the present-day land cover and impervious fraction. The extra contribution or responsibility of the developed land area is then equal to the difference between these two numbers expressed as a volume by multiplying by area (e.g., as acre-feet of runoff). The method is readily applied to developed areas. It can also be applied to different types of agriculture, or even parks, based on their changes in land cover and impervious extent.

Tetra Tech has also developed a grid-based Revised Universal Soil Loss Equation (RUSLE) analysis of erosion rates from upland land areas, supported by high-resolution LiDAR-based analysis of soil cover developed by the Sonoma VegMap project. RUSLE only estimates soil loss, not delivery to downstream points; however, the RUSLE analysis was combined with a detailed topography-based of analysis of connectivity to stream channels to estimate sediment delivery to the Laguna from any point within the watershed (see Appendices to *Laguna de Santa Rosa – Linkage Analysis for Sediment Impairments (Revised)* for details.) The sediment loading and delivery analysis provides another line of evidence to corroborate relative rankings for crediting scores obtained from the surrogate analysis. It can also be combined with information on soil phosphorus concentrations to provide a similar analysis relative to phosphorus loads, as most phosphorus delivery occurs in association with sediment erosion.

Proposed Work

Based on the discussion above, Tetra Tech proposes to focus Subtask 1.2 on GIS-based testing and analysis of the surrogate measure. We propose to divide the Laguna watershed into approximately 120 NHD high-resolution subwatersheds. We will then calculate the surrogate measure (i.e., change in storm runoff relative to natural conditions) for each of these small watersheds to provide spatial estimates and ranking for initial targeting and crediting of restoration opportunities relative to both upland pollutant load generation and effects of modified flows (both local runoff and accumulated upstream flows) on potential channel degradation.

The RUSLE work will also be reanalyzed across the same small subbasins to help corroborate and test the surrogate measures-based analysis. Together these analyses will address the "need" side of the watershed management concepts from the Vision listed in Table 1.

As resources allow, Tetra Tech will also pursue several additional analyses that will augment the work already available and described above.

[7] Butkus, S. 2011. Development of the Laguna de Santa Rosa Watershed Pre-European Settlement Spatial Data Model. Memo to file, California Regional Water Quality Control Board, North Coast Region, Santa Rosa, CA.

- **Infiltration Capacity**: The WInzler & Kelly – GHD 2012 analyses were focused on high-capacity groundwater recharge projects. These could be high-value components of restoration planning. However, the analysis does not address opportunities for smaller-scale, distributed recharge using GI or modified agricultural practices. The analyses were also completed before the high-resolution LiDAR-based DEM was available. Tetra Tech can augment the existing analysis by developing spatial coverages that identify areas that combine high soil infiltration potential and low slope (e.g., < 2%).
- **Poor Soil Cover**: Sonoma VegMap LiDAR analyses provide direct, high-resolution information on soil cover by vegetation. Areas with soil cover that is less than expected for similar land use / slope combinations is at greater risk for increased flow, erosion, and pollutant load generation. Direct analysis of areas with poor soil cover is thus a useful tool for targeting and crediting restoration efforts.
- **Connectivity Analysis**: Land areas that have greater connection to the stream network due to the combination of proximity, slope, and upgradient flow accumulation have greater risk of delivering pollutant loads to the Laguna and are thus potential hotspots for restoring assimilative capacity. Tetra Tech developed topography-based Connectivity Index[8] primarily as a means to estimate sediment delivery ratios[9] for the RUSLE analysis. However, the Connectivity Index itself provides direct information on the risk of transport of pollutants of all types to the Laguna. Tetra Tech can reanalyze the Connectivity Index outputs to provide a high-resolution spatial tool for fine-scale analysis of potential project locations.

[8] Borselli, L., P. Cassi, and D. Torri. 2008. Prolegomena to sediment and flow connectivity in the landscape: A GIS and field numerical assessment. *Catena,* 75: 268-277.
[9] Vigiak, O., L. Borselli, L.T.H. Newham, J. McInnes, and A.M. Roberts. 2012. Comparison of conceptual landscape metrics to define hillslope-scale sediment delivery ratio. *Geomorphology*, 138: 74-88.