

Sonoma Water

Nutrient Offset Project Proposal Laguna de Santa Rosa Reaches 1 and 2

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Basic Information

Project Name

Sonoma Water's Laguna de Santa Rosa sediment removal project to reduce phosphorus through legacy sediment removal.

Date of Submittal

April 15, 2019

Project Location

The project area occurs along the western border of the City of Rohnert Park, within the Laguna de Santa Rosa watershed, along the mainstem Laguna de Santa Rosa near its confluence with the Bellevue-Wilfred flood control channel (Figure 1). As part of its Stream Maintenance Program (SMP), Sonoma Water manages urban stream channels for flood control and habitat restoration, including this portion of the Laguna de Santa Rosa, designated in the SMP as the upper portion of reach Laguna 1 and all of reach Laguna 2.

Estimated Size of the Project Area

Sonoma Water proposes to excavate legacy sediment and organic matter from Laguna 1 and Laguna 2. The Proposed Project will remove an estimated 7,330 yd³ of sediment from both reaches.

Dimensions of Laguna 1 and Laguna 2 and estimated amount of sediment removed from the project area.

Reach	Length (ft)	Mean width (ft)	Area (ft ²)	Mean depth (ft)	Volume (yd ³)
Laguna 1	1,223	24.0	29,352	2.0	2,174
Laguna 2	3,053	24.0	73,272	1.9	5,156
TOTAL	4,267		102,624		7,330

Name of the Project Developer

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Name of the Initial Owner of Water Quality Credits

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Proposal Summary

Credit Generating Practices

Credit generating practice: legacy sediment removal

Quantification methods: reduced internal loading and direct removal of phosphorus

Margin of Safety/Credit Trading Ratios

- Reduced internal loading
 - Uncertainty ratio: 2.0
 - Retirement ratio: 0.0

- Direct removal of phosphorus
 - Uncertainty ratio: 1.5
 - Retirement ratio: 0.0

Calculated Credits and Credit Life for Proposed Actions

Estimated annual and total phosphorus (P) reduction, proposed uncertainty and retirement ratios, and annual and total phosphorus credits generated.

Quantification Method	Annual P Reduction lbs/yr	Proposed Eligibility Period	Uncertainty Ratio	Retirement Ratio	Annual P Credits lbs/yr (yrs)	Total P Credits total lbs (yrs)
Reduced Internal loading	200 ^a	10 years	2.0	0.0	100^b (10 years)	1,000^c (10 years)
Direct removal	4,500 ^d	3 years	1.5	0.0	3,000^e (3 years)	9,000^f (3 years)

^aReduced internal phosphorous loading quantification assumes annual reduction of 200lbs/yr for the life of the project (10 years).

^bAnnual credits for reduced internal loading = annual phosphorus reduction (200lbs/yr) / (uncertainty [2.0] + retirement ratios [0.0])

^cTotal credits for reduced internal loading = annual credits * eligibility period

^dDirect removal of phosphorous assumes reduction of 13,500 lbs total, with a 3 year eligibility period (4,500 lbs/yr for 3 years).

^eAnnual credits for direct removal = annual phosphorus reduction ([13,500 lbs] / eligibility period [3 years]) / (uncertainty [1.5] + retirement ratios [0.0])

^fTotal credits for direct removal = annual credits * eligibility period

Sonoma Water Laguna de Santa Rosa Sediment Removal Project Synopsis

The Sonoma County Water Agency (Sonoma Water) proposes to excavate legacy sediment and organic matter from the mainstem Laguna de Santa Rosa near its confluence with the Bellevue-Wilfred flood control channel (Figure 1). As part of its Stream Maintenance Program (SMP), Sonoma Water manages urban stream channels for flood control and habitat restoration, including this portion of the Laguna de Santa Rosa, designated by the SMP as reaches Laguna 1 and Laguna 2. The action will modify hydraulic conditions to reduce *Ludwigia hexapetala* (*Ludwigia* or water primrose) growth and mosquito proliferation, favor establishment of native vegetation, and remove a large phosphorus load from the system. The Proposed Project is intended for consideration by the North Coast Regional Water Quality Control Board (NCRWQCB or Regional Board) as a basis for project approval under the Santa Rosa Nutrient Offset Program adopted by the Regional Board with Resolution No. R1-2008-0061 (NCRWQCB 2008), which allows the City of Santa Rosa (City) to offset nutrient discharges from its Subregional Water Reclamation Facility (Subregional Facility) by performing off-site nutrient reduction projects. Sonoma Water proposes to conduct and fund the voluntary Proposed Project by selling the nutrient credits to the City as part of the Nutrient Offset Program under Resolution No. R1-2008-0061. The City would apply reductions at Laguna 1 and Laguna 2 as offsets toward its compliance with regulatory requirements on annual discharges from the Subregional Facility to the Laguna de Santa Rosa.



Figure 1. Location of the project area and Laguna 1 and Laguna 2 (from Freshwater Trust 2017a).

Project Design and Credit Information

Introduction

This document describes Sonoma Water's Laguna de Santa Rosa Sediment Removal Project (Proposed Project) and is intended for consideration by the North Coast Regional Water Quality Control Board (NCRWQCB or Regional Board) as a basis for project approval under the Santa Rosa Nutrient Offset Program adopted by the Regional Board with Resolution R1-2008-0061 (NCRWQCB 2008). The resolution approving the Santa Rosa Nutrient Offset Program generally defines conditions for credit-generating project eligibility and credit life. This formal proposal complies with those conditions and relies on previous discussions with the Regional Board. At a pre-proposal meeting held on April 12, 2017, the Regional Board, Sonoma Water, and the City of Santa Rosa agreed that the Proposed Project as described below met the requirements for generating nutrient offset credits that could be transferred from Sonoma Water to the City of Santa Rosa.

Since the pre-proposal meeting on April 12, 2017, the Regional Board approved a new Water Quality Credit Trading Framework for the Laguna de Santa Rosa Watershed (Resolution No. R1 2018-0025 [NCRWQCB 2018]), updating and revising the Santa Rosa Nutrient Offset Program (Resolution R1 2008-0061 [NCRWQCB 2008]). While this proposal follows the guidance in NCRWQCB (2008), it recognizes the NCRWQCB (2018) framework and follows the guidance and organization of NCRWQCB (2018) whenever practicable. NCRWQCB (2018) integrates knowledge from a recent Conservation Innovation Grant from the United States Department of Agriculture awarded to the Sonoma and Gold Ridge Resource Conservation districts to develop locally appropriate recommendations for a Laguna de Santa Rosa water quality trading program. Further, NCRWQCB (2018) benefits from recent guidance from the National Network on Water Quality Credit Trading (Building a Water Quality Trading Program: Options and Considerations [Willamette Partnership, World Resources Institute, and the National Network on Water Quality Trading 2015]) and the Association of Clean Water Administration (Water Quality Trading Toolkit. [ACWA and Willamette Partnership 2016]).

Site Description

Laguna 1 and Laguna 2 convey storm water from the southern portions of the City of Santa Rosa and from the cities of Rohnert Park and Cotati. Laguna 1 and Laguna 2 are wide and flat with little overhead canopy, and typically contain stagnant water exposed to the sun for much of the year (Figure 2). The stagnant water contributes to infestations of the exotic invasive weed *Ludwigia*, leading to poor water quality (low dissolved oxygen, high water temperature) that creates ideal conditions for mosquito breeding (Figure 3).



Figure 2. Laguna 2 at confluence with Bellevue-Wilfred with wide channel and low velocity flows.



Figure 3. Laguna 2 with *Ludwigia* growing in-channel.

Sonoma Water proposes to excavate legacy sediment and organic matter from Laguna 1 and Laguna 2. The action will modify hydraulic conditions to reduce *Ludwigia* growth and mosquito proliferation, favor the establishment of native vegetation, and remove a large phosphorus load from the system. The Proposed Project will remove an estimated 7,330 yd³ of sediment from both reaches (Table 1). The modifications will allow these channels to better remove phosphorus and other pollutants from water flowing through the channels when native riparian vegetation establishes and matures, and in turn will reduce the solar radiation reaching the water surface.

Table 1. Dimensions of Laguna 1 and Laguna 2 and estimated amount of sediment removed from the project area.

Reach	Length (ft)	Mean width (ft)	Area (ft ²)	Mean depth (ft)	Volume (yd ³)
Laguna 1	1,223	24.0	29,352	2.0	2,174
Laguna 2	3,053	24.0	73,272	1.9	5,156
TOTAL	4,267		102,624		7,330

Anticipated Project Benefits

Aquatic and Riparian Habitat

The excavation will create a narrower and deeper summer low flow channel than under current conditions (Figure 4) to benefit aquatic and riparian habitat. Current channel width ranges from 50 to 200 ft (mean = 125 ft) and channel depth ranges from 0.1 to 2.0 ft (mean = 0.5 ft). The excavated channel would be substantially narrower (mean = 24.0 ft) and deeper (mean = 2.0 ft) and concentrate flow within a more defined thalweg, creating an inset floodplain (Table 1). The narrower and deeper dimensions will allow the current floodplain to drain into the newly excavated summer low flow channel to create conditions less suitable for *Ludwigia* and emergent (submerged) aquatic plants. The proposed configuration would place most of the current floodplain above the summer water surface elevation, diminishing available habitat for *Ludwigia* and creating conditions more suitable for the establishment of native grasses, sedges, and other riparian vegetation capable of suppressing *Ludwigia*. The native plants would then remove contaminants from urban and rural runoff during the winter while providing shade during the summer. The narrower channel would also limit insolation of the water surface, further reducing water temperature.

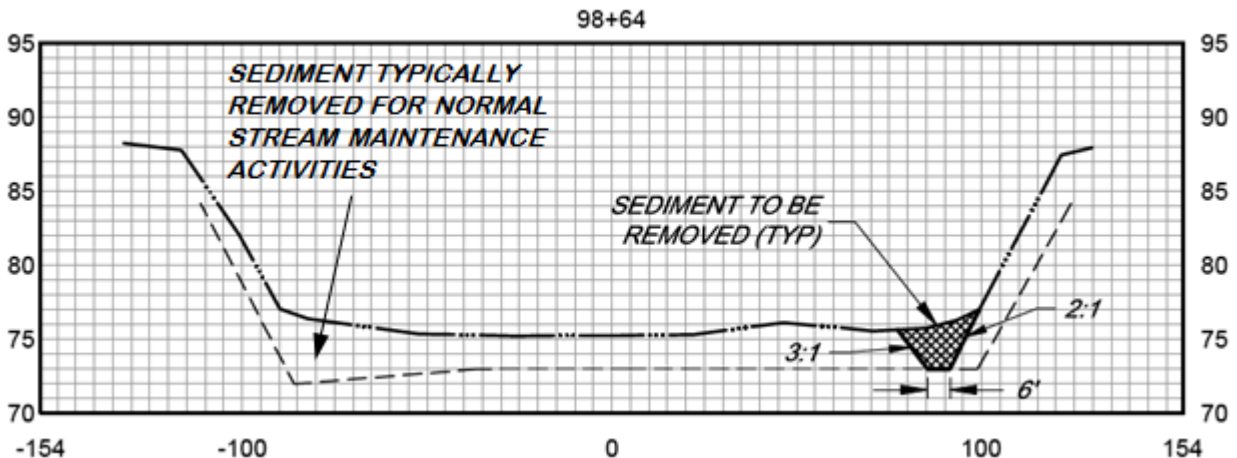


Figure 4. Typical dimensions of sediment to be removed from Laguna 1 and Laguna 2 as part of this project (cross-hatched area) and typical dimensions of sediment removed for normal stream maintenance activities to maintain flood capacity (dashed line represents "as built" channel dimension).

Wildlife Habitat

Reconfiguration of the channel will provide for more in-channel transitional wetlands that would improve habitat for aquatic species, encourage wildlife movement, and foraging and nesting opportunities for native birds along the riparian corridor. Several restoration projects have previously occurred in the Rohnert Park/Cotati area and the Proposed Project would link these projects together. Recent restoration efforts include sediment removals and floodplain restoration on over 6,000 feet of Laguna 1 by Sonoma Water and the Laguna Foundation as part of a California Proposition 84 Urban Greening Grant, 4,000 feet of upper bank and instream

restoration on Laguna Reach 3, as part of a California Department of Transportation Environmental Enhancement and Mitigation Program grant, as well as ongoing routine flood control projects followed by riparian restoration over the last 10 years on creeks in Rohnert Park-Cotati, including Copeland, Hinebaugh, Five, Crane, and Gossage creeks. A similar approach (creating a narrower, deeper channel) under Sonoma Water's SMP has proven effective for improving fish passage and habitat, reducing vegetation management needs, and creating discrete management areas for future sediment removals.

Mosquito Control

The Marin-Sonoma Mosquito and Vector Control District is unable to adequately control mosquito production in the project area as *Ludwigia* is a physical barrier against the application of control products. The District has found mosquitos carrying West Nile Virus in nearby channels (Marin-Sonoma Mosquito and Vector Control District 2014, 2015, 2016).

Project Eligibility

Eligibility of Project to Generate Credits

NCRWQCB (2008) and NCRWQCB (2018) describe the conditions under which National Pollution Discharge Elimination System (NPDES) permittees (including the Santa Rosa Subregional Water Reclamation System) can use nutrient offset credits to comply with NPDES requirements. The potential credits must be generated from projects within the Laguna de Santa Rosa and its tributaries. Further, credit generation comes from reductions in phosphorus quantified in pounds removed (as measured directly or estimated) from the Laguna de Santa Rosa due to offset actions. NCRWQCB (2008, 2018) do not identify specific actions appropriate for credit generation, but recent guidance from Keiser and Associates, LLC (2015) details project types and Beneficial Management Practices (BMPs) applying to the Laguna de Santa Rosa watershed that:

- Have common applicability within the Laguna de Santa Rosa watershed
- Are desirable from a water quality perspective
- May have additional natural resource co-benefits in addition to water quality
- Present potential for generating water quality credits

Sonoma Water considered the above guidance in developing the proposed credit generating action.

The Proposed Project meets credit eligibility requirements for the current Santa Rosa Nutrient Offset Program and Water Quality Trading Framework for the Laguna de Santa Rosa Watershed. The project area occurs within the Laguna de Santa Rosa mainstem at the confluence with the Bellevue-Wilfred flood control channel (Figure 1 and Figure 2), which falls within the trading area described in NCRWQCB (2008) and NCRWQCB (2018). The project proposes to remove legacy phosphorus, quantified in pounds (detailed in Section “Quantity of Phosphorus Removed/Expected Life of Crediting Practices”) through reduced internal loading and sediment removal directly from the channel. As noted above, NCRWQCB (2008) does not identify specific actions appropriate for credit generation, but Keiser and Associates, LLC (2015, Appendix C) details potential actions, including legacy nutrient and sediment removal, which are included in this proposal.

Eligibility of Practices to Generate Credits

The practices of the credit generator to generate credits must be voluntary and not required by “law, regulation, permitting instrument, or enforcement action” (NCRWQCB 2018). The benefits of generating credits from a project should be “additional” if the action is not required. Regulatory requirements and obligations may also create a baseline, either physical or financial, defining the minimum amount of effort that must be achieved before the project is eligible to generate credits (Willamette Partnership, World Resources Institute, and the National Network on Water Quality Trading 2015, NCRWQCB 2018).

Baseline Requirements

An analysis by The Freshwater Trust has provided information on how to determine the “trading baseline” for Sonoma Water actions within the Laguna de Santa Rosa (The Freshwater Trust 2017a [included as Appendix A]). A trading baseline is the threshold a source must meet before generating credits for sale. The Freshwater Trust (2017a) refers to the 2003 United States Environmental Protection Agency (USEPA) trading policy that states pollutant reductions should be greater than required by regulatory requirement or a Total Maximum Daily Load (TMDL) document. In the absence of a TMDL, as is the case in the Laguna de Santa Rosa (a TMDL for phosphorus is in preparation by the Regional Board), per USEPA policy, the baseline “should be the level of pollutant load associated with existing land uses and management practices that comply with applicable state, local or tribal regulations.” The following flowchart from The Freshwater Trust (2017a) and the National Network on Water Quality Credit Trading (NNWQCT) (Willamette Partnership, World Resources Institute, and the National Network on Water Quality Trading 2015) illustrates the trading baseline with and without a TMDL, and under different regulatory obligations (Figure 5).

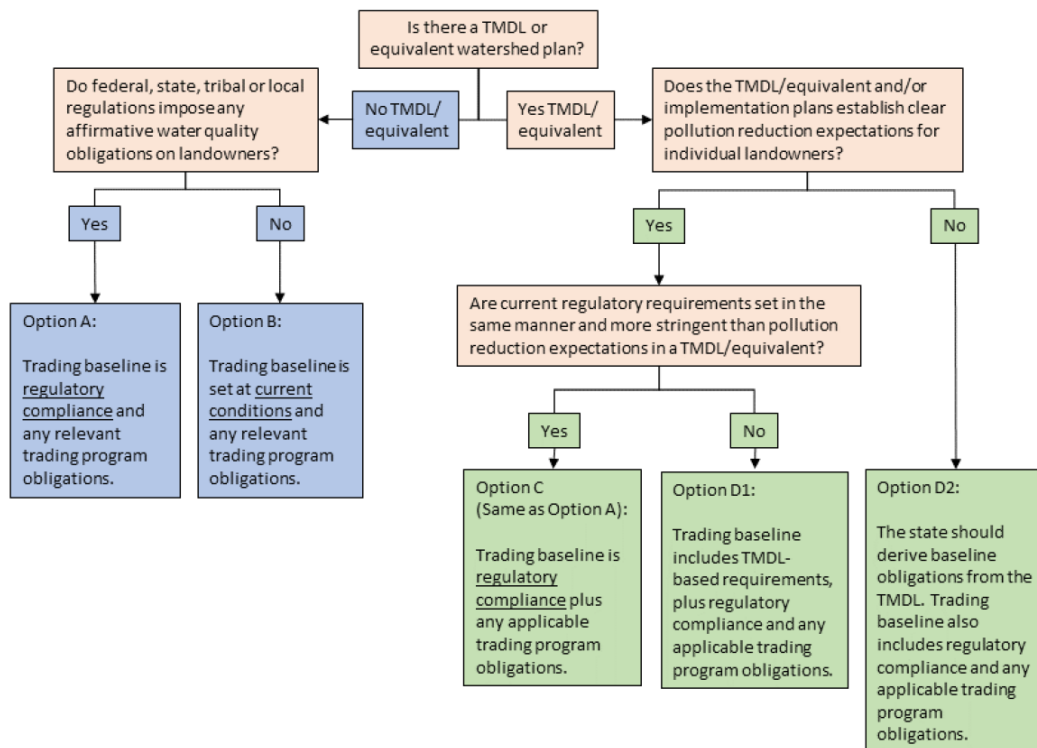


Figure 5. Flow chart to determine trading baseline. Adapted by The Freshwater Trust (2017a) from the National Network on Water Quality Trading (2015).

After establishing the framework to determine trading baseline, the Freshwater Trust (2017a) examined existing management regulations that affect the baseline of potentially creditable Sonoma Water actions. The Sonoma County Flood Control and Water Conservation District Act gives Sonoma Water broad discretion regarding how to accomplish its statutory purpose. Sonoma Water’s actions in this context are discretionary, and thus additional. But, to the extent

Sonoma Water is required to conduct an action that fulfills a statutory obligation, such as sediment removal for flood control, then the action is non-additional and within the baseline (i.e., not eligible to generate credits). Sonoma Water has no statutory or contractual obligation to maintain flood channels in any particular manner. Based on this discretion, most sediment removal projects implemented by Sonoma Water would be creditable. An exception is the required low-flow channel in salmonid bearing channels described below.

The Russian River Biological Opinion (Russian River BO) issued by the National Marine Fisheries Service (NMFS) on the water supply, flood control operations, and channel maintenance conducted by the United States Army Corps of Engineers (ACOE), Sonoma Water, and the Mendocino County Russian River Flood Control And Water Conservation Improvement District in the Russian River watershed also establishes regulatory requirements relevant to the baseline. The Russian River BO concluded that continuing operations of the Coyote Valley and Warm Springs dams in a manner similar to recent historical practices, along with stream maintenance activities and estuary management, likely adversely modified critical habitat of California Central Coast (CCC) coho salmon (Federal and State endangered species) and steelhead (Federal and State threatened species), jeopardizing the continued existence of these species in the Russian River basin. NMFS (2008) suggested a Reasonable and Prudent Alternative (RPA) made up of 23 actions for Sonoma Water and ACOE to implement that would avoid jeopardizing coho salmon and steelhead. As some of the RPA actions could result in incidental take of CCC coho salmon and steelhead and California Coast (CC) Chinook salmon (Federal and State threatened species), NMFS (2008) suggested Reasonable and Prudent Measures (RPMs) to minimize the likelihood of take. Specific to the Laguna de Santa Rosa, NMFS (2008) suggested that to reduce the impacts of channel maintenance conducted by Sonoma Water's Stream Maintenance Program on habitat complexity, Sonoma Water would construct a low flow channel to provide enhanced salmonid migration habitat through sediment removal areas in Flood Control Zone 1a, which encompasses the Laguna de Santa Rosa (Reasonable and Prudent Measure #5 Section D, #13). This RPM effectively creates a regulatory obligation (constructing a low flow channel) relevant to the trading baseline for sediment removal in the Laguna de Santa Rosa. Water quality credits for sediment removal could only be accrued after low flow channel excavation. Sediment removed beyond low flow channel excavation would be eligible to generate credits. The trading baseline created by the requirement to construct a low flow channel does not apply to all sediment removal actions (only those in salmonid bearing streams).

Sonoma Water's trading baseline for sediment removal activities in the Laguna de Santa Rosa is set conditionally according to whether the action is mandatory or discretionary (Figure 5). A mandatory action, such as sediment removed to maintain flood capacity, fulfills statutory (flood control) and regulatory (low flow channel excavation) compliance and would occur regardless of the opportunity to generate water quality credits. Accordingly, the trading baseline is statutory and regulatory compliance (low flow channel excavation), after which credit generation begins (Option A in Figure 5). A discretionary action, such as sediment removal for habitat restoration, is not required for statutory or regulatory compliance. Discretionary sediment removal may include a low flow channel to support fish migration or passage, but since the action is not required, excavating the low flow channel is additional and not part of baseline requirements. As

such, the trading baseline is set at current conditions, and sediment removed to fulfill the discretionary purpose of habitat restoration can generate credits (Option B in Figure 5).

Satisfaction of Baseline Requirements

The entire amount of sediment removed for the Proposed Project is available to generate water quality credits (Option B in Figure 5). Sonoma Water proposes to remove sediment from Laguna 1 and Laguna 2 at its discretion for the purpose of habitat restoration. The project is not part of regular stream maintenance activities for flood control. The low flow channel excavation is intended to drain adjacent floodplains to eliminate ecological conditions favorable to establishment of the exotic invasive *Ludwigia*, to allow for mosquito abatement, and promote establishment of native riparian vegetation. As the low flow channel is excavated for the purposes of habitat restoration, not to comply with statutory or regulatory requirements, the entire amount of sediment removed is eligible to generate credits.

The Proposed Project differs from a typical stream maintenance reach-scale sediment removal project. For such a project, undertaken to maintain flood capacity, Sonoma Water removes sediment across the entire bed to the as-built dimension (Figure 4), leaving enough sediment to create a low flow channel per the Biological Opinion, the Stream Maintenance Program Manual (SMP Manual) (Appendix D; Horizon Water and Environment 2009), and permit requirements (detailed in sections “Project Implementation” and “Description of Anticipated Permitting Needs and CEQA Documentation”). Sonoma Water can also request authorization from the Army Corps of Engineers to excavate beyond the as-built channel depth. The Proposed Project would remove sediment for a low-channel, leaving the remaining bed at its current elevation, to create a floodplain that drains into the newly excavated channel (Figure 4).

Quantity of Phosphorus Removed/Expected Life of Crediting Practices

The quantity of phosphorus removed due to legacy sediment removal can be quantified by 1) calculating the reduction in internal phosphorus loading and 2) calculating the actual phosphorus load removed with the sediment (Table 2). The Freshwater Trust (2017b; included as Appendix B) details the assumptions and calculations associated with each of these approaches. The equations and variables presented below estimate quantity of phosphorus removed in metric units. To avoid rounding errors between units and between calculations, metric units are converted to English units for the final calculation of total phosphorus reduction.

Table 2. Estimated pounds of phosphorus (P) reduced annually, proposed eligibility period, and total pounds of P reduced by legacy sediment removal in Laguna 1 and Laguna 2.

Proposed Crediting Practice	Quantification Method	Annual P Reduction (lbs/yr)	Proposed eligibility period	Total P Reduction (lbs)
Legacy Sediment Removal	Reduced internal phosphorus loading	200 ^a	10 years	2,000
	Direct removal of phosphorous	4,500 ^b	3 years	13,500

^a Reduced internal phosphorous loading quantification assumes annual reduction of 200lbs/yr (90.72 kg) for the life of the project (10 years).

^b Direct removal of phosphorous quantification assumes reduction of 13,500 lbs total, with a 3 year eligibility period (4,500/lbs/yr for 3 years).

Reduced Internal Phosphorus Loading

Internal phosphorus loading is the flux of phosphorus from the sediment into the water column, which can occur under anoxic conditions, such as during summer low flow. The main source of phosphorus to the water column comes from the upper 1 in. (2 cm) of sediment experiencing anoxic conditions. The Freshwater Trust (2017b) estimated the potential flux of phosphorus from the sediment using the equation:

$$P_{flux} = E_{dif} (C_{sw} - C_w) / h \quad [1]$$

where:

- P_{flux} = Release of phosphorus from the sediment, grams P/m²/day
- E_{dif} = Diffusion coefficient (2 x 10⁻⁴ m²/second or 17.28 m²/d), m²/day
- C_{sw} = Phosphorus concentration of sediment pore water, grams P/m³
- C_w = Phosphorus concentration in the water column, grams P/m³
- h = Active sediment depth (2 cm or 0.02 m), m

Equation [1] yields the daily release of phosphorus by mass/area/time (Equation [1] is presented in grams P/m²/day, but is converted to lbs/ft²/day in this proposal).

Given concentrations of phosphorus in the water column and in sediment pore water, one can estimate release of phosphorus to the water column from an area of sediment over time under low-oxygen or anoxic conditions. The Freshwater Trust (2017b) used data and results from a previous study on the Laguna de Santa Rosa (Sloop et al. 2007) to assume a P_{flux} of 0.02 grams P/m²/day, then calculated a phosphorus load for the project area under anoxic conditions through time using:

$$P_{load} = P_{flux} * A * T \quad [2]$$

where:

- P_{load} = Phosphorus load from internal loading, grams P
- P_{flux} = Release of phosphorus from the sediment, grams P/m²/day
- A = Area of sediment contributing to internal loading, m²
- T = Internal loading time period, day

The Freshwater Trust (2017b) determined the flux of phosphorus from the area (A in Equation [2] above) of channel inundated during low flow, potentially anoxic conditions (T in Equation [2], above). Using Sonoma County LiDAR from 2013 and stream gage information from United States Geological Survey (USGS) Gage #11465680 (Laguna de Santa Rosa at Stony Point Road near Cotati CA) just downstream of the Proposed Project to determine the water surface elevation (stage) of the project area with the proposed summer low flow channel and the duration and frequency of low flow conditions (Figure 6), and assuming that channel area currently covered with *Ludwigia* (validated through aerial photography interpretation) likely experiences anoxic conditions, The Freshwater Trust (2017b) estimated an area of reduced internal loading of 735,000 ft² (68,280 m²). To avoid double counting the nutrient benefits of legacy sediment removal (calculated below), The Freshwater Trust (2017b) subtracted the area of the proposed low flow channel (102, 624 ft² [9,530 m²]; Table 2), for a total area of 632,000 ft² (58,700 m²) (A in Equation [2] above). The low flow conditions occur approximately 155 days out of the year, but likely occur for only half of each day due to diel variability in photosynthetic activity or 77.5 days out of the year (T in Equation [2], above). Following this, the estimated annual reduction in total phosphorus resulting from the removal of sediment and *Ludwigia* that eliminates low, flow anoxic conditions is 200 lb/year (90,720 g [90.72 kg]/yr) for the life of the project (10 years) (Table 2).

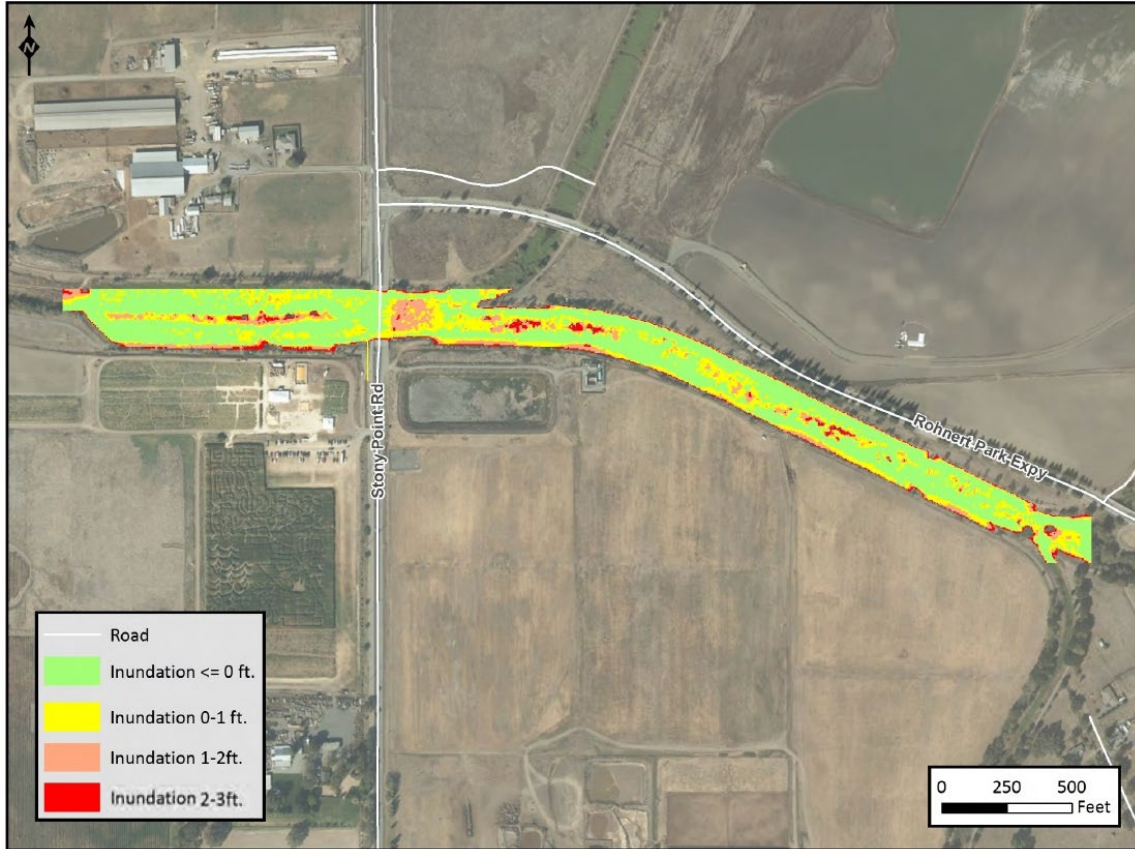


Figure 6. Depths above the proposed low flow channel at which floodplains are inundated in Laguna 1 and Laguna 2 under the Proposed Project, estimated using 2013 Sonoma County LiDAR (from The Freshwater Trust 2017b). Areas with low depths are inundated frequently for long durations (weeks to months) at lower flows, while areas with greater depths are inundated less frequently for shorter durations (days to weeks) at higher flows.

Direct Removal of Phosphorus

Further nutrient reductions come from removal of legacy sediment containing phosphorus. The quantification approach outlined above for reduced internal loading assumes that nutrients below 1 in. (2 cm) are unavailable to the system and do not affect water quality (The Freshwater Trust 2017b). But, *Ludwigia* removal is a focus of this project for habitat restoration and for mosquito control. *Ludwigia* also exacerbates poor environmental conditions within standing water and accelerates sediment accumulation, leading to degraded water quality from low dissolved oxygen and high water temperature. As such, the removal of *Ludwigia* and sediment supporting the growth of *Ludwigia* (as a rooting substrate) will improve water quality and reduce the nutrient load in Laguna 1 and Laguna 2. Sediment removal to at least the rooting depth of *Ludwigia* would likely yield water quality improvements while improving habitat and reducing legacy nutrient load.

The calculation of the total benefit from sediment removal in Laguna 1 and Laguna 2 relies on phosphorus load to the rooting depth of *Ludwigia*. The Freshwater Trust (2017b) found that the rooting depth of *Ludwigia* depends on nutrient availability and water depth, with mean depths extending 2 ft (60 cm) below the soil surface (Hussner 2010, as cited in Freshwater Trust

[2017b]), 2 ft (60 cm) corresponds to the proposed excavated depth (Table 1). The Freshwater Trust (2017b) calculated the mass of removed sediment from the volume of sediment using:

$$S_{load} = \rho_{sed} * A_{sed} * D_{root} \quad [3]$$

where:

S_{load} = Sediment load, kg
 ρ_{sed} = Sediment bulk density, kg/m³
 A_{sed} = Area of sediment removal, m²
 D_{root} = Mean *Ludwigia* root depth, m

There are currently no field data for the bulk density of sediment within Laguna 1 and Laguna 2, but a general value for the particle density of normal soils is 2.65 g/cm³. Values collected from Colgan Creek by the City of Santa Rosa ranged from 0.90 to 2.10 g/cm³, likely varying by the amount of organic material found at sample sites. The Freshwater Trust (2017b) used a value of 0.7 g/cm³ based upon values from lake sediment containing organic material (Avnimelech et al., 2001, as cited in The Freshwater Trust [2017b]). Based upon the estimated bulk density, the area of sediment removed, and the rooting depth of *Ludwigia* (2ft [60 cm]), The Freshwater Trust (2017b) estimated a total mass of 8.6 million pounds from 7,300 yd³ (5,580 m³) removed.

The total load of phosphorus removed is based upon the total mass of sediment and the concentration of phosphorus within the mass and can be calculated from:

$$P_{load} = P_{sed} * \rho_{sed} * A_{sed} * D_{root} \quad [4]$$

where:

P_{load} = Sediment total phosphorus load, g
 P_{sed} = Sediment total phosphorus concentration, g/kg
 ρ_{sed} = Sediment bulk density, kg/m³
 A_{sed} = Area of sediment removal, m²
 D_{root} = Mean *Ludwigia* root depth, m

Similar to the bulk density of sediment, there are currently no field data for phosphorus concentration at Laguna 1 and Laguna 2. Values recorded in the mainstem Laguna de Santa Rosa range from 0.73g/kg to 2.4g/kg, likely varying with the amount of organic matter in samples. The Freshwater Trust (2017b) used a value of 1.56g/kg, which is the average of two values from sites with greater occurrence of organic matter to calculate an estimate of 13,500 lb (6,100 kg) of phosphorus removed by legacy sediment removal (Table 2).

Proposed Margin of Safety/Credit Trading Ratio

The Santa Rosa Nutrient Offset Program (Resolution R1 2008-0061 [NCRWQCB 2008]) directs that all proposals must include an appropriate Margin of Safety to account the uncertainties in granting reduction credits. The Margin of Safety can be described numerically, spatially, or temporally depending on the project type. The calculations and results presented for reduced internal loading and legacy sediment removal have different levels of uncertainty. The source for both results is empirical data and data collected elsewhere within the Laguna de Santa Rosa watershed, and both sources carry uncertainty. The estimated flux of phosphorus from the sediment (P_{flux}) to the water column used to calculate the reduced phosphorus load from internal loading (P_{load} [200 lbs/yr]) is presented in this proposal as a single value with no range or comparison to other values that may provide an estimate of uncertainty. Limited data were available to estimate reduced internal loading and The Freshwater Trust (2017b) does not suggest a Margin of Safety. Likewise, the estimate of nutrient reduction from legacy sediment removal is presented as a single value with no range or comparison to other values. But, the estimates for bulk density (0.7 g/cm^3) and phosphorus concentration (1.56 g/kg) are conservative compared to the range of potential values (2.65 g/cm^3 to 0.4 g/cm^3 for bulk density; 2.4 g/kg to 0.7 g/kg for phosphorus concentration), likely giving a lower value of expected nutrient reduction.

In the absence of discrete Margin of Safety factors for internal loading and legacy sediment removal, this proposal uses the credit trading ratios proposed by the Regional Board in the Laguna de Santa Rosa Watershed (Resolution No. R1 2018-0025 [NCRWQCB 2018]) (Table 3). The default trading ratio proposed in NCRWQCB (2018) is 2.5:1, or that the discharger must generate or purchase credits equal to 2.5 times the amount of pollutant discharged. The trading ratio is the sum of two sub-ratios: 1) an uncertainty ratio, and 2) a retirement ratio. The uncertainty ratio reduces the estimated credit amount to account for scientific uncertainty, including inaccuracies in estimation methods and variability in project performance (Willamette Partnership, World Resources Institute, and the National Network on Water Quality Trading 2015, NCRWQCB 2018). The retirement ratio sets aside, or retires, a portion of each credit to achieve an environmental benefit. The purpose of the retirement ratio is to accelerate water quality improvements and demonstrate environmental gains (Willamette Partnership, World Resources Institute, and the National Network on Water Quality Trading 2015).

Table 3. Proposed credit trading ratios from NCRWQCB (2018).

Ratio Type	Multiplier	Rationale
Uncertainty	2.0	<p>A factor of 2.0 accounts for all potential sources of variability and uncertainty, including the following factors that may affect credit estimation</p> <ul style="list-style-type: none"> • Average site conditions • Meteorological phenomena • Practice efficiency rates • Practice maturation rates • Pollutant equivalencies • Pollutant transport, delivery, and attenuation characteristics
Retirement	0.5	A factor of 0.5 is recommended to ensure that all trades generate a net water quality benefit.
Total	2.5:1	

NCRWQCB (2018) suggests variable multipliers for each ratio type (Table 3). The suggested multiplier for the uncertainty ratio is 2.0 to account for all potential sources of variability and uncertainty, while the suggested retirement ratio is 0.5 to ensure a water quality benefit. Still NCRWQCB (2018) conditionally allows the ratios to be reduced by as much as 0.5:

- A reduced uncertainty ratio may be applied when a credit-generating project includes direct measurement of pollutant reductions.
- A reduced retirement ratio may be applied when a credit-generating project is explicitly designed to enhance environmental values (e.g., habitat or ecosystem restoration, recognized priority or multi-benefit actions)
- A reduced retirement ratio may be applied when a credit-generating project occurs on permanently protected lands

Elements of the project described within this proposal should be eligible for reduction of the uncertainty and retirement ratios from default values. The project includes an action that allows a direct measurement of pollutant reduction (legacy sediment removal) and is intended to enhance environmental values, both of which meet conditions for ratio reduction. This proposal suggests unique trading ratios for reduced internal loading and legacy sediment removal (Table 4). As noted above and shown in Table 2, the estimated flux of phosphorus from the sediment (P_{flux}) to the water column used to calculate the reduced phosphorus load from reduced internal loading (P_{load} [200 lbs/yr]) is presented as a single value with no range or comparison to other values that may provide an estimate of uncertainty. The P_{flux} value also depends on site

conditions, which vary seasonally and annually. Consequently, this proposal does not suggest a reduction in the default uncertainty ratio for reduced internal loading. The estimates for bulk density (0.7 g/cm³) and phosphorus concentration (1.56 g/kg) used to estimate the mass of phosphorus removed are conservative compared to the range of potential values, likely giving a lower value of expected nutrient reduction. But, these values are directly measurable and quantifiable from field sampling that will be conducted as part of monitoring and reporting. Field sampling would allow direct measurement of pollutant reduction, phosphorus mass removed with legacy sediments, meeting a condition for reducing the uncertainty ratio. This proposal suggests reducing the uncertainty ratio for legacy sediment removal by 0.5 to 1.5. Since the entire project is intended to enhance habitat by improving the riparian corridor, suppressing the occurrence of *Ludwigia*, and improving water quality (temperature, dissolved oxygen), this proposal suggests reducing the retirement ratio to zero for both quantification methods. Trading ratios applied to water quality credits would range from 2.0:1 for reduced internal loading to 1.5:1 for legacy sediment removal (Table 4).

Table 4. Estimated annual and total phosphorus reduction, proposed uncertainty and retirement ratios, and annual and total phosphorus credits generated.

Quantification Method	Annual P Reduction lbs/yr	Proposed Eligibility Period	Uncertainty Ratio	Retirement Ratio	Annual P Credits lbs/yr (yrs)	Total P Credits total lbs (yrs)
Reduced Internal loading	200 ^a	10 years	2.0	0.0	100^b (10 years)	1,000^c (10 years)
Direct removal	4,500 ^d	3 years	1.5	0.0	3,000^e (3 years)	9,000^f (3 years)

^aReduced internal phosphorous loading quantification assumes annual reduction of 200lbs/yr for the life of the project (20 years).

^bAnnual credits for reduced internal loading = annual phosphorus reduction (200lbs/yr) / (uncertainty + retirement ratios [2.0])

^cTotal credits for reduced internal loading = annual credits * eligibility period.

^dDirect removal of phosphorous assumes reduction of 13,500 lbs total, with a 3 year eligibility period (4,500/lbs/yr for 3 years).

^eAnnual credits for direct removal = phosphorus reduction ([13,500lbs] / eligibility period [3 years]) / (uncertainty + retirement ratios [1.5])

^fTotal credits for direct removal = annual credits * eligibility period

Project Implementation

Sonoma Water developed preliminary designs showing current channel configuration and proposed sediment excavation (Appendix C) and the project would be implemented as an activity under the SMP. The purpose of the SMP is to improve the management and maintenance of flood control channels and streams under Sonoma Water's authority (Horizon Water and Environment 2009). Laguna 1 and Laguna 2 are engineered channels owned in fee by Sonoma Water typically maintained through limited area-specific (in this case, Flood Control Zone 1a) property taxes. Engineered channels were designed for a specific carrying capacity, are typically trapezoidal with earthen bed and banks, and are maintained through bank stabilization, landscaping, fencing, mowing, sediment removal, debris removal, and vegetation thinning.

Stream Maintenance Plan Approach

The project will follow the implementation approach detailed in the SMP Manual (Appendix D; Horizon Water and Environment 2009). The SMP follows an approach that informs activities by detailing broad principles for the entire program and for primary activities by describing ecological goals for each activity. Maintenance principles provide overall guidance for primary SMP activities, including impact avoidance and minimization approaches (Table 5). A set of framing considerations place primary SMP activities of sediment and vegetation management within the context of natural stream function (Table 5; bank stabilization is also a primary SMP activity, but is not part of the Proposed Project and is not discussed in this proposal. See Horizon Water and Environment [2009] for further detail on Sonoma Water's bank stabilization activities). The goals for sediment and vegetation management describe the desired outcomes for maintenance.

Table 5. Maintenance principles guiding Sonoma Water Stream Maintenance Program activities and framing considerations that provide context to sediment management, vegetation management, and bank stabilization activities.

Stream Maintenance	
Maintenance principles	• No unnecessary intervention
	• Understand the system and its processes
	• Consider adjacent land uses
	• Apply system understanding to maintenance actions
	• Manage for incremental ecologic improvement (lift)
	• Integrate maintenance activities toward sustainability
Sediment Management	
Framing considerations	• The natural function of streams is to convey sediment from headwater source areas (or upstream in-channel source areas) to downstream reaches, lowlands, or basins where the sediment ultimately deposits
	• Sediment transport is an inherently dynamic process
	• Sediment loading and vegetation growth are intimately related in a feedback loop
	• Sediment accumulation can reduce the channel's ability to convey floodwaters
	• Accumulated sediment can obstruct infrastructure such as culverts and bridge underpasses
Goals	• Understand the way each reach functions as a sediment conduit within its stream, its sub-watershed, and its land use context
	• Identify an appropriate maintenance target condition that balances flood protection needs, economizes maintenance activities, and avoids and minimizes environmental impacts for that reach
	• Contribute to improvement of water quality conditions through nutrients removal, invasive plants removal, and hydraulic improvement
	• Implement treatments that will enhance the stream's function toward the desired condition while minimizing the need for repeat maintenance
Vegetation Management	
Framing considerations	• Riparian vegetation provides physical stabilization for bank and terrace surfaces through the growth of root structure
	• Riparian vegetation benefits instream habitat by shading the channel, drawing subsurface water up, lowering water temperatures, limiting in channel emergent vegetation, and providing large woody debris
	• Invasive species may limit the success of native, slower growing vegetation and can degrade habitat quality over time
	• Excessive vegetation growth can decrease a channel's flood conveyance capacity
	• Establishing adequate flood protection may require aggressive vegetation management
Goals	• Ensure that adequate flood conveyance capacity is maintained
	• Develop a mature and complex riparian canopy and corridor that offers substantial habitat, shading of the creek, and aesthetic value while minimizing future understory maintenance requirements

Activities

Sediment Management

Sediment Removal

Sediment management refers to the removal of excess sediment from constructed flood protection facilities (Horizon Water and Environment 2009). Sediment will be mechanically removed from Laguna 1 and Laguna 2 with a long-reach excavator (Figure 7) positioned on the adjacent (north; Figure 1) maintenance road along the top of the bank. If the channel shape, bank height, or the presence of large mature trees prevents the use of the top-of-bank access roads, an earthen access ramp will be used to move equipment lower on the bank, or to move equipment into the channel. Access ramp locations would avoid impacts to vegetation, while providing efficient and safe equipment access to the work area. If used, access ramps are temporary and will be regraded and replanted following the sediment removal activities. The ramps will be seeded with native grasses and erosion control fabric will be installed.



Figure 7. Example of a long-reach excavator that will be used from the north to remove sediment and *Ludwigia* from Laguna 1 and Laguna 2

Channel Excavation

As stated above, the channel will be excavated to a narrower and deeper summer low flow channel than under current conditions (Figure 4, Appendix B) to benefit aquatic and riparian habitat. Current channel width ranges from 50 to 200 (mean = 125 ft) and channel depth ranges from 0.1 to 2.0 (mean = 0.5 ft). The excavated channel would be substantially narrower (mean = 24.0 ft) and deeper (mean = 2.0 ft) and concentrate flow within a more defined thalweg, creating an inset floodplain. The narrower and deeper dimensions will allow the current floodplain to drain into the newly excavated channel and place most of the current floodplain above the summer water surface elevation. Sediment removal and channel excavation will not exceed the depth of the original channel design (Figure 4, Appendix B).

Dewatering

Dewatering of the stream may be necessary to conduct sediment removal if the channel is not dry during the low-flow period. Sonoma Water typically installs a coffer dam, pump, and a re-

routing pipeline dewaterers a short section of channel at a time. Pumping rates are set to match inflows to the coffer dam with the downstream release of the diverted flows. Pump intake lines are protected with screens according to NMFS and CDFW criteria to prevent the entrainment of aquatic species. The diverted flows will be released back into the channel as near as possible to the downstream end of the project area. Channels will only be dewatered to the extent necessary to conduct sediment removal activities while protecting water quality and avoiding impacts to aquatic species.

Vegetation Management

Willow Removal and Tree Pruning

Vegetation management refers to the trimming and removal of vegetation from engineered channels (Horizon Water and Environment 2009). Vegetation will be managed by thinning and pruning willows, and in the case of Laguna 2, thinning or pruning of upper bank trees and shrubs. Willows generally grow from the bank slope, near or at the toe-of-slope, can grow into and across the channel bed, and similar to *Ludwigia*, can trap sediment. Arroyo willows (*Salix lasiolepis*) will be removed wherever they are significantly impeding the flow of water, or in areas that contain more desirable tree species. If arroyo willows are not removed, they will be pruned to minimize their ability to catch debris and impede the flow of water. Red and Pacific willows (*Salix lucida lasiandra*) will generally be pruned to reduce the number of branches and trunks below the top of the channel banks. Willow removal generally requires hand clearing using chainsaws, pole saws, pruners, and loppers. The preferred approach to maintaining upper bank trees is to prune lower limbs up to the top of the channel banks, if possible. The goal is to develop a native canopy over the channel while avoiding an increase in channel roughness that increases flood hazard.

Ludwigia Removal

Along with sediment and vegetation management, and excavating a narrower channel, Sonoma Water proposes to remove *Ludwigia* from Laguna 1 and Laguna 2. Currently, the channel is filled with mats of *Ludwigia* that trap sediment and contribute to poor water quality (Figure 3). Similar to sediment removal, *Ludwigia* would be removed mechanically within the reach of a long-reach excavator from maintenance roads adjacent to the project area. Where the channel is too wide, the excavator may occasionally travel partially down the bank in areas that will not impact existing native and riparian vegetation.

Sediment Disposal

Sonoma Water will excavate Laguna 1 and Laguna 2, as described above, and place sediment within truck beds lined with impervious material and covered to prevent spillage. Sediment will be transported to a temporary staging area where Sonoma Water would implement measures to control runoff as needed. The materials would be stockpiled to dry for a period of less than 30 days, then transported to Sweet Lane Nursery (6652 Petaluma Hill Road in Rohnert Park) (Grossi Site) or another approved site as per the SMP Manual (Appendix D; Horizon Water and Environment 2009). Mr. Grossi has an existing agreement with Sonoma Water to accept sediment from stream channels in the SMP area. As part of this agreement, wetlands and waters were mapped at the proposed disposal locations so spoils can be placed without filling jurisdictional areas. As approved in past maintenance seasons, the Grossi property has received and reused sediment from stream maintenance activities since 2009. The memorandum of agreement between Mr. Grossi and Sonoma Water for soil disposal expires in 2023. The sediment would not be used for agricultural purposes, such as growing feed grasses or reuse as potting soils for edible plants, but will be reused only as fill material.

Revegetation

Sonoma Water will revegetate Laguna 1 and Laguna 2 to restore and improve habitat affected by sediment removal activities. Revegetation will follow a robust planting program to develop a fuller riparian corridor and to remove exotic and invasive species. Revegetation will consist of planting native species in suitable locations in all available channel zones, including: along the channel edge; along the intermediate channel-side banks; and along the top-of-bank. The intent is to establish vegetation that mimics natural communities found nearby under similar environmental conditions. Sonoma Water's planting strategy focuses on introducing plants and propagules that will be strong competitors for undesirable species such as Himalayan blackberry and cattail species which result in unfavorable ecological and flood management conditions.

The SMP developed planting plans for a suite of channel forms that vary based upon channel bottom width and access road location, which affect channel capacity (See SMP Manual [Horizon Water and Environment 2009], Appendix E for description of channel forms). The planting approach for Laguna 1 and Laguna 2 would largely follow the plan for channel form 1D, which has a wide channel bottom and access roads on the upper banks (Figure 8). Sonoma Water would document any differences from channel form 1D. Exposed soils at the bank repair sites will be seeded per erosion control BMPs. Toe trees will be installed on 15 foot centers in existing gaps on both sides of low-flow channel, as feasible. Upper bank trees will be installed in existing gaps at 40-foot centers (10-foot center if direct seeding is employed). A mix of approximately 2,000 in-stream graminoids, herbaceous perennials and upland grasses will also be installed throughout project area.

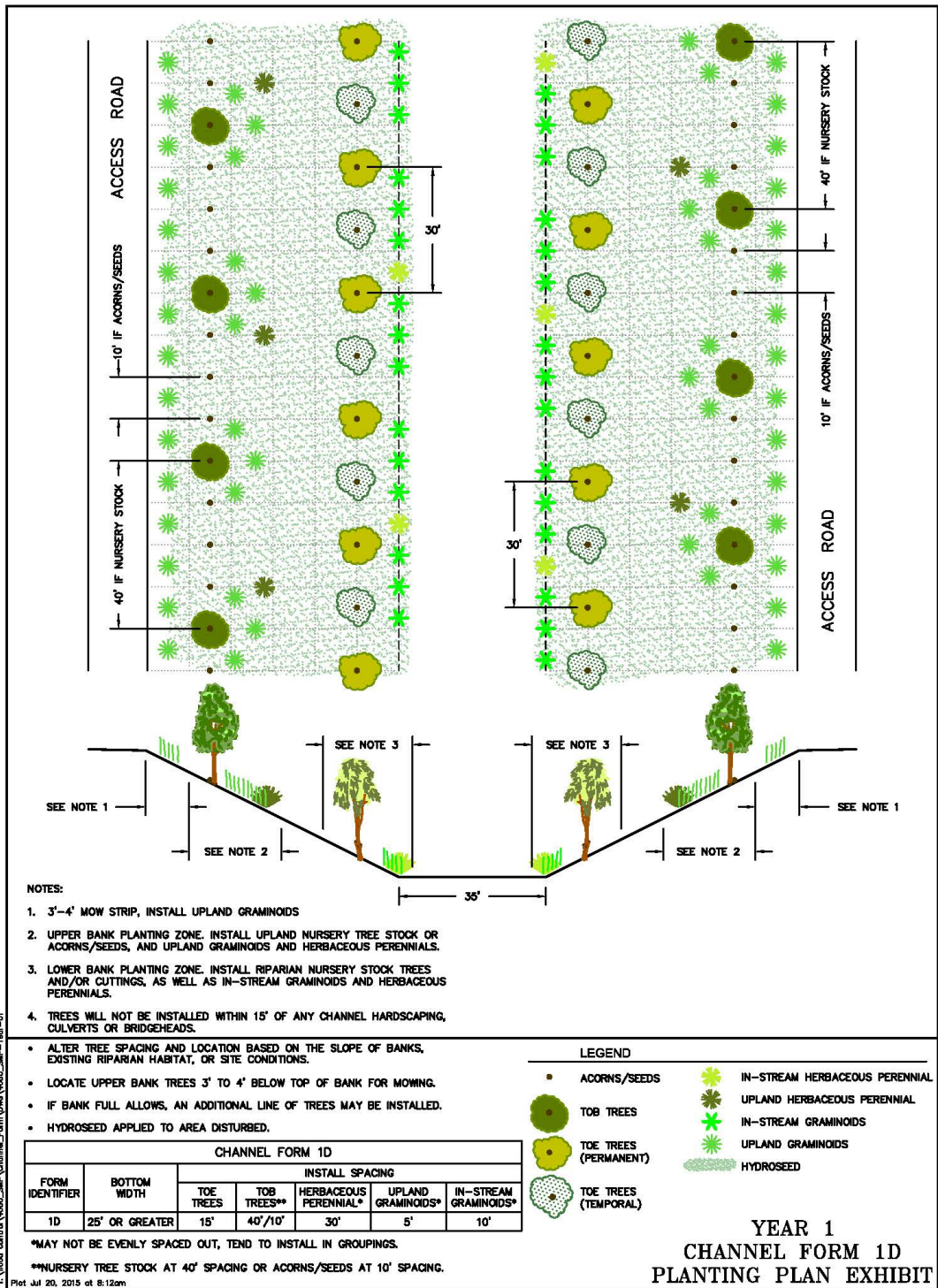


Figure 8. Channel form 1D planting plan for Laguna 1 and Laguna 2.

Impact Avoidance and Minimization

The SMP greatly reduces impacts through avoidance and minimization measures implemented within its overall approach with BMPs for each activity, including sediment disposal. The SMP approach reduces potential impacts through pre-maintenance planning and avoidance approaches, using a variety of impact avoidance and reduction measures, and by taking steps to reduce the overall need for maintenance work over the longer-term. Still, some program impacts are not entirely avoided or reduced by implementing the SMP approach. Such residual impacts require additional mitigation.

The Proposed Project would follow SMP guidelines for reach-scale sediment and vegetation management in engineered channels, and sediment disposal and adhere to BMPs to avoid and minimize impacts to environmental resources, particularly to aquatic habitats (Table 6; See Table 7-1 in Appendix D for full description of BMPs). The work would occur within the work window of June 15th to October 31st, but the specific implementation schedule and timing would be finalized upon acceptance of this proposal. If a significant rainfall occurs, all in-channel equipment and/or diversion structures shall be removed. Significant rainfall is defined as 0.5 inch of rain in a 24-hour period. Exposed soils in upland channel areas will be stabilized via hydroseeding or with erosion control fabric/blankets.

Table 6. Stream Maintenance Program Best Management Practices (BMPs) for proposed activities in Laguna 1 and Laguna 2.

BMP	Name	Sediment Removal	Willow Removal	Nursery Tree Planting	Sediment Disposal
GEN-1	Work Window	X	X		X
GEN-2	Staging and Stockpiling of Materials	X	X	X	X
GEN-3	Channel Access	X	X	X	
AQ-1	Dust Management	X	X	X	X
AQ-2	Enhanced Dust Management	X	X	X	X
BR-1	Area of Disturbance	X	X	X	
BR-2	Pre-maintenance Educational Training	X	X	X	
BR-4	Impact Avoidance and Minimization During Dewatering	X			
BR-5	Fish and Amphibian Species Relocation Plan	X			
BR-6	On-Call Wildlife Biologist	X	X	X	X
BR-7	Special Status Plant Survey	X	X	X	X
BR-8	Nesting Migratory Bird and Raptor Pre-maintenance Surveys	X	X	X	X
BR-9	California Freshwater Shrimp Avoidance and Impact Minimization for Vegetation Management	X	X		X
BR-10	California Red-legged Frog Avoidance and Impact Minimization Measures for Ground-Disturbing Activities	X	X	X	
BR-11	California Red-legged Frog Avoidance and Impact Minimization Measures for Vegetation Management		X	X	
BR-12	California Tiger Salamander Avoidance and Impact Minimization Measures for Sediment and Debris Removal	X	X		X
BR-13	California Tiger Salamander Avoidance and Impact Minimization Measures for Bank Stabilization				
BR-14	California Tiger Salamander Avoidance and Impact Minimization Measures for Vegetation Management		X	X	
BR-15	Foothill Yellow-legged Frog Avoidance and Impact Minimization Measures for Ground-Disturbing Activities. Includes springtime egg mass surveys at ground-disturbing project reaches with potential habitat.	X	X		
BR-16	Foothill Yellow-legged Frog Avoidance and Impact Minimization Measures for Vegetation Management		X		
BR-17	Western Pond Turtle Pre-maintenance Surveys for Ground-Disturbing Activities	X	X	X	
BR-18	Zone 1A Salmonid Avoidance and Impact Minimization Measures	X	X		
BR-19	Zones 2A and 3A Salmonid Avoidance and Impact Minimization Measures	X	X		

Table 6. Stream Maintenance Program Best Management Practices (BMPs) for proposed activities in Laguna 1 and Laguna 2.

BMP	Name	Sediment Removal	Willow Removal	Nursery Tree Planting	Sediment Disposal
CR-1	Phase I Cultural Investigation and Report	X			X
CR-2	Previously Undiscovered Cultural Resources	X	X	X	X
CR-3	Previously Undiscovered Paleontological Resources	X	X	X	X
HAZ-1	Spill Prevention and Response	X	X	X	X
HAZ-2	Equipment and Vehicle Maintenance	X	X	X	X
HAZ-3	Equipment and Vehicle Cleaning	X	X	X	X
HAZ-4	Refueling	X	X	X	X
HAZ-5	On-Site Hazardous Materials Management	X	X	X	X
HAZ-6	Existing Hazardous Sites or Waste	X	X	X	X
HAZ-7	Fire Prevention	X	X	X	X
HAZ-8	Testing and Disposal of Spoils	X			X
VEG-1	Removal of Existing Vegetation	X	X	X	
VEG-2	Use of Herbicides		X		
VEG-3	Planting and Revegetation After Soil Disturbance	X		X	
WQ-1	Apply Erosion Control Fabric to or Hydroseeding of Exposed Soils	X	X		X
WQ-2	Prevent Scour Downstream of Sediment Removal	X			
WQ-3	In-Channel Grading	X			
GN-1	Work Site Housekeeping	X	X	X	X
GN-2	Public Outreach	X	X	X	X
GN-3	Noise Control	X	X	X	X
GN-4	Traffic Flow, Pedestrians, and Safety Measures	X	X	X	X
GN-5	Odors	X			X

Project Verification, Monitoring and Reporting

Verification

Project Implementation

When projects are implemented, the SMP Manual directs that data will be collected at the project area prior to, during, and immediately after, project implementation, as required by regulatory permits. Data collected will include: water quality monitoring data (turbidity, temperature, pH); before, during, and after photos; cross section or topographic surveys after sediment removal is conducted; quantification of material removed or placed, length of stream channel maintained; sensitive species or other resources encountered at the site during pre-construction surveys or during project implementation; quantity, characteristics, and location of any debris disposed off-site; and any additional information.

Upon implementation, the Proposed Project will be evaluated and reviewed in the same manner as other SMP reach-scale sediment management and vegetation management projects. The area and depth of sediment removal estimated in Table 1 will be verified by as-built cross-sectional or topographic surveys of Laguna 1 and Laguna 2, similar to as-built surveys presented in SMP annual reports. Implementation of BMPs and revegetation for the Proposed Project will also be confirmed through an annual reporting process. A third-party credit verifier (e.g., a resource conservation district or a qualified non-profit organization) will review the list of BMPs for each project activity (Table 6) and verify BMP application. Implementation of revegetation plan will be confirmed through comparison of Laguna 1 and Laguna 2 to the planting plan for channel form 1D (Figure 8), through photo documentation of the site, and through documentation of the exact plant species and quantities installed in the project area. The extent of *Ludwigia* remaining after project implementation will also be recorded along transects used for as-built cross-sectional surveys.

Reduced Internal Phosphorous Loading

Topographic surveys, transects, and low elevation aerial photographs collected by a small unmanned aerial system (sUAS [drone]) will be used to verify the area of sediment (A [m^2]) contributing to internal loading ($[P_{load}]$ in Equation [2]). Pre-project and as-built topographic surveys (described above) will verify the extent and area of sediment and *Ludwigia* removal before and after project implementation. Sonoma Water is also licensed by the United States Federal Aviation Administration to fly a drone, where permissible. The drone collects a series of overlapping aerial photographs that Sonoma Water will process into a single high-resolution, distortion-free orthophotograph from which it is possible to map the area of *Ludwigia*, riparian vegetation, bank vegetation, and open water (Figure 9).

Water surface elevation (stage) and daily discharge from USGS Gage #11465680 (Laguna de Santa Rosa at Stony Point Road near Cotati CA) just downstream of the Proposed Project will be used to determine the inundation depth and duration of the project area to determine the internal loading time period (T [days]) contributing to P_{load} in Equation [2]. Stage height above surveyed floodplain elevation would indicate floodplain inundation and potentially anoxic

conditions. USGS Gage #11465680 records stage at 15-minute intervals, allowing a calculation of the duration of the water surface above a specified datum (e.g., floodplain elevation). The average duration of inundation for the most recent water year (WY; October 1 at the end of one year through September 30 of the next year) prior to project implementation would account for recent and current project area conditions. The average duration in days (divided in half to account for diel variability in photosynthetic activity) will be used as T (internal loading time period [day]) in Equation [2].

The actual water quality benefit from reduced internal loading due to sediment and *Ludwigia* removal will be calculated by comparing phosphorous loading under pre-project conditions (before sediment removal) and post-project conditions (after sediment removal). The actual benefit can be calculated from

$$P_{reduction} = P_{pre} - P_{post} \quad [6]$$

where:

$P_{reduction}$	= Phosphorus load reduction, g
P_{pre}	= Pre-project phosphorus load, g
P_{post}	= Post-project phosphorous load, g

Equation [6] uses results from Equation [2] (P_{load}) to calculate pre-project (P_{pre}) and post-project phosphorous (P_{post}) loads.

Given the project design, with a low flow channel meant to drain the floodplain and create conditions less suitable for *Ludwigia* and emergent (submerged) aquatic plants, the expected post implementation phosphorous (P_{post}) contribution from internal loading is anticipated to be zero. Low oxygen conditions would not be expected to occur in areas outside of the constructed low flow channel as *Ludwigia* would no longer be present.

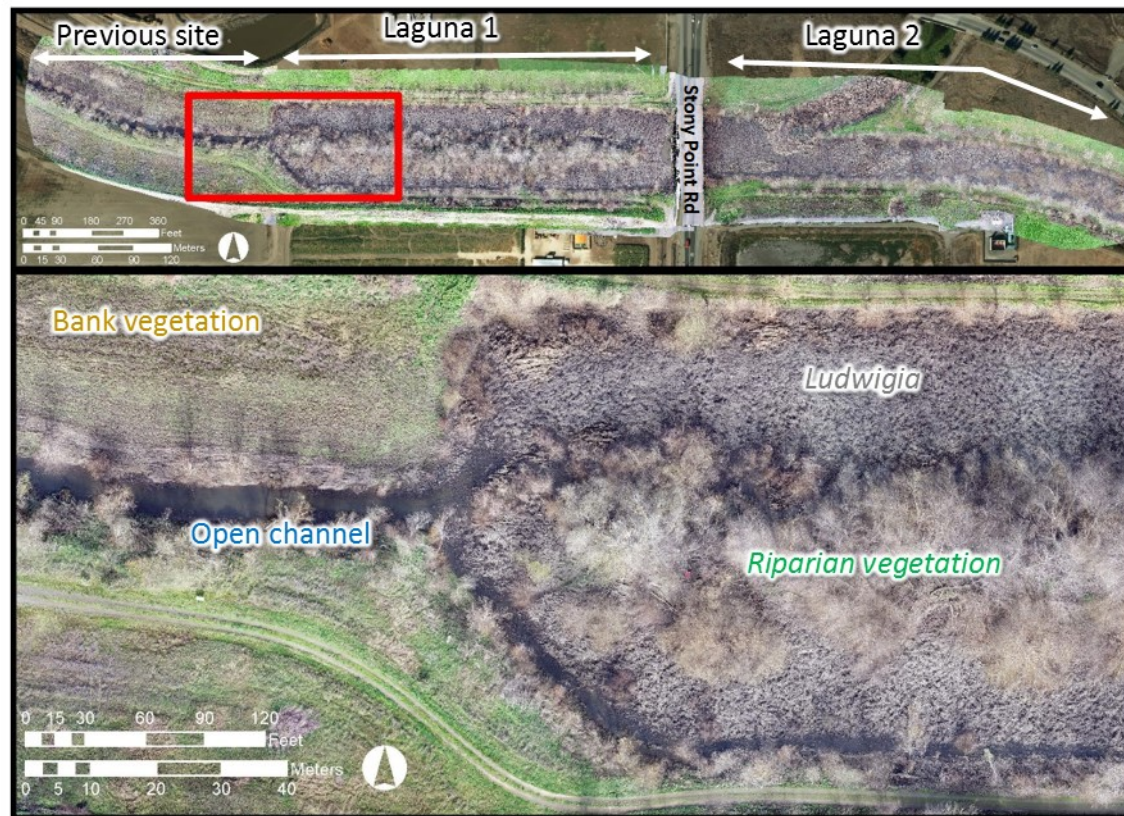


Figure 9. Orthophotograph of Laguna 1, Laguna 2, and a previously excavated site near Stony Point Road showing areas of *Ludwigia*, riparian vegetation, bank vegetation, and open channel (Photo taken January 2019).

Direct Removal of Phosphorous

Area and Depth of Sediment Removed

The verified area (A_{sed} , area of sediment removal [m²]) and depth (D_{root} , mean *Ludwigia* root depth [m]) of sediment removed will be used to calculate, in part, sediment load (S_{load}) in Equation [3] and phosphorous load (P_{load}) in Equation [4]. The initial estimated volume of sediment removed assumed mean excavation depths (Table 1; 2.0 ft in Laguna 1 and 1.9 ft in Laguna 2) equal to or less than the mean rooting depth of *Ludwigia* (2 ft below the soil surface (Hussner 2010, as cited in Freshwater Trust [2017b])). As-built surveys after project implementation will verify the actual excavation depth required to remove *Ludwigia* to its roots, which may exceed depths estimated from design drawings (Figure 4) or the mean depth from Hussner (2010, as cited in Freshwater Trust [2017b])). As built surveys will also verify the amount of sediment removed by Sonoma Water.

Bulk Density and Phosphorus Concentration

Sediment samples will be collected in the project area and analyzed to determine values for bulk density (ρ_{sed} ; sediment bulk density, kg/m³y) and phosphorous concentration (P_{sed} ; sediment total phosphorus concentration, g/kg) to calculate, in part, sediment load (S_{load}) in Equation [3] and phosphorous load (P_{load}) in Equation [4]. The SMP Manual recommends that for sediment removal projects of more than 250 yd³, one sample should be collected for every 500 yd³ increment (Horizon Water and Environment 2009). For project sites that require more than one sample, such as Laguna 1 and Laguna 2, as they both exceed 500 yd³ (Table 7), sampling locations should be selected to target conditions at the upstream and downstream ends of the reach. Further, the SMP Manual recommends that for long reaches that are not particularly wide or deep with sediment, it would be preferable to take sediment samples for every 1,000 ft length rather than per 500 yd³ increment. But, as per amended MRP R1-2009-0049, no more than three composite samples shall be collected to characterize sediment quality from long, homogeneous reaches of sediment deposits (NCRWQCB 2016). Based upon the above standards, Sonoma Water will collect three sediment samples prior to project implementation, each consisting of two sediment cores (composite samples), within Laguna 1 and Laguna 2 (Table 7). The sediment samples will be collected along previously established transects and within the project area and within the area of sediment removal (See Appendix C for design drawing and cross-section locations).

Table 7. Proposed Sediment Sampling Plan Laguna 1 and Laguna 2.

Reach number	Length (ft)	Volume (yd ³)	Number of samples*	Sample locations
Laguna 1 ^a	1,223	2,174	3	Sample 1: Cores at Stations 88+57 and 89+68 Sample 2: Cores at Stations 91+37 and 93+58 Sample 3: Cores at Stations 96+52 and 98+64
Laguna 2 ^a	3,053	5,156	3	Sample 1: Cores at Stations 105+32 and 107+30 Sample 2: Cores at Stations 115+33 and 117+49 Sample 3: Cores at Stations 127+19 and 128+30

^aPer Amended MRP R1-2009-0049, Sampling Frequency and Locations: *No more than three composite samples shall be collected to characterize sediment quality from long, homogeneous reaches of sediment deposits.*

Monitoring

Vegetation monitoring

Sonoma Water will maintain the project under the guidelines detailed in the SMP Manual to ensure continued nutrient reductions and water quality benefits for the life of the credit eligibility period (Table 4). The SMP includes a five-year monitoring requirement to validate the success of restoration efforts, but in this case riparian vegetation monitoring will continue for 10 years after project implementation. Generally riparian restoration under the SMP, particularly for riparian trees, involves a successional approach, where many more trees than can be supported on the site long term are installed and monitored (temporary versus permanent trees). These “temporary” trees are intended to provide additional ecological function while the “permanent trees” establish. While these trees are often the same species, as they grow and mature, temporary trees are removed to maintain roughness allowances usually between 3 and 7 years following establishment. During the validation period, installed “permanent” plant materials must meet a 75 percent success metric overall.

Vegetation monitoring will be conducted at the project site by the third party credit verifier for the duration of the eligibility period (10 years) following construction and planting. Information collected will include the number or percent of successional species (trees and shrubs) installed and surviving, line intercept cover measurements to track establishment of herbaceous understory and emergent species, square footage of channel planted, estimated percent canopy cover, number or percent of planted trees and shrubs surviving, and the annual cost for implementing the planting program. Site conditions will be documented annually by taking repeat photographs at set reference locations. Monitoring of invasive and exotic plant removal will include tracking the number of invasive or exotic trees removed, length of channel of removal activities, area of removal activities for shrubby or herbaceous species, observing whether recolonization of invasives occurs after removal, and documenting the annual cost for invasive and exotic removal. The monitoring data will be reviewed in annual reports (see below) to evaluate the overall success of the revegetation approach.

Reduced Internal Phosphorous Loading

As described above, channel area covered with *Ludwigia* experiences anoxic conditions that lead to phosphorous flux from the sediment to the water column. As such, monitoring of reduced internal phosphorous loading will focus on the presence, extent, and area of *Ludwigia* within the project area, and follow methods used to verify pre- and post-construction internal loading. Topographic surveys, transects, and low elevation aerial photographs collected by a drone will be used to annually verify the area of *Ludwigia* (A [m^2]) contributing to internal loading ($[P_{load}]$ in Equation [2]). 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 (Figure 9).

Water surface elevation (stage) and daily discharge from USGS Gage #11465680 (Laguna de Santa Rosa at Stony Point Road near Cotati CA) just downstream of the Proposed Project will be used to determine the inundation depth and duration of the project area to determine the internal loading time period (T [days]) contributing to P_{load} in Equation [2] over the preceding year. Stage height above surveyed floodplain elevation would indicate floodplain inundation and potentially anoxic conditions in areas occupied by *Ludwigia*. USGS Gage #11465680 records stage at 15-minute intervals, allowing a calculation of the duration of the water surface above a specified datum (e.g., floodplain elevation). The average duration of inundation over the previous water year (WY; October 1 at the end of one year through September 30 of the next year) would account for recent project area conditions. The average duration in days (divided in half to account for diel variability in photosynthetic activity) will be used as T (internal loading time period [day]) in Equation [2].

The water quality benefit from reduced internal loading due to sediment and *Ludwigia* removal will be calculated by comparing phosphorous loading under pre-project conditions (before sediment removal) and post-project (year [t+1]) conditions (t+1 years after sediment removal). The actual benefit can be calculated from

$$P_{reduction (year [t+1])} = P_{pre} - P_{post (year [t+1])} \quad [7]$$

where:

$P_{reduction (year [t+1])}$	= Phosphorus load reduction, g
P_{pre}	= Pre-project phosphorus load, g
$P_{post (year [t+1])}$	= Post-project (year [t+1]) phosphorous load, g

Equation [7] uses results from Equation [2] (P_{load}) to calculate pre-project (P_{pre}) and post-project phosphorous ($P_{post (year [t+1])}$) loads.

As observed just downstream, the post-project area of *Ludwigia* within the channel will likely remain low compared to pre-project conditions (Figure 9). Low oxygen conditions would not be expected to occur in areas outside of the constructed low flow channel as *Ludwigia* would no longer be present. Still, monitoring will document the area and extent of *Ludwigia* and document the duration of inundation to estimate annual phosphorous loading. During the project life, *Ludwigia* area must not exceed 25 percent of the pre-project area (i.e., should remain 75 percent lower) before triggering maintenance by Sonoma Water.

Direct Removal of Phosphorous

The width, depth, and area of the excavated portions of Laguna 1 and Laguna 2 will be monitored annually through topographic surveys or repeat cross-sectional surveys. If possible Sonoma Water or the third party credit verifier will use topographic data to construct a digital elevation model (DEM) of the project area within a geographic information system. Successive, annual DEMs will be compared to one another to detect and quantify geomorphic change (scour and fill) from year to year (Figure 10). The geomorphic change analysis would quantify the volumes scour and fill separately, quantify the net volume of scour or fill, and identify areas of

channel degradation and aggradation. The data would characterize reach-wide geomorphic processes and potentially identify local, sub-reach areas needing maintenance during the project life for sediment removal (three years).

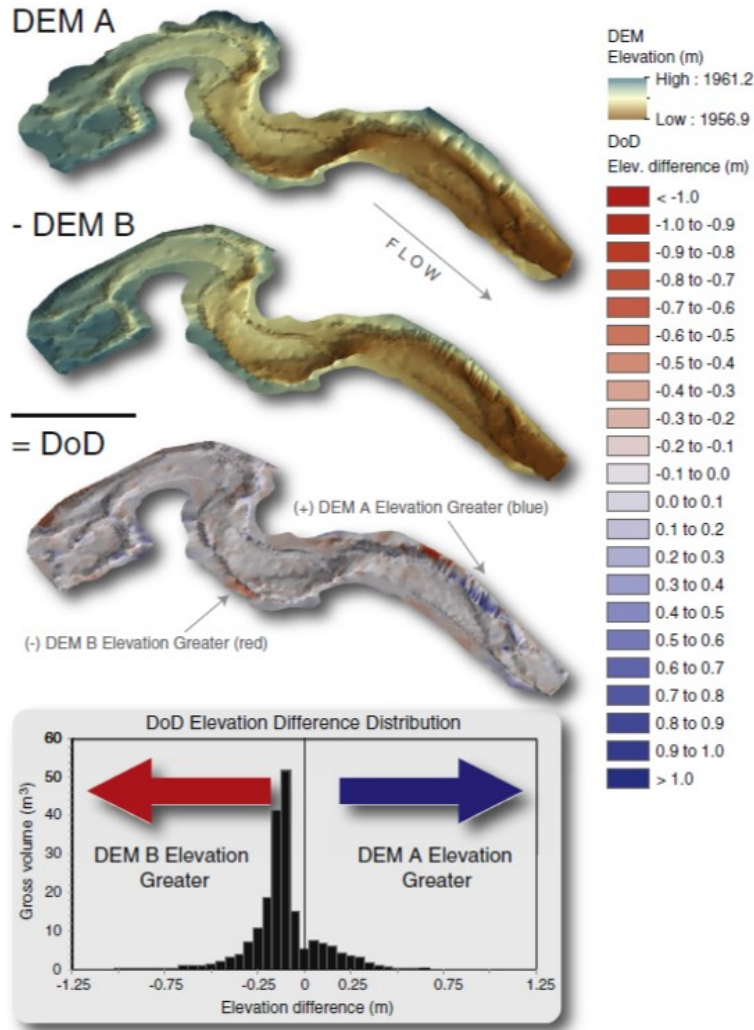


Figure 10. Conceptual figure showing geomorphic change calculated by comparing digital elevation models from one time period (DEM A) to the next (DEM B) to create a spatially explicit DEM of difference (DoD) showing areas of scour and fill. The analysis also estimates volumes of scour and fill (From Bangen et al. 2013).

Reporting

Each year, Sonoma Water summarizes its stream maintenance activities in an annual report to fulfill reporting requirements to the following regulatory agencies: California Department of Fish and Wildlife (CDFW); National Marine Fisheries Service (NMFS); North Coast Regional Water Quality Control Board (NCRWQCB); San Francisco Bay Regional Water Quality Control Board (SFBRWQCB); United States Army Corps of Engineers (USACE); and United States Fish and Wildlife Service (USFWS). Monitoring of site conditions will be the responsibility of the third party credit verifier, but it will be Sonoma Water's responsibility to communicate monitoring results annually as part of the Nutrient offset reporting process. Sonoma Water will be responsible for coordinating monitoring reports to the relevant agencies. The reports will include a description of how the project achieved objectives identified in the proposal, how the project is developing over time, and if the project requires adaptive management or maintenance.

Site conditions for credit-generating projects approved under most water quality credit trading frameworks must be independently assessed and documented by a credit seller before and after project implementation. Sonoma Water will enter into an agreement with a third party to provide initial and annual credit verification.

Initial project/credit verification will include:

- An administrative review to confirm project eligibility (Regional Board)
- A technical review to confirm accurate quantification of estimated water quality credits and completeness of background information (Regional Board or third party credit verifier)
- An implementation review to confirm project installation consistent with the approved project proposal (third party credit verifier)
 - Verify accuracy of measurements used to calculate credits
 - Determine whether the project was built according to the approved design. Any deviations would be noted and assessed to determine potential changes to credit calculation

Annual project/credit verification will include:

- Regular site visits throughout the life of credits to assure project is maintained adequately to meet performance standards and generate credits (third party credit verifier)
 - Inspection of all components of the project and surrounding area to ensure proper function/operation (using final engineering specifications)
 - Documentation of project operation and maintenance through forms and photographs

- Notification of deficiencies to credit seller (third party credit verifier)
 - All deficiencies would be reported to Sonoma Water after receiving the inspection documentation
 - These would be appropriately corrected to previously specified conditions within 15 days of discovery, or within 30 days if an alternative improvement is necessary to avoid future failures (the Regional Board will be notified of this latter condition where applicable)
 - Third party credit verifier would complete a second site visit verifying deficiencies were corrected

- Verification letter stating the project passed the annual inspection will be included in Sonoma Water's annual report (separate from SMP annual report) to Regional Board (third party credit verifier)

- Verification letters for all phosphorus reduction practices will be forwarded to the NCRWQCB as proof that offset credits are being maintained (third party credit verifier)

Description of Anticipated Permitting Needs and CEQA Documentation

Sonoma Water will be responsible for CEQA documentation and obtaining all permits related to the Proposed Project. The project will be conducted as part of Sonoma Water's Stream Maintenance Program. An Environmental Impact Report (EIR) was prepared for the SMP in 2009. Impacts and required mitigation and BMPs associated specifically with the Proposed Project are currently detailed in the EIR and Sonoma Water holds the needed regulatory permits. Currently to conduct flood control work in Sonoma County, Sonoma Water complies with the following permits including:

- Individual Permit Number 2009-00079n, Sonoma County Stream Maintenance Program, Clean Water Act Section 404: regulates the discharge of dredged and fill materials into waters of the United States; administered by the San Francisco District, Army Corps of Engineers
- Order No. R1-2009-0049 Waste Discharge Requirements and 401 Water Quality Certification for Sonoma County Water Agency Stream Maintenance Program WDID NO.1B09026WNSO, Clean Water Act Section 401: regulates: activities that may result in the discharge of dredged and fill materials into surface waters of the United States (including wetlands) administered by Region 1 North Coast Regional Water Quality Control Board
- Final Lake and Streambed Alteration Agreement, Notification Number 1600-2009-0399-R3 California Fish and Wildlife Code Section 1602: regulates projects that affect the flow, channel, or banks of rivers, streams, and lakes; administered by Region 3 Bay Delta Region of the California Department of Fish and Wildlife
- Sonoma County Anti Roiling Permit: The ordinance is administered by Sonoma County Permit and Resource Management Department and regulates work in riparian zones.

The Sonoma County Board of Supervisors approves roiling permits under Section VIII of the Water Clarity Ordinance of the County of Sonoma, Ordinance No. 3836R.

Sonoma Water will be responsible for conducting CEQA and obtaining all permits related to the project. If additional CEQA analysis and permits are required, Sonoma Water will prepare documentation as appropriate to ensure proper practices are used for excavation and work within a waterway to ensure no significant, negative impact to the environment. In summary, Sonoma Water currently possesses the required CEQA and regulatory permits to implement the proposed credit trading project as described. In the event project parameters change enough to be ineligible under existing permits and CEQA, Sonoma Water would develop the adequate CEQA analysis and obtain permits necessary to implement the Proposed Project.

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Appendices

Appendix A. The Freshwater Trust. 2017a. Water Quality Trading Program Design and Analysis, Task 3 Legal and Policy Gap Analysis. Prepared for the Sonoma County Water Agency. The Freshwater Trust, Portland, OR.

Appendix B. The Freshwater Trust. 2017b. Water Quality Trading Program Design and Analysis, Task 2 Environmental Benefit Calculation. Prepared for the Sonoma County Water Agency. The Freshwater Trust, Portland, OR.

Appendix C. Sonoma County Water Agency. 2016 SMP - Laguna de Santa Rosa Watershed - Zone 1a; Laguna de Santa Rosa - SMP-1 and SMP-2 (2016) Reach Sediment Removal. Design Drawings.

Appendix D. Horizon Water and Environment. 2009. Stream Maintenance Program Manual.
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