STATE OF CALIFORNIA
REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

STAFF SUMMARY REPORT (Kevin B. Lunde)
MEETING DATE: FEBRUARY 12, 2014

ITEM: **6**

SUBJECT: **Napa River and Sonoma Creek Non-tidal Portions – Delist for Nutrients from Impaired Water Bodies List –** Adoption of Resolution Recommending Delisting

DISCUSSION: The Revised Tentative Resolution (Appendix A) would approve two revisions to the federal Clean Water Act (CWA) section 303(d) list of impaired waters (303(d) list) in our Region. In accordance with State policy, Board staff has determined that the non-tidal portions of the Napa River and Sonoma Creek are not impaired by nutrients and therefore should be "delisted" or removed from the 303(d) list.

One of the Board's functions is to evaluate the water quality condition of all waters in the Region. Under CWA regulations, the State is required to report to the U.S. EPA on the status of water quality in the State and provide an updated list of impaired water bodies (the 303(d) list) based on that status. Water bodies placed on the 303(d) list usually require development of a total maximum daily load (TMDL) to address the impairment. In preparation for the next listing/delisting cycle, staff is bringing this item to the Board for its consideration.

The main stems of the Napa River and Sonoma Creek were placed on the 303(d) list in the 1970s (Napa) and 1980s (Sonoma) for impairment due to elevated levels of nutrients (nitrates and phosphorus) that can cause excessive algae growth, known as eutrophication. Eutrophic waters can significantly alter dissolved oxygen levels and pH, which are critical to aquatic wildlife, and can impact beneficial uses including cold freshwater habitat, warm freshwater habitat, and recreation. Staff began working on developing TMDLs for these two water bodies in 2003. Since then, data have been collected that demonstrate improved water quality conditions and support removing these two water bodies from the 303(d) list for impairment by nutrients. These water bodies will remain on the 303(d) list for pathogens and sediment, for which the Board has already adopted TMDLs.

The Revised Staff Report (Appendix B) provides our assessment of all readily-available data related to nutrients for the non-tidal portions of the Napa River's and Sonoma Creek's main stem and tributaries. In assessing these waters, we applied a weight of evidence approach, because there are no numeric water quality objectives or U.S. EPA criteria for algae indicators that could be used to determine impairment. Because evaluation guidelines for appropriate amounts of algae in freshwater streams are available, we focused our analysis on the non-tidal, freshwater portions of these water bodies. The reviewed data is of good quality, as indicated by quality assurance and quality control procedures, and meets the spatial and temporal requirements of the State Board's Listing Policy.

Our assessment shows that benthic (i.e., bottom-growing) algae levels were below the available evaluation guidelines for chlorophyll *a* and percent cover of algae. Those two indicators directly assess the amount of benthic algae growing in the stream. At locations where an exceedance of one benthic algae indicator was observed, a second benthic algae indicator and subsequent indicators, such as pH or dissolved oxygen, did not show consistent signs of eutrophication. Nutrients such as nitrite, nitrate+nitrite, and total and un-ionized ammonia and water column chlorophyll *a* levels were all below levels of concern. We conclude that water quality conditions in the non-tidal portions of the Napa River and Sonoma Creek are meeting the Basin Plan narrative biostimulatory water quality objective with respect to nutrients and eutrophication.

Comments Received: Public notice of this hearing occurred in December, and the draft tentative resolution and supporting staff report were circulated for public comment ending on January 15, 2014. We received four comment letters (Appendix C) on the draft tentative resolution and staff report. Two letters were supportive of the delisting recommendation. Two letters disagreed with our assessment of the data used to support delisting. Our responses to the comments received are provided in Appendix D, and we have revised the tentative resolution and staff report as appropriate. We plan to make a presentation to the Board at the Board meeting to further describe our basis for recommending delisting these stream segments for nutrient impairment.

RECOMMEN-DATION: Adoption of the Revised Tentative Resolution

APPENDIX A: Revised Tentative Resolution
APPENDIX B: Revised Staff Report
APPENDIX C: Comment Letters
APPENDIX D: Response to Comments

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

RESOLUTION NO. R2-2014-0006

RECOMMENDING CHANGES TO THE LIST OF WATER BODIES AS REQUIRED IN SECTION 303(d) OF THE CLEAN WATER ACT

WHEREAS, the California Regional Water Quality Control Board, San Francisco Bay Region (Water Board), finds that:

1. Section 303(d) of the federal Clean Water Act requires the State to identify waters within the State for which water quality standards are not attained; and

2. The Napa River and Sonoma Creek main stems currently are identified on California's Clean Water Act Section 303(d) List as impaired by nutrients, resulting in eutrophication (excessive algal growth); and

3. Water Board staff assembled and considered all readily available data to assess water quality conditions in the non-tidal portions of the Napa River and Sonoma Creek main stems and tributaries to evaluate this listing consistent with the Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (Listing Policy); and

4. Data used to evaluate nutrient impairment for both proposed delistings meet the spatial and temporal Listing Policy requirements for delisting (State Water Resources Control Board 2004); and

5. Data used for this analysis are high quality and meet Water Board quality assurance and quality control standards; and

6. This delisting relies on the weight of evidence approach using Section 4.11 of the Listing Policy because the evaluation focuses heavily on two lines of evidence based on algae biomass metrics that are not formally adopted water quality objectives or U.S. EPA criteria. Therefore, the single line of evidence binomial distribution approach described in Tables 4.1 or 4.2 of the Listing Policy does not apply. This is an appropriate approach; and

7. Each delisting is supported by a total of eight lines of evidence that evaluate the listing for biostimulatory nutrients. These evaluate: 1) benthic chlorophyll *a*, 2) percent macroalgae cover, 3) water column chlorophyll *a*, 4) nitrite, 5) nitrate + nitrite, 6) un-ionized ammonia, 7) total ammonia, and 8) pH; and

8. All lines of evidence indicate that both narrative and numeric water quality objectives are being met in the non-tidal portions of the Napa River and Sonoma Creek main stems and tributaries, and the water bodies are supporting all designated beneficial uses that could be affected by nutrients for which there are numeric evaluation guidelines; and

9. Water Board staff provided advance notice of the Water Board meeting and opportunity for public comment on the tentative resolution and associated staff report during a 30-day public comment period commencing on December 16, 2013; and

10. Water Board staff developed written responses to all public comments received and revised the tentative resolution and supporting staff report for the Water Board's consideration; and

11. The Water Board's approval of recommended modifications to California's Clean Water Act Section 303(d) List, and submittal to the State Water Resources Control Board for its consideration for approval, is not a "project" as defined in the California Environmental Quality Act (CEQA) (Pub. Res. Code § 21065) and the CEQA Guidelines (Cal. Code Regs., tit. 14, § 15378). The Water Board's approval of the recommended 303(d) list modifications is not an "activity which may cause either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment." (Pub. Res. Code § 21065.); and

12. The Listing Policy requires that the Water Board consider and approve each proposed list change; and

13. On February 12, 2014, the Water Board held a public hearing to consider the recommendations to change California's Clean Water Act Section 303(d) List for the Napa River and Sonoma Creek water bodies.

THEREFORE, BE IT RESOLVED that the Water Board approves removing the non-tidal Napa River main stem (a 36-mile reach) and the non-tidal Sonoma Creek main stem (a 23-mile reach) from California's Clean Water Act Section 303(d) List as being impaired for nutrients, as documented in the attached Staff Report.

BE IT FURTHER RESOLVED that the Water Board, in fulfillment of the requirements described in Section 303(d) of the federal Clean Water Act, hereby authorizes the Executive Officer to transmit the Water Board's recommended modifications to California's Clean Water Act Section 303(d) List, as detailed in the attached Staff Report dated December 16, 2013, to the State Water Resources Control Board for approval and submission to the United States Environmental Protection Agency for approval.

I, Bruce H. Wolfe, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of a resolution adopted by the California Regional Water Quality Control Board, San Francisco Bay Region, on February 12, 2014.

Digitally signed by Bruce H. Wolfe
DN: cn=Bruce H. Wolfe, o=SWRCB, ou=Region 2, email=bwolfe@waterboards.ca.gov, c=US
Date: 2014.02.18 13:04:48 -08'00'

Bruce H. Wolfe
Executive Office

Appendix B

Revised Staff Report

REVISED STAFF REPORT

Evaluation of Water Quality Conditions for Nutrients in Napa River and Sonoma Creek

Proposed Revision to Section 303(d) List

February 2014

Regional Water Quality Control Board
San Francisco Bay Region

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Contents

Executive Summary

The federal Clean Water Act requires that each state develop a list of impaired water bodies and associated pollutants under Section 303(d) of the Act. California's "303(d) list," after approval by the U.S. Environmental Protection Agency (U.S. EPA), sets the California Water Boards' (State Water Resources Control Board's [State Water Board] and nine Regional Water Quality Control Boards') action agenda for achieving or maintaining water quality standards in our state.

For more than 25 years the main stems of the Napa River and Sonoma Creek have been on the 303(d) list for impairment from elevated levels of nutrients (nitrates and phosphorus) that cause excessive algae growth, known as eutrophication. Eutrophic waters can significantly alter dissolved oxygen levels and pH, which are critical to aquatic wildlife and can impact recreational beneficial uses.

This report reviews all readily available data to assess current water quality conditions related to nutrients in the Napa River and Sonoma Creek main stem and tributaries. We used a weight of evidence approach because there are no numeric Water Quality Objectives or U.S. EPA criteria for algae-based indicators that could be used to determine whether these waters' beneficial uses are impaired by eutrophication. Because evaluation guidelines for appropriate amounts of algae in freshwater streams are available, we focused our analysis on the non-tidal, freshwater portions of the Napa River and Sonoma Creek. The reviewed data is of good quality, as indicated by quality assurance and quality control procedures, and meets the spatial and temporal requirements of the State Water Board's Listing Policy.

We produced eight lines of evidence, some of which directly examined how much algae was present in the Napa River and Sonoma Creek, while others assessed whether nutrients alone were present at toxic concentrations.

Our results show that benthic (i.e., bottom-growing) algae levels were below recently published evaluation guidelines for chlorophyll *a* and percent cover of algae. Those two indicators directly assess the amount of algae growing in the stream. Water column chlorophyll *a* levels were also below recently published evaluation guidelines. At locations where an exceedance of one benthic algae indicator was observed, a second benthic algae indicator and subsequent indicators, such as pH or dissolved oxygen, did not show consistent signs of eutrophication. Nutrients such as nitrite, nitrate, and ammonia were not found at concentrations that are directly toxic to humans or aquatic wildlife. In sum, we conclude that water quality conditions in the Napa River and Sonoma Creek are meeting the narrative biostimulatory Water Quality Objectives with respect to nutrients and eutrophication. Staff's analysis has determined that these water bodies are supporting designated beneficial uses that could be affected by nutrients for which there are numeric evaluation guidelines. Therefore, we propose to delist the non-tidal portion of the Napa River main stem and Sonoma Creek main stem for impairment caused by nutrients.

1 Napa River and Sonoma Creek: Proposed Delisting for Nutrients

1.1 Introduction and Rationale for Delisting

In 1976, the Napa River (River) main stem was identified on California's Clean Water Act Section 303(d) List (303(d) list) as impaired by excessive levels of nutrients, resulting in eutrophication (excessive algal growth). Ten years later, nearby Sonoma Creek (Creek) was added to the list, also for impairment by nutrients. San Francisco Bay Regional Water Quality Control Board (Water Board) staff began work developing water quality action plans ("total maximum daily loads" or TMDLs) for both water bodies that included data collection and analysis indicating that these waters were in fact no longer impaired by nutrient pollution. Building on these data, Water Board staff undertook the current project to complete a rigorous analysis of available data, water quality standards, and listing/delisting guidelines, aiming to develop a rationale for delisting non-tidal reaches of these waters. This review was complicated by a lack of numeric nutrient Water Quality Objectives in the Water Board's Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) sufficient to allow a bright-line determination of whether a river or creek is impaired by nutrients (Water Board 2013). The Basin Plan's narrative water quality objective for biostimulatory substances states that water bodies "shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses." Staff considered this objective along with regulatory guidance to make a determination of impairment.

Section 4.7.1 of the Listing Policy describes an approach to assessing excessive algae growth based on the binomial distribution found in Table 4.1. Although staff used Table 4.1 to evaluate nutrient-related toxicity, we used Section 4.11 (situation-specific weight of evidence delisting factor to evaluate impairment) to evaluate potential impairment of the narrative biostimulatory objective for the following reasons:

1) We are evaluating a narrative water quality objective using multiple lines of evidence and the evaluation guidelines for those lines of evidence are not formally adopted Water Quality Objectives or criteria;
2) The evaluation of the narrative biostimulatory objective is complicated by the fact that we are evaluating a substance that naturally occurs in streams and is affected by multiple co-factors;
3) Relatively few chlorophyll *a* samples are taken each year because results tend to be relatively consistent over weeks to months. As a result, there are insufficient samples to meet Table 4.1 requirements for each individual line of evidence. However, a single sample represents conditions over a substantial period of time;
4) Further, chlorophyll *a* data points are more expensive and time consuming to collect, so they are generally fewer in number than typical water chemistry measures;
5) This dataset does not contain enough samples to utilize Table 4.1 for each individual line of evidence related to algal biomass, although 134 algal biomass samples were collected across both watersheds; and

6) The negative effects of eutrophication on beneficial uses are interpreted by secondary indicators such as dissolved oxygen, pH, or nuisance odors.

Based on a weight of evidence approach to this work, Water Board staff believe that the non-tidal portions of the River and Creek should be delisted because these water bodies currently meet the Basin Plan's narrative objective for biostimulatory substances. This finding is based on the weight of evidence approach described in the State Water Board's Policy for Developing California's Clean Water Act Section 303(d) List (Listing Policy, Section 4.11; State Water Board 2004) and uses multiple lines of evidence as well as the most recent numeric evaluation guidelines. Further, both the River and Creek are currently attaining all applicable numeric Water Quality Objectives related to nutrient toxicity.

Data used for our analyses are high quality and meet Water Board quality assurance and quality control standards. Data collected in 2011-2012 were Surface Water Ambient Monitoring Program (SWAMP) compliant or qualified, meeting the rigorous criteria established by the SWAMP program. Previous data were analyzed by U.S. EPA (2009) and passed all relevant Quality Assurance (QA) and Quality Control (QC) requirements for that laboratory. The QC samples collected from the 2002-2004 collections were within expected ranges of precision and accuracy for the method (SFEI 2005).

In sum, staff's analysis determined that these water bodies support designated beneficial uses that could be affected by nutrients and for which there are numeric evaluation guidelines.

1.2 Weight of Evidence Approach to Delisting the Napa River

The datasets used to evaluate nutrient impairment in the River are both spatially representative of the watershed and span a decade. Staff compiled nutrient chemistry data from 2002-2004, 2009, and 2011-2012. We developed benthic algae-based lines of evidence using data collected most recently in 2011 and 2012, which represent current conditions in the watershed. Therefore, this dataset meets the spatial and temporal Listing Policy requirements.

We used three lines of evidence (i.e., water column chlorophyll *a*, benthic chlorophyll *a*, benthic percent macroalgae cover) to directly quantify the amount of algae in the stream, in order to determine if the narrative water quality objective for biostimulatory substances (i.e., eutrophication) is currently exceeded. However, because these algae-based metrics are not formally adopted numeric Water Quality Objectives or U.S. EPA Criteria, the binomial distribution approach used in Tables 4.1 or 4.2 of the Listing Policy does not apply (State Water Board 2004). In fact, the evaluation of eutrophic conditions requires the weight of evidence approach because the evaluation process examining a stream's trophic status requires measuring naturally occurring stream organisms (i.e., algae) and determining if the current amount of algae is affecting recreational beneficial uses or water quality parameters that influence aquatic life (e.g., pH and dissolved oxygen). Such an analysis requires the integration of secondary water quality indicators at sites with high algal biomass because the presence of algae alone does not demonstrate that aquatic impacts have occurred.

We developed a total of eight lines of evidence to evaluate the current listing for nutrients in the River (Table 6). We developed three direct lines of evidence (benthic chlorophyll *a*, benthic percent macroalgae cover, and water column chlorophyll *a*) and an indirect line of evidence (pH) using evaluation guidelines provided by Tetra Tech (2006), which showed that the narrative biostimulatory water quality objective was not exceeded. For the eutrophication-based lines of evidence (i.e., chlorophyll *a* and percent macroalgae cover) we collected 16 benthic chlorophyll *a*, 17 macroalgae percent cover, and 40 water column samples. However, these measures are fairly consistent over time, so they take into account water quality conditions for weeks to months around the sample date. The temporally integrative nature of the algal biomass lines of evidence is supported by growth rates of algae, and the minor change in percent algae cover observed across the summer in 2012 at six sites. As a result, we are confident that the weight of evidence approach is appropriate for this analysis. For the four lines of evidence regarding nutrients with direct toxic effects (e.g., un-ionized ammonia, total ammonia, nitrite, and nitrate + nitrite), we used Listing Policy Table 4.1 criteria for toxicants to show that exceedances have been below the maximum number of exceedances allowed to remove a water segment and that municipal, agricultural, and aquatic life beneficial uses were not affected by nutrient toxicity.

The nuisance algae indicators showed that the River is not impaired for nutrients because they had a low rate of exceedance of the applicable guidelines; for those instances, the secondary indicators were not consistently exceeded. Of the samples collected in 2011 and 2012, we observed two (12.5 percent) exceedances for chlorophyll *a* based on the Cold Freshwater Habitat beneficial use threshold of 150 mg/m^2, and two exceedances (11.8 percent) of the percent filamentous cover threshold of 30 percent. At the three sampling locations where we observed exceedances of these evaluation guidelines, the alternate algae indicator and secondary indicators (e.g., pH and dissolved oxygen) showed that potentially impacted beneficial uses were not affected by nutrients.

Following the guidance in 4.11 of the Listing Policy, we propose the following:

- Delist the Napa River water body segment from the River's headwaters to the City of Napa (at Trancas Street) for eutrophication related to nutrients.
- Do not change the original listing for the River from the City of Napa at Trancas Street to the River mouth because this tidal portion of the stream should be evaluated using estuarine-based sampling methods and numeric endpoints. Freshwater standards do not apply to this tidally-influenced reach.

The Water Board is currently developing an assessment framework to evaluate impairment due to nutrients in tidal areas of San Francisco Bay, and, when that process is complete, we expect to collect data to evaluate the tidal portion of the River.

1.3 Weight of Evidence Approach to Delisting Sonoma Creek

The datasets used to evaluate nutrient impairment in the Creek are both spatially representative of the watershed and span a decade. Nutrient chemistry data were collected from 2002 (fall), 2003 (winter, summer), 2004 (spring), 2009 (summer), 2011 (late summer) 2012 (summer, late summer). The benthic algae-based lines of evidence were developed using data collected most recently in late summer of 2011 and 2012 and represent current conditions in the watershed. Therefore, this dataset meets the spatial and temporal Listing Policy requirements (State Water Board 2004).

We used three lines of evidence (i.e., water column chlorophyll *a*, benthic chlorophyll *a*, and benthic percent macroalgae cover) to directly quantify the amount of algae in the stream, in order to determine if the narrative water quality objective for biostimulatory substances (i.e., eutrophication) is currently exceeded. However, because these algae-based metrics are not formally adopted numeric Water Quality Objectives or U.S. EPA Criteria, the binomial distribution approach used in Tables 4.1 or 4.2 of the Listing Policy does not apply (State Water Board 2004). In fact, the evaluation of eutrophic conditions requires the weight of evidence approach because the evaluation process examining a stream's trophic status requires measuring naturally occurring stream organisms (i.e., algae) and determining if the current amount of algae is affecting recreational beneficial uses or water quality parameters that influence aquatic life (e.g., pH and dissolved oxygen). Such an analysis requires the integration of secondary water quality indicators at sites with high algal biomass because the presence of algae alone does not demonstrate that aquatic impacts have occurred.

We developed a total of eight lines of evidence to evaluate the current listing for nutrients in the Creek (Table 13). We developed three direct lines of evidence (benthic chlorophyll *a*, benthic percent macroalgae cover, water column chlorophyll *a*) and an indirect line of evidence (pH) using evaluation guidelines provided by Tetra Tech (2006), which showed that the narrative biostimulatory water quality objective was not exceeded. For the eutrophication-based lines of evidence (i.e., chlorophyll *a* and percent macroalgae cover) we collected 18 benthic chlorophyll *a*, 18 macroalgae percent cover, and 25 water column samples. However, these measures are fairly consistent over time, so they take into account water quality conditions for weeks to months around the sample date. The temporally integrative nature of the algal biomass lines of evidence is supported by growth rates of algae, and the minor change in percent algae cover observed across the summer in 2012 at six sites. As a result, we are confident that the weight of evidence approach is appropriate for this analysis. For the four lines of evidence regarding nutrients with direct toxic effects (i.e., un-ionized ammonia, total ammonia, nitrite, and nitrate + nitrite), we used Listing Policy Table 4.1 criteria for toxicants to show that exceedances have been below the maximum number of exceedances allowed to remove a water segment and that municipal, agricultural, and aquatic life beneficial uses were not affected by nutrient toxicity.

The nuisance algae indicators showed that the Creek is not impaired for nutrients because they had a low rate of exceedance of the applicable guidelines, and for those instances, the secondary indicators were not consistently exceeded. Of the samples collected in 2011 and 2012, we observed one (5.5 percent) exceedance for chlorophyll *a* based on the Cold Freshwater Habitat beneficial use threshold of 150 mg/m^2, and no exceedances of the percent filamentous cover threshold of 30 percent. At the three sampling locations where we observed exceedances of these evaluation guidelines, the alternate algae indicator and secondary indicators (e.g., pH and dissolved oxygen) showed that potentially impacted beneficial uses were not affected by nutrients.

Following the guidance in 4.11 of the Listing Policy, we propose the following:

- Delist the Sonoma Creek water body segment from the Creek's headwaters to Hwy 121 for eutrophication related to nutrients.
- Do not change the original listing for the Creek from Hwy 121 to the Creek mouth because this tidal portion of the stream should be evaluated using estuarine-based sampling methods and numeric endpoints. Freshwater standards do not apply to this tidally-influenced reach.

The Water Board is currently developing an assessment framework to evaluate impairment due to nutrients in tidal areas of San Francisco Bay, and, when that process is complete, we expect to collect data to evaluate the tidal portion of the Creek.

2 Water Quality

2.1 Background on Water Quality Impairments Associated with Nutrients

Water quality impairment from nutrients is usually associated with excess concentrations of nitrogen and phosphorus, as these are usually growth-limiting in freshwaters. The primary consequence of excess nutrients is eutrophication, the stimulation of excessive algae or weedy plant growth. Algae blooms often occur in the form of large floating mats of filamentous algae, but excessive algae can also grow on the stream bottom. Algae blooms can cause severe changes in dissolved oxygen, significantly affecting aquatic life beneficial uses, and certain types of algae (e.g., cyanobacteria) can produce toxins that are harmful to wildlife, domestic animals, and humans. Additionally, nuisance algae levels can impair recreation-based beneficial uses by producing strong decaying odors or preventing suitable swimming or wading conditions. Therefore, understanding the levels and behavior of nitrogen and phosphorus in water bodies is an important step in preventing eutrophic conditions. Reductions in nutrients can be achieved through many actions depending on their sources.

Nitrogen and phosphorus are usually transported to a stream in dissolved and particulate forms. The dissolved inorganic form of phosphorus is orthophosphate, PO_4^{3-} (US Department of Agriculture, 1999), which is the form in which it is most bioavailable in streams. However, most of the phosphorus in the environment is in particulate forms consisting of either phosphate adsorbed on mineral surfaces, or iron, aluminum or calcium phosphate minerals that are relatively insoluble. In natural systems, the sources of orthophosphate are the decomposition of organic phosphorus-containing materials and the release of adsorbed orthophosphate. These two processes are slow compared to normal stream flow. Therefore, the loads of orthophosphate to a stream dictate the impact of this nutrient on algal growth.

Dissolved nitrogen forms include ammonium, nitrate, and nitrite (US Department of Agriculture, 1999). Nitrate is the stable form in streams, so nitrite concentrations are generally lower than nitrate. Nitrate and ammonium are the dissolved nitrogen species that are bioavailable for algal growth. In natural systems, the source of nitrate and ammonium is the decomposition of materials containing organic nitrogen. The decomposition process is slow compared to normal stream flow, and ammonium readily converts to nitrate in surface waters. Therefore, the loads of nitrate usually dictate the impact of nitrogen on algal growth.

Both nitrogen and phosphorus can also occur as dissolved organic ions, which may also be bioavailable. Overall, however, the loadings of nitrate and orthophosphate into a stream determine the potential for eutrophication Tetra Tech 2006).

While high nutrient loads often result in nuisance algae growth, a number of other variables, such as sunlight, water temperature, and stream velocity, also influence the levels of algae observed in water bodies. The complex causes and results of excessive algae growth are described in detail in *Conceptual Approach for Developing Nutrient TMDLs for San Francisco Bay Area Waterbodies* (Water Board 2003).

Many interacting factors determine algae growth rates (Gasith and Resh 1999, Biggs 2000, Dodds 2006). Some of the most important factors are listed below:

- External nutrient loading, which is nutrients entering the stream via surface runoff, groundwater seepage, or precipitation, is the primary source of nutrients for algal growth. The form of nutrients entering the water also affects algal growth rates. Dissolved inorganic nutrients are generally more available to algae and tend to have a greater stimulatory effect on algal growth than organic and particulate forms of nutrients.
- Internal loading can also be a source of nutrients. Internal loading is the release of nutrients stored in the sediment or in decaying biomass back into the water column, where they are again available for algal uptake. However, the rate of biomass decomposition is usually slow compared to surface or ground water inflows carrying nitrate.
- Light is essential for photosynthesis. The shade provided by riparian vegetation can be a major limiting factor on algae growth in streams.
- Stream flow can also influence algal growth. Low flows provide an environment conducive to rising stream water temperature, which can result in increased rates of algal growth. Conversely, extremely high flows inhibit biomass accumulation by detaching algae and transporting it downstream.
- Grazing of algae by benthic macroinvertebrates is important in controlling the accumulation of algal biomass and under some circumstances can prevent excessive algal growth even when nutrient and light conditions are optimal for growth.

All of these factors vary a great deal from location to location, which complicates efforts to predict algae growth and underscores the need to collect site-specific data. Note that the environmental factors that promote algal growth can occur downstream from the source of nutrients, and therefore, the presence of algae does not necessarily indicate a source of nutrients at the area the algae is observed.

Conditions that tend to support eutrophication, such as sufficient light, low flows, and higher temperatures, occur during the dry spring and summer months and act together with dry weather loads of nitrate and orthophosphate to effect algae growth. Loads of nitrate and orthophosphate during the wet winter months rapidly flow out of the watershed to the Bay and do not contribute, or contribute only minimally, to algal growth observed in the spring and summer.

Oxygen depletion is an important effect of excessive algal growth due to its direct negative impact on aquatic life. Most native aquatic organisms found in streams are adapted to high levels of dissolved oxygen, and, when oxygen levels fall, these organisms must either leave the system or die. Factors that consume oxygen in aquatic systems include decomposition, biological oxidation of ammonia to nitrate (nitrification), and respiration. In pristine streams these processes are fairly slow relative to reoxygenation from the atmosphere, and dissolved oxygen levels remain near equilibrium with the atmosphere – that is, near 100 percent saturation. By contrast, excessive nutrient loading can drastically accelerate algal-related oxygen-consuming processes, respiration by living algal cells, and decomposition of dead algal material, causing severe oxygen depletion.

Periphyton (benthic algae) growth in Bay Area streams occurs primarily from late spring though early autumn (Water Board 2012), the period when temperatures and light levels are optimal for algal growth and when scouring high flow conditions are absent. However, this is also often the period of lowest external nutrient loads (Boyer et al. 2006). Loading through surface runoff is low or completely absent in low-rainfall summer months, so external loading occurs almost exclusively through groundwater seepage. Limited loading combined with rapid uptake by the growing mass of algae tends to result in declining nutrient concentrations throughout the summer months. Eventually, nutrient concentrations may become so low that they limit further algal growth. The exact nutrient levels at which algal growth limitation begins to occur vary, but are generally less than 0.5 mg/L for total nitrogen or 0.1 mg/L for total phosphorus (Bowie et al. 1985). In the Napa River and Sonoma Creek watersheds, where nitrogen is typically limiting, nitrate is a significant component of total nitrogen and is one of the most bioavailable forms of nitrogen (SFEI 2005). If nutrient concentrations fall to limiting levels early in the season, only a modest standing crop of algae will be produced; if limiting concentrations do not occur until later, or if nutrient levels remain high all summer, large, problematic quantities of algal biomass may develop (Biggs 2000, Dodds and Welch 2000).

The question of "how much algae is too much" is complex. Numerous sources have proposed quantitative periphyton density targets for western streams based on densities of chlorophyll *a*, a common photosynthetic pigment in freshwater algae (Welch et al. 1988, Dodds et al. 1998, Sosiak 2002). Proposed targets range from 100 to 200 milligrams per square meter (mg/m^2) of benthic chlorophyll *a*. Benthic chlorophyll *a* measures the amount of living plant material growing along the stream bottom (benthos) and includes submerged or floating mats of filamentous algae, if present at the exact sample location. The values represent levels of benthic algae above which recreational or aquatic habitat uses are impaired. In its *Technical Approach to Developing Nutrient Numeric Endpoints for California*, Tetra Tech, Inc. proposed a seasonal maximum impairment threshold of 150 mg/m^2 chlorophyll *a* for Cold Freshwater Habitat California streams (Dodds et al. 1997, Dodds and Welch 2000, Dodds et al. 2002, Tetra Tech 2006). The development of nutrient numeric endpoints is a State Water Board-led effort to develop numeric criteria to evaluate nuisance algae conditions caused by eutrophication.

Even in the absence of consistent quantitative targets, it is still possible to characterize impairment through qualitative or semi-quantitative observation of periphyton densities. It has been reported that the range of quantitative targets mentioned above correlates with approximately 30 percent stream bottom coverage by filamentous algae (Welch et al. 1988, Biggs, 2000, Tetra Tech 2006). While 30 percent filamentous algae cover does not constitute impairment in all situations, coverage levels far in excess clearly represent significant impairment.

The causal relationship between nutrient concentrations and periphyton growth is complex and site-specific. For this reason, definitive nutrient concentration targets have not been developed. However, Tetra Tech has developed modeling tools, calibrated to California data, that can be used to provide provisional screening-level nutrient targets under conditions of slow flow, shallow water depth, adequate sunlight and warmer weather (Tetra Tech, 2006). Based on these modeling tools, screening-level concentrations of 0.150 mg/L nitrogen or 0.0064 mg/L phosphate are predicted to result in less than 150 mg/m^2 chlorophyll *a* under favorable summer conditions (Tetra Tech, 2006).

These nutrient screening levels are generally consistent with proposed benthic algae targets below 150 mg/m^2 (Biggs 2000, Dodds et al. 2002). Note, however, that these screening levels represent the nutrient concentrations supplied for algal growth and not necessarily the stream's water column concentration over time. That is, the most limiting nutrient will be depleted to the maximum extent possible by growing biomass, while other nutrients will only be used until the most limiting nutrient is depleted. In the River and Creek, where nitrogen is typically the limiting nutrient, low nitrate concentrations in summer months can be indicative of either low supply or ongoing algal growth (SFEI 2005).

2.2 Nutrient Sources

Nutrient sources for nitrogen and phosphorus include a variety of anthropogenic activities and natural sources. The Water Board and U.S. EPA classify sources as point or non-point sources, using different regulatory tools to address each source type.

Point sources are those where the discharge to a water body is at a discrete physical location, or point. In contrast, non-point sources are spatially distributed in a catchment or watershed. As an example of a non-point source, pesticides are applied to agricultural fields in a distributed fashion but can then migrate to surface water or groundwater.

The main *non-point sources* of nutrients (especially nitrate) are: onsite wastewater treatment systems (septic systems), grazing lands, confined animal facilities, agriculture/vineyards, wildlife, direct wet and dry atmospheric deposition, and groundwater discharges (Figures 2, 4). The contribution that these sources make to nutrient-related water quality impacts depends heavily on the timing of their delivery to streams and rivers as well as physical conditions such as stream flow, shading, and temperature.

The important *point sources* of nitrate are: municipal wastewater treatment facilities, failing sanitary sewer collection systems, and municipal runoff. These three point source categories discharge little nitrate during the dry season; wastewater treatment plants in these watersheds, for example, recycle their effluent for agricultural use and only discharge to surface waters on the few days when rainfall exceeds recycling capacity. Municipal runoff is similarly low during dry weather. During the wet season when point sources do discharge nitrate, algal growth is minimal due to low temperature and solar radiation as well as the depth and rapidity of flows. As a result, these nutrients are washed out to the Bay and do not contribute significantly to dry weather impairment in freshwater reaches of the River and Creek. Impacts due to elevated nutrients in the Bay, however, are being analyzed as part of the San Francisco Bay Nutrient Numeric Endpoint Development http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/amendments/estuarynne.shtml.

2.3 Changes in Nutrient Sources

Since the original listings, the relative contributions of these sources have changed. A detailed description of the key changes is provided in Sections 3.1.4 (Napa River) and 4.1.4 (Sonoma Creek).

2.4 Water Quality Criteria

Under the authority of the federal Clean Water Act, the Water Board has established water quality standards for the River and its tributaries. Water quality standards consist of: a) beneficial uses[1] for the water body, b) Water Quality Objectives[2] (numeric or narrative) to protect those beneficial uses, and c) the Antidegradation Policy, which requires the continued maintenance of existing high-quality waters. The Basin Plan specifies beneficial uses for water bodies in the San Francisco Bay Region as well as Water Quality Objectives and implementation measures necessary to protect those uses (Water Board 2013). Beneficial uses designated for the River and its tributaries are listed in Table 1. Table 2 specifically lists the beneficial uses that could be affected by nutrients for which the Water Board has established Water Quality Objectives or for which there are evaluation guidelines to interpret existing objectives. It is important to note that evaluation guidelines are not established Water Quality Objectives, but, rather, are used as guidance to inform consideration as to whether the relevant narrative objectives are being achieved.

A number of nutrient analytes (i.e., total phosphorus, total nitrogen, and orthophosphate) were collected during these various studies but were not analyzed as lines of evidence due to the absence of numeric guidance, or because existing numeric guidance, is unsuitable for this Region. U.S. EPA provided guidance on eutrophication thresholds by setting benchmarks for total nitrogen and total phosphorus for the western United States using the 25th percentile method of available data (US Environmental Protection Agency, 2000a). The numeric guidance for subregion 6, which covers the Napa River watershed, was 0.518 mg/L for total nitrogen (TN) and 0.03 mg/L for total phosphorus (TP). However, nutrient data collected from reference streams (streams with minimal anthropogenic stress in the watershed) within the San Francisco

1 Synonymous with “designated uses” as used in the CWA.

2 Synonymous with “water quality criteria” as used in the CWA.

Bay Area showed frequent exceedances of these benchmarks, demonstrating that these may not be suitable criteria for reference conditions in the Bay Area (Water Board 2012). Therefore, in the absence of vetted numeric guidance, TP and TN were not analyzed as lines of evidence for this delisting. The Basin Plan (Water Board 2013) does not provide guidelines for TP, TN, or phosphate (PO_4^{3-}) nor does the California Toxics Rule (US Environmental Protection Agency, 2000b), so this analyte was also not used as a line of evidence.

The State Water Board is initiating the process to develop a nutrient policy for inland surface waters, excluding inland bays and estuaries in California (http://www.waterboards.ca.gov/plans_policies/nutrients.shtml). The State Water Board intends to develop narrative nutrient objectives, with numeric guidance to translate the narrative objectives. This numeric guidance could include the Nutrient Numeric Endpoint (NNE) framework which establishes numeric endpoints based on the response of a water body to nutrient overenrichment (e.g., algal biomass, dissolved oxygen, etc.). Until a statewide policy is in place, regions must analyze eutrophication problems on a case by case basis.

Table 1. Designated Beneficial Uses for the Napa River and Sonoma Creek and potential impairment by nutrients for which there are numeric evaluation guidelines or objectives.

Beneficial uses	Potentially impaired
Agricultural supply (AGR)	X
Cold freshwater habitat (COLD)	X
Fish migration (MIGR)	
Fish spawning (SPWN)	
Municipal and domestic supply (MUN)	X
Navigation (NAV)	
Non-contact water recreation (REC-2)	X
Preservation of rare or endangered species (RARE)	
Warm freshwater habitat (WARM)	X
Water contact recreation (REC-1)	X
Wildlife habitat (WILD)	

In terms of toxicity for drinking water sources, the Basin Plan (Water Board 2013) provides threshold criteria for nitrate plus nitrite ($NO_2^- + NO_3^-$) of 10 mg/L for municipal supply and 5 mg/L for agricultural supply, and 1 mg/L for nitrite (NO_2^-) (Table 2). The national primary drinking water standard for nitrite (NO_2^-) is 1 mg/L and for nitrate (NO_3^-) is 10 mg/L. The Basin Plan specifies an annual median numeric water quality objective for un-ionized ammonia (NH_3), the form of ammonia that is toxic to aquatic life (Water Board 2013). This objective is 0.025 mg/L. No annual measures exceeded this objective. Additionally, the U.S. EPA Office of Water released final guidelines for total ammonia for freshwater to protect aquatic life beneficial uses to address toxicity due to un-ionized ammonia (U.S. Environmental Protection Agency, 2013). U.S. EPA put forward both an acute and a chronic criterion which requires an assessment of total ammonia concentrations along with water pH and temperature because the toxic form of ammonia, the un-ionized fraction, depends on those parameters. Therefore, we compared every observed total ammonia value to the instantaneous total ammonia nitrogen criterion according to the chronic (Criterion Continuous Concentration) formula (U.S. Environmental Protection Agency, 2013, p. 46). Some pH and temperature values were missing from the older datasets, so we used the average pH and temperature values from the current data to fill in missing data. On average, the chronic toxicity criterion was 0.769 mg/L total ammonia and was never exceeded. The acute toxicity criterion is, by definition, higher than the chronic criterion, so it was also never exceeded. The instantaneous chronic criterion was not calculated in this analysis since no sample exceeded the chronic threshold (Table 2).

The Basin Plan's (Water Board 2013) narrative water quality objective for biostimulatory substances states that water bodies "shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses." This objective applies to nutrients, since eutrophication is synonymous with nutrient-induced biostimulation. Nutrient-induced biostimulation, or eutrophication, impairs aquatic habitat uses through broad impacts on the entire biological community. This objective also applies to impairment of recreational uses (primarily through the negative aesthetic effects of excessive algal growth), or aquatic life uses (though the impacts of algae on habitat quality). Three numeric evaluation guidelines were used to evaluate this narrative objective (Table 2).

The biostimulatory substances narrative water quality objective was evaluated using three lines of evidence based on numeric targets related to algal biomass. Tetra Tech modeled the relationships between nutrients and benthic algae cover as described in section 2.1. This effort resulted in statewide numeric guidance, called beneficial use risk category (BURC) thresholds. The first line of evidence is based on chlorophyll *a* for the Cold Freshwater Habitat beneficial use, which is the more protective than the Warm Freshwater Habitat beneficial use. Levels of benthic algae above 150 mg/m^2 are presumed to be impaired for Cold Freshwater Habitat, so this number became the guidance threshold (Table 2). This threshold is supported by regional reference site monitoring in perennial and non-perennial streams, which found high values of up to 100 and 169 mg/m^2 in late summer (Water Board 2012).

The second direct line of evidence related to the biostimulatory narrative objective was based on percent cover of filamentous algae. There is not a clearly established percent cover threshold described by Tetra Tech (2006), but the report references two papers that discussed such thresholds (Appendix 2-4). Biggs (2000) recommended a 30 percent cover by filamentous green or brown algae, which was associated with chlorophyll *a* readings of approximately 120 mg/m^2 in order to protect recreation and fisheries. Additionally, Quinn (1991) used a 40 percent cover threshold to protect recreation and aesthetics. Tetra Tech used 20 percent filamentous cover to set the chlorophyll *a* threshold (Tetra Tech 2006). The method of sampling percent cover according to the SWAMP bioassessment protocol (Fetscher et al. 2009) slightly overestimates the true percent cover because crews often record filamentous algae as present when only a few strands of algae are located at each of the 105 sample points that comprise this metric. The average over-estimate for this method when compared to an area-based visual cover estimate was 7.3 percentage points (SWAMP unpublished data). Therefore, the evaluation guideline based on the SWAMP protocol was set at 30 percent filamentous algae cover (Table 2). The

SWAMP bioassessment protocol involves a visual estimate of percent filamentous algae cover at 11 sections along the stream, but these data were not used in this report. According to this method, the visual percent cover estimates are placed into binned categories of 0, 1-10%, 10-40%, 40-70% and >70% cover, and these bins are averaged over all 11 observations to determine the mean percent cover for the 150 m section of stream. Therefore, the 105 point observations is the most accurate metric collected by SWAMP because the percent visual cover algae binned metric result in reduced data accuracy compared to a numeric observation.

The third direct line of evidence related to the biostimulatory narrative objective the water column chlorophyll *a* metric. Water column chlorophyll *a* measures the amount of algae growing in the water column, which are called phytoplankton. There are no formal criteria for evaluating this indicator, so we relied on an evaluation guideline proposed by the Central Coast Water Board (Central Coast Water Board 2013) of 15 µg/L, which is also the same threshold used by North Carolina to protect trout-supporting (coldwater) water bodies and by Oregon to determine nuisance levels. This concentration was derived by the Central Coast Water Board by investigating sites known to be impacted by nutrients and reference conditions that did not have excessive levels of nutrients.

Table 2. Applicable Water Quality Objectives or Evaluation Guidelines and Associated Beneficial Uses

Beneficial use	Analyte	Water Quality Objective[1]	Evaluation Guideline*	Application of WQO
AG	Nitrate+ Nitrite	5 mg/L		Instantaneous
MUN	Nitrite	1 mg/L		Instantaneous
MUN	Nitrate+ Nitrite	10 mg/L		Instantaneous
WARM, COLD, WILD, RARE	Ammonia, un-ionized	0.025 mg/L		Annual median
WARM, COLD, WILD, RARE	Ammonia, total		0.1-2.8 mg/L [2]	Instantaneous (chronic)
REC-1, REC-2, WARM, COLD	Percent algae cover	Biostimulatory substances narrative	30% filamentous cover [3]	Instantaneous
COLD	Benthic biomass chlorophyll *a*	Biostimulatory substances narrative	BURC II/III boundary < 150 mg/m^2 [2 4]	Instantaneous
WARM	Benthic biomass chlorophyll *a*	Biostimulatory substances narrative	BURC II/III boundary < 200 mg/m^2 [2 4]	Instantaneous
WARM	Dissolved Oxygen	5.0 mg/L		Instantaneous
WARM	Dissolved Oxygen		4.0 mg/L [4]	7 day avg of min values
COLD	Dissolved Oxygen	7.0 mg/L		Instantaneous
COLD	Dissolved Oxygen		5.0 mg/L [4]	7 day avg of min values
Generally applicable	pH	6.5 -8.5		Instantaneous
WARM, COLD, WILD, RARE	Water column chlorophyll *a*		15 µg/L [5]	Instantaneous

[1] *The San Francisco Bay Basin (Region 2) Water Quality Control Plan* (Water Board 2013)
[2] *2013 Aquatic Life Ambient Water Quality Criteria For Ammonia* – Freshwater EPA-822-R-13-001 (U.S. Environmental Protection Agency 2013)
[3] *New Zealand periphyton guideline: Detecting, monitoring and managing enrichment of stream.* (Biggs 2000)
[4]*Technical Approach to Develop Nutrient Numeric Endpoints for California*. (Tetra Tech 2006) BURC stands for beneficial use risk categories. These chlorophyll *a* values correspond to the BURC II/III boundary, which represents a threshold above which the risk of beneficial use impairment by nutrients is probable.
[5]Interpreting Narrative Objectives for Biostimulatory Substances for California Central Coast Waters (Central Coast Water Board 2010)

*Note: Evaluation Guidelines are used as numeric thresholds when numeric Water Quality Objectives are lacking.

3 Napa River

3.1 Project Definition

3.1.1 Background

In 1976, the Napa River (River) main stem was identified on California's Clean Water Act Section 303(d) List as impaired by excessive levels of nutrients resulting in eutrophication (excessive algal growth). The listing encompassed 57 miles[3] of stream as measured by the National Hydrography Dataset (US Geological Survey 2013) between the River mouth and the top of the watershed (Figure 1). The River lies within the jurisdiction of the Water Board and drains to San Francisco Bay. The original listing largely stemmed from concerns over wastewater treatment plant discharges to the River, particularly during periods of low flow, and from observations of excessive algal growth (Water Board 1975).

The primary effect of excess nutrients on the River is eutrophication (Carpenter et al. 1998); that is, the stimulation of excessive algal growth. Phosphorus and nitrogen are the nutrients usually responsible for eutrophication, as these are usually growth-limiting in uncontaminated surface waters. Eutrophication in Bay Area streams, including the River and neighboring Sonoma Creek, usually takes the form of algae that grow attached to the bottom substrate (periphyton), as opposed to suspended in the water column (phytoplankton). Excessive periphyton growth can smother bottom habitat and depress dissolved oxygen concentrations in bottom gravels and in the water column. Dissolved oxygen is a critical water quality condition that can affect survival of protected salmonids, such as steelhead trout (*Oncorhynchus mykiss*) and Chinook salmon (*Oncorhynchus tshawytscha*), in these waters. Because the Bay Area has a Mediterranean climate, excessive algal growth is typically a dry season phenomenon that occurs during the summer and early fall months prior to the rainy season.

3.1.2 Proposed Delisting

We are proposing to delist the non-tidal River main stem for nutrient impairment upstream of Trancas Street in the City of Napa (US Army Corps of Engineers 1988), which is 36 miles of stream according to the National Hydrography Dataset (US Geological Survey 2013). The Water Board has observed improvement in water quality conditions in the 30 years since the River was listed as impaired for nutrients. Additionally, in 2006, the State Water Board released draft numeric endpoints for nutrients and other tools to predict acceptable nutrient concentrations (Tetra Tech 2006). These tools allow for numeric review of whether narrative Water Quality Objectives are being met and beneficial uses supported.

This project:

1) Compiled all known existing data related to nutrients and algae growth in the watershed;

[3] The current listing description at the State Water Board website (http://www.waterboards.ca.gov/water_issues/programs/#wqassessment) is for 65 miles but the current stream length measured using the National Hydrography Dataset is 57 miles.

2) Collected additional data on benthic algae in a manner consistent with the State Water Board's nutrient numeric endpoint guidance (Tetra Tech 2006);
3) Created eight lines of evidence to evaluate all relevant available data; and
4) Proposes to refine the nature and scope of the beneficial use impairment in the River based on its findings.

This delisting report does not include a proposal to modify the nutrient listing for the tidal portion of the River because guidelines and standards for such an evaluation do not yet exist. The Water Board is developing a model to understand nutrients in tidal areas of the Bay, and when that process is complete, we plan to evaluate the tidal portion of the River.

3.1.3 Analysis Supporting Delisting

Data allowing us to consider delisting the River for nutrients were collected between 2002 and 2012. This assessment included examination of nuisance algae levels caused by excess nutrients resulting in eutrophication and toxicity resulting from ammonia, nitrate, and nitrite. Eight lines of evidence were produced using the following analytes: ammonia, nitrate, nitrite, benthic chlorophyll *a*, percent macroalgae cover, pH, and water column chlorophyll *a*. Data used to create these lines of evidence were collected by the San Francisco Estuary Institute (SFEI) (2002-2004), Water Board staff (2009), and the Water Board's Surface Water Ambient Monitoring Program (SWAMP) staff (2011-2012). Additionally, continuous monitoring dissolved oxygen data were collected at a subset of sites during the 2011-2012 sampling effort.

New water quality policy and tools to measure and evaluate excess algae levels have allowed staff to conduct a rigorous and standardized analysis of algae levels and water quality conditions in the River. The analysis presented in this report relied on guidance set forth in 2004 by the State Water Board's 303(d) Listing Policy (Listing Policy) in regards to sample size, analysis approach, and data quality assurance (State Water Board 2004). SWAMP recently created standardized sampling methods to quantify algal biomass (Fetscher et al. 2009) and quality assurance and quality control procedures for field crews and laboratories collecting these data (SWAMP 2008). Subsequently, SWAMP staff collected algal biomass and nutrient data from 2011-2012 using these standardized sampling techniques. Algal biomass data were reviewed against the available guidance thresholds (Tetra Tech 2006). Therefore, the current evaluation of water quality standard attainment is more sophisticated and relies on a better dataset compared to analyses that were possible during the original 1976 listing.

Current water quality conditions in the River (2002-2012) show that nutrient-related numeric and narrative Water Quality Objectives are being met and potentially impacted beneficial uses are not negatively affected by nutrients in this water body. The eight lines of evidence did not show exceedances beyond what is specified in the Listing Policy (State Water Board 2004). Therefore, we conclude that water quality conditions have improved since the original listing in 1976. No algae cover data were available from the time of the listing, so a direct comparison between current and past conditions was not possible. However, limited historical nutrient data were available. Nitrate concentrations along River averaged 6.2 mg/L between 1968-1972, yet are now 10 times lower on average in the watershed (mean = 0.6 mg/L).

3.1.4 Rationale for Reduced Algae Growth

The reduction in nuisance algae levels was probably a cumulative effect of NPDES permit restrictions on wastewater discharges, changes in land use in the River's watershed over the past 30 years, and improved agricultural best management practices (BMPs). Few water quality controls were in place before the federal Clean Water Act or the 1975 San Francisco Bay Basin Water Quality Control Plan (Basin Plan) (Water Board 1975). Historical conditions could generally be described as having higher levels of cattle grazing (probably with direct access to streams and tributaries), more dairies and confined animal feeding operations (i.e., milking cows) with limited BMPs, and limited requirements on the 3 non-tidal and 2 tidal wastewater treatment plants. Nutrient loads from these sources have been reduced through activities described below.

The River was identified as having poor water quality conditions and designated as Water Quality Limited in the 1975 Basin Plan (Water Board 1975). The Basin Plan's narrative description of past conditions and sources focused on contributions of biological oxygen demanding substances from agricultural lands and municipal wastewater treatment facilities. This 1975 designation was restated in 1976, when the River was placed on the section 303(d) list of impaired water bodies for nutrients causing eutrophic conditions (State Water Board 1976). Although point source and non-point sources of nutrients were identified in the original listing (Table 3), wastewater treatment plants were considered to be a major contributor of nutrients at the time. However, over the past 30 years, improvements to and changed practices at wastewater treatment plants have significantly reduced discharges and nutrient impacts in discharges to the River.

By the 1980s, NPDES permits issued by the Water Board to municipal wastewater treatment plants included specific language prohibiting discharge during the "dry season," when the minimum 10:1 river water to discharge dilution ratio could not be achieved as dictated by the 1982 Basin Plan (Water Board 1982).[4] This discharge prohibition significantly reduced nutrient loading into the River at a time when flows are naturally low because of the summer drought occurring in this Region's Mediterranean climate. With the prohibition, wastewater treatment plants in these watersheds generally store or recycle 100 percent of their discharge during the dry season, and employ those same techniques during the wet season when the 10:1 ratio cannot be achieved. This has resulted in no dry season discharges to the River, and only occasional discharges during the rainy season, when the impacts of nutrient discharges are limited because environmental conditions result in very limited algal growth and rapid flushing of nutrients into the Bay. Current NPDES permits require dilution ratios of up to 50:1, so treatment plants are discharging even less frequently into the River during the winter season. Additionally, over the past 30 years, the three plants that discharge to the non-tidal River reach (Calistoga, St. Helena, and Yountville) have improved treatment BMPs or added treatment technologies to reduce nitrogen inputs.

Shifts in agriculture practices likely have also played a role in reducing nutrient loads to the River. Guidance provided by the U.S. Department of Agriculture National Resources

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[4] The exact dates of the dry season varied slightly in each permit, but it was generally from May 1 – October 31.

Conservation Service and by local Resource Conservation Districts has improved agricultural BMPs for grazing animals and confined animal facilities. Examples include the development of Farm Conservation Plans, Nutrient Management Plans, Waste Management Systems, and Ranch Water Quality Control Plans (reviewed in Lewis et al. 2011). The implementation of such plans in the San Francisco Bay Region has resulted in fewer nutrient inputs and less sediment erosion into water bodies (Larson et al. 2005, Lewis et al. 2011). Additionally, crop reports produced by the Napa County Agricultural Commissioner show that cattle and calf production decreased tenfold from 247,000 centum weight (CWT) in 1970 to 27,188 CWT in 2011 (http://www.countyofnapa.org/AgCommissioner/CropReport/). CWT is a measure of weight in 100-lb units. Decreased production of cattle occurred because of reductions in cattle on rangelands and a reduction in number of confined animal facilities. In fact, no dairy confined animal facilities were identified in this watershed under actions of the 2003 waiver of waste discharge requirements for confined animal facilities (Resolution No. R2-2003-0094).

Since the 1970s, vineyard acreage has increased in the Napa Valley to 43,581 from 14,597 acres (http://www.countyofnapa.org/AgCommissioner/CropReport/), an increase of about 45 square miles. However, nutrient addition to vineyards is low (Rosenstock et al. 2013), and a portion of the vineyard acreage increase was conversion from other agricultural land uses with greater potential to contribute nutrients to the River. Additionally, there are active watershed programs to reduce the water quality impacts from vineyards. In 2002, the Napa Valley Vintners Association, the Napa County Grapegrowers Association, and the Napa County Farm Bureau brought the Fish Friendly Farming program to Napa County (http://www.fishfriendlyfarming.org/). This program teaches the use of sediment control and bank stabilization BMPs, efforts that will also reduce sediment bound nutrients from entering the streams. About a third of acreage currently planted in vineyards has been certified under the Fish Friendly Farming program.

We did not find evidence of significant changes to physical conditions in the watershed that were likely to facilitate algae blooms. For example, increases in water temperature, decreases in water depth, decreases in riparian shade, and decreases in stream flow can increase algae growth. An analysis of annual steam flow between 1960 and 2010 from two U.S. Geological Survey stations along the River showed no consistent change over time. The U.S. Geological Survey did not collect temperature data over the same time period, so a historical temperature analysis could not be performed. A historical ecology analysis of the Napa Valley found that from the 1940s to now, riparian shade has increased significantly (Grossinger 2012).

Table 3. 1976 EPA 303(d) listing information for the Napa River related to nutrients and eutrophic conditions.

Segment name & description	Beneficial uses evaluated*	Objective violated	Source
Napa River main stem	WARM, COLD, MUN, AG, REC-1, REC-2	Nutrients resulting in eutrophication	Point and non-point sources

*The original 1976 listing included WARM, SPWN, MIGR, and REC-1 as the beneficial uses affected. The beneficial uses noted in this table are for uses currently applied to this water body with numeric Water Quality Objectives or evaluation guidelines. Beneficial Use designations are described in Table 1.

3.2 Watershed Description

The Napa River watershed is located in the California Coast Ranges north of San Pablo Bay (Figure 1) and covers an area of approximately 426 square miles (1,103 square kilometers). The main stem of the River flows approximately 57 miles in a southeasterly direction though the Napa Valley before discharging to San Pablo Bay. Although the original listing only focused on the River main stem, numerous tributaries enter the main stem from the mountains that rise abruptly on both sides of the valley. In this report, the terms “Napa River” and “River” refer to the main stem of the River as well as its tributaries within the Napa River watershed. Combined, the River main stem and tributaries are over 464 miles long. We conducted a watershed-based water quality assessment, examining conditions in both the tributaries and the main stem. The results of this assessment and subsequent lines of evidence are discussed in Section 3.3.

This watershed has a Mediterranean climate with warm, dry summers and cool, wet winters (Gasith and Resh, 1999). Average annual rainfall ranges from 25 to 38 inches in the Napa Valley, and the large majority of rainfall occurs from November through April, with the heaviest rainfall occurring from December through February (Gilliam 2002). This rainfall regime results in two distinct seasons in the watershed. During the winter wet season, stream flow and pollutant loading are dominated by precipitation-driven surface runoff. In contrast, during the dry summer months, groundwater inflow and minor runoff from watershed activities are dominant. Major land cover types in the watershed are forest (38 percent), grassland/rangeland (18 percent), and agriculture (20 percent). Approximately two-thirds of agricultural land is in vineyards (16 percent of total area). Developed land (e.g., residential, industrial, and commercial) accounts for approximately 16.5 percent of the watershed (Association of Bay Area Governments 2006, Table 4). The population of the Napa River watershed is 238,660.

Table 4. Land use in the Napa River watershed.

Land use*	Percentage of watershed
Forest / Open Space	38.2%
Rangeland	18.1%
Agriculture-vineyard*	16.2%
Agriculture other	3.4%
Urban-Residential	7.7%
Urban-Commercial & Industrial	2.9%
Urban-Open	2.0%
Urban-Other	3.8%
Water & Wetlands	7.6%

*Land use from Association of Bay Area Governments (2006) except vineyard area from Napa County Agriculture layer from 2007 (http://gis.napa.ca.gov/giscatalog/catalog.asp).

3.3 Water Quality Data

3.3.1 Data quality

Data to support this delisting were collected over multiple years (2002-2012) by different sampling crews and analyzed by multiple laboratories (Table 5). All data used as lines of evidence are considered to be high quality. Data collected from 2011-2012 are either SWAMP-compliant or qualified as determined by the SWAMP Quality Assurance Program Plan (2008). Data collected from 2009 were analyzed by a U.S. EPA lab, so these samples underwent the QC testing required of U.S. EPA labs. Nutrient data collected from 2002-2004 were analyzed for precision and accuracy. Laboratory duplicate samples showed a precision range of < 30 percent, which we consider to be of acceptable quality because it is just above SWAMP guidance of a relative percent difference of 25 percent (SWAMP 2008, 2013). One chlorophyll *a* result was removed from the analysis due to a spurious result. The result was over 500 mg/m^2, which was the second highest reading in the SWAMP databases for chlorophyll *a* when compared against 2000 samples throughout California, and was found at a stream with no filamentous algae. This reading cannot be accurate for a site that lacked filamentous algae and did not have high levels of microalgae (diatoms). Rejection of this data point was approved by the SWAMP Quality Assurance Team. For 2002-2004 pH data, SFEI did not produce a Sampling and Analysis Plan or Quality Assurance Project Plan that could confirm the reliability of the equipment used, pH standards, number of points used for calibration, adequate frequencies pre- and post-measurement calibrations, and established measurement quality objectives for drift. For these reasons, we determined these data to be unusable for the pH line of evidence analysis.

3.3.2 Lines of evidence

Four lines of evidence support removing the original listing for eutrophication and four lines of evidence show that nutrient toxicity is not present (Table 6).

3.3.2.a Eutrophication

Three direct lines of evidence for biostimulation of algae and a fourth indirect line of evidence demonstrate that Water Quality Objectives are not exceeded and designated beneficial uses are supported. The three direct lines of evidence are algal biomass indicators represented by benthic chlorophyll *a* and percent macroalgae cover (attached + unattached) collected using the SWAMP Bioassessment protocol (Ode 2007, Fetscher et al. 2009), and water column chlorophyll *a*.

The direct benthic chlorophyll *a* line of evidence showed two exceedances of evaluation guidelines out of 16 samples collected over two years. Likewise, we recorded only two exceedances for percent macroalgae cover out of 17 samples collected across two years. The proportion of exceedances in this study (≤12.5 percent) is within acceptable proportions discussed in the Listing Policy. Relatively fewer data points are available for the algae mass indicators compared to water column chemistry measures (e.g., ammonia, nitrate, and nitrite) because they are more expensive and time consuming to collect. However, fewer data points are necessary to evaluate overall water quality conditions because they are seasonally integrative measures. A single data point represents weeks to months of water quality conditions.

Table 5. Data summary for delisting.

Year	Seasons	Sampling crew	Laboratory	Analytes
2002	October	SFEI	Romberg Tiburon Center	ammonia, nitrite, nitrate+nitrite, total dissolved nitrogen, total dissolved phosphorus, & orthophosphate.
2003	January, July	SFEI	Romberg Tiburon Center	ammonia, nitrite, nitrate+nitrite, total dissolved nitrogen, total dissolved phosphorus, & orthophosphate.
2004	May	SFEI	Romberg Tiburon Center	ammonia, nitrite, nitrate+nitrite, total dissolved nitrogen, total dissolved phosphorus, andorthophosphate.
2009	July	Water Board Staff	EPA Region 9 Lab	ammonia, nitrite, nitrate, total Kjeldahl nitrogen, total phosphorus, & orthophosphate.
2011	August-September	Water Board Staff	Delta Environmental Laboratories, DFW Water Pollution Control Laboratory	ammonia, nitrite, nitrate, total Kjeldahl nitrogen, total phosphorus, orthophosphate, benthic Chl-a, & percent macroalgae cover (field).
2012	June, August-September	Water Board Staff	Delta Environmental Laboratories, DFW Water Pollution Control Laboratory	ammonia, nitrite, nitrate, total Kjeldahl nitrogen, total phosphorus, orthophosphate, benthic Chl-a, & percent macroalgae cover (field).

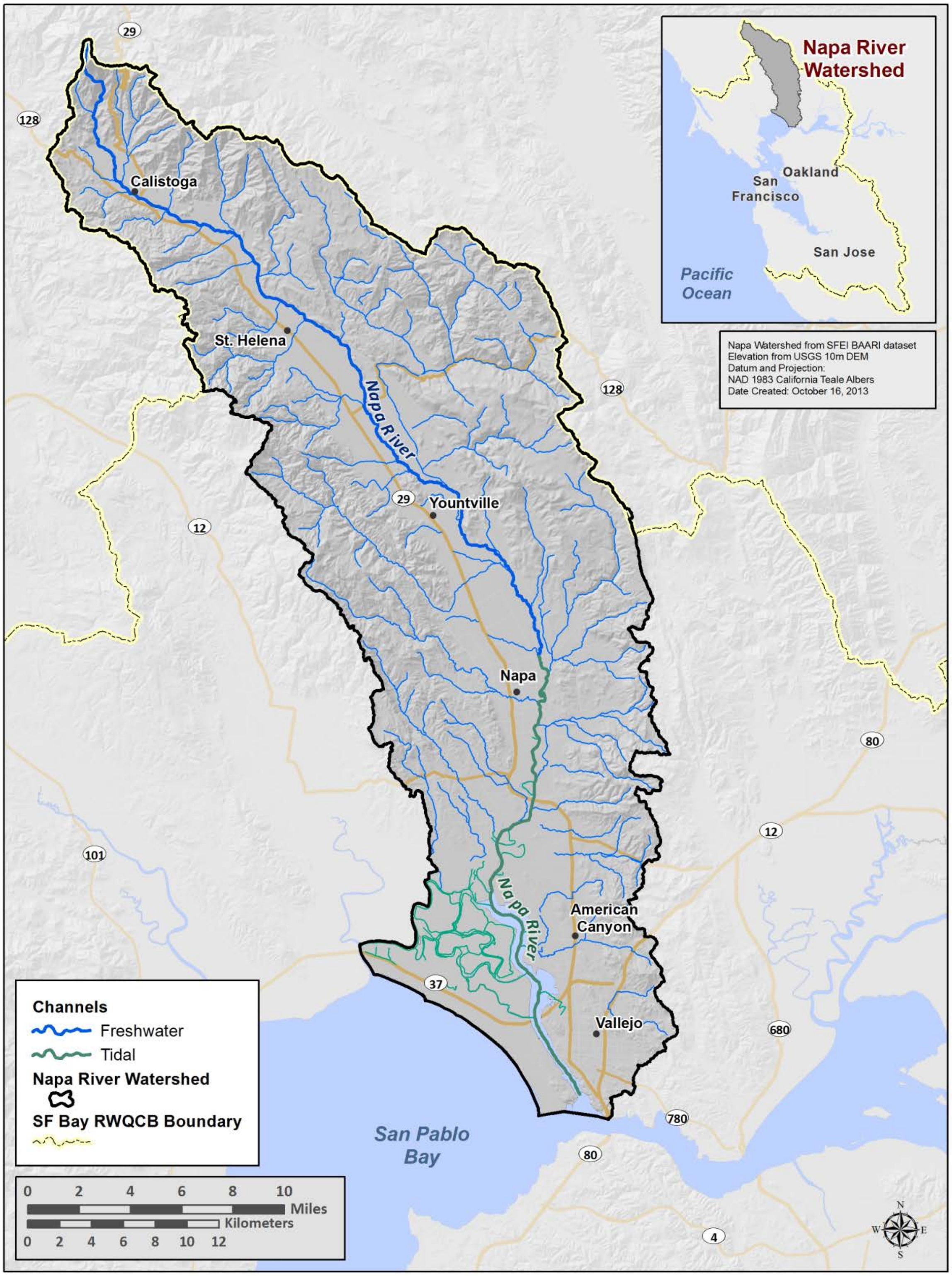

Figure 1. Map of the Napa River watershed.

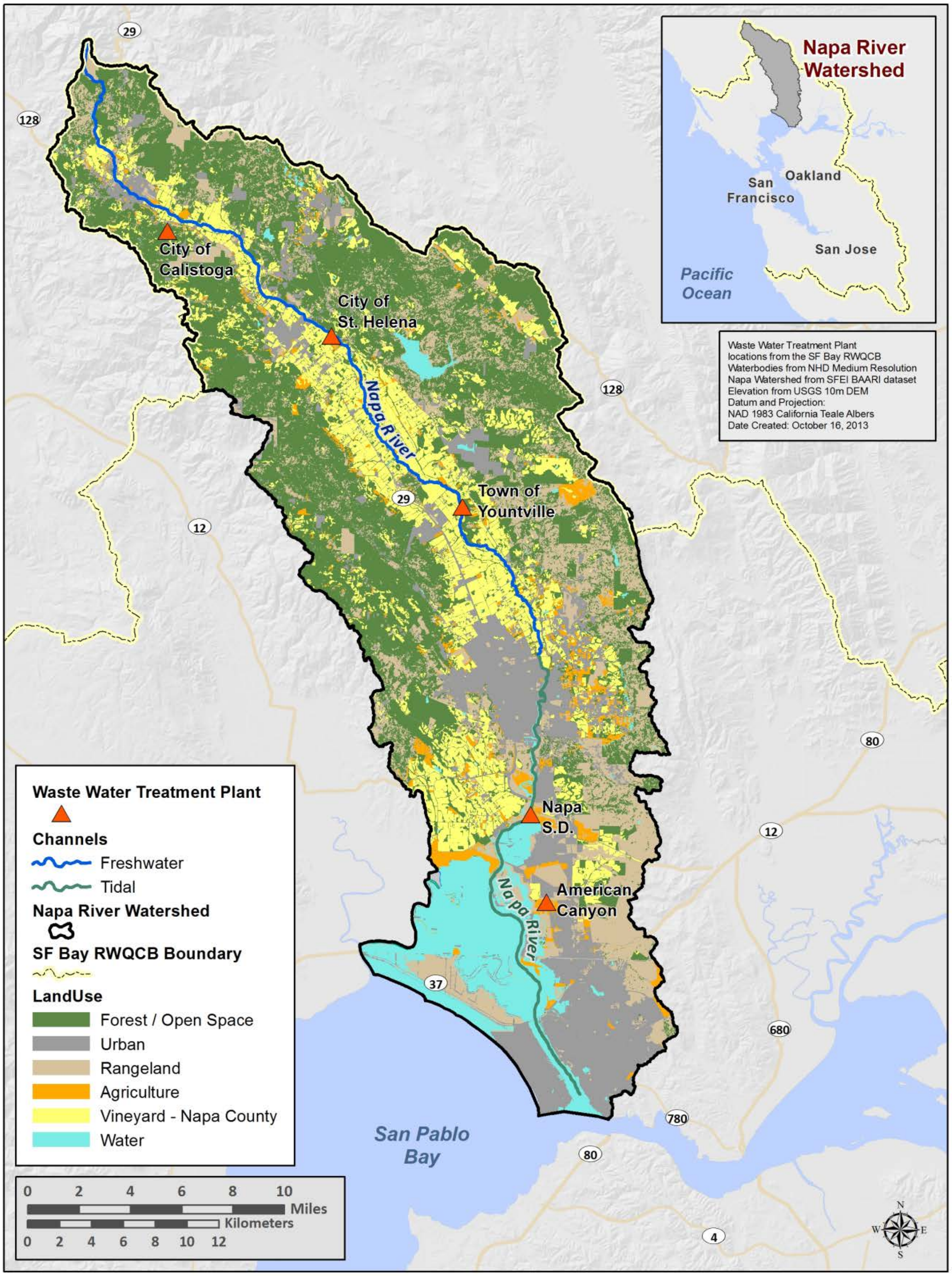

Figure 2. Map of land use and potential nutrient sources in the Napa River watershed.

Table 6. Napa River Summary of Lines of Evidence and exceedances of Evaluation Guidelines

LOE	Analyte	Numeric Evaluation Guideline	Number of exceedances	Numeric metric	Listing factor
1	Benthic biomass chlorophyll *a*	< 150 mg/m^2	2/16	Evaluation Guideline	4.11 weight of evidence
2	Percent macroalgae cover [a]	30%	2/17	Evaluation Guideline	4.11 weight of evidence
3	Nitrite	1 mg/L	0/120	Water Quality Objective	4.1 toxicant
4	Nitrate+ Nitrite	10 mg/L	0/120	Water Quality Objective	4.1 toxicant
5	Ammonia, un-ionized	0.025 mg/L	0/6 [b]	Water Quality Objective	4.1 toxicant
6	Ammonia, total	0.1-2.8 mg/L	0/120	U.S. EPA Criterion	4.1 toxicant
7	pH [c]	6.5-8.5 units	0/27	Water Quality Objective	4.1 toxicant
8	Water column chlorophyll *a*	15 µg/L	1/40	Evaluation Guideline	4.11 weight of evidence

[a] metric calculated from the SWAMP bioassessment protocol from 105 observations along a 150 m section of stream.
[b]120 unique samples analyzed by year.
[c] Only pH data collected using the SWAMP QAPrP were incorporated into this assessment.

Table 7. Napa River water quality parameters at the two sites with chlorophyll *a* algae exceedances listed in LOE 1 in Table 6

Sample site	Year	Season	Benthic chlorophyll *a*	% Macroalgae cover	% Riparian cover	Dissolved oxygen median (mg/L)
N-09	2011	Late summer	162 mg/m^2	58.1	74	7.33
N-09	2012	Late summer	42 mg/m^2	45.7	65	6.40
N-55	2012	Late summer	161 mg/m^2	6.7	41	2.87

Chlorophyll *a* in the water column was collected by SFEI in 2002 and 2003 and showed few exceedances. A total of 1 of 40 samples exceeded the 15 µg/L evaluation guideline. Therefore, this line of evidence does not support impairment according to the biostimulatory objective.

At the two sites with exceedances of the chlorophyll *a* evaluation guideline (N-09 and N-55), other algal biomass or eutrophication indicators did not demonstrate a consistent problem (Table 7). For example, in 2011 the N-09 benthic chlorophyll *a* level of 162 mg/m^2 was slightly above the 150 mg/m^2 guideline for the Cold Freshwater Habitat beneficial use (although still below the 200 mg/m^2 guideline for Warm Freshwater Habitat), yet chlorophyll *a* data from the following year (2012) was well below the threshold. However, the percent macroalgae cover (based on 105 sample points along a 150 m section of stream) was consistently high in both years. Secondary indicators at N-09, such as continuously monitored dissolved oxygen, showed that water quality conditions were adequate for aquatic life uses (both cold water and warm water uses) based on guidance from Tetra Tech (2006). Also the strong daily (diel) swing of dissolved oxygen, which occurs in severely eutrophic waters, was not observed, nor were highly oxygenated water above 13 mg/L observed. Fisheries population data from the Napa Resource Conservation District shows that populations of steelhead trout and Chinook salmon continue to be supported by this watershed (Koehler and Blank 2013). Recent surveys identify steelhead redds and surviving smolts, which provides support that the overall watershed supports conditions necessary for multiple life stages (Koehler and Blank 2013). This reach continues to support both Human Contact and Non-contact beneficial uses as it is accessible to the public and frequently visited. The geomorphology of the stream reach is a wide, braided channel, so there is less shading from tall upland trees compared to other portions of the River where the stream is incised or has been partially channelized. In sum, the weight of evidence at this site does not indicate an exceedance of the narrative biostimulatory objective at this location.

The second site with a chlorophyll *a* exceedance was N-55. Similar to the other site, the chlorophyll *a* value was just above the 150 mg/m^2 threshold for Cold Freshwater Habitat, but was below the 200 mg/m^2 threshold for Warm Freshwater Habitat. This site was only sampled once, so it is not possible to compare this parameter over time. However, the percent macroalgae cover (7 percent) observed at the same time as chlorophyll *a* sampling was well below the evaluation guideline of 30 percent. Dissolved oxygen concentrations at this site were far below the minimum thresholds listed in the Tetra Tech guidance (2006), but daily variation in dissolved oxygen levels were generally 4-5 mg/L, which is within the range observed in non-eutrophic reference streams (Water Board 2012, raw data). The River at this location was deep and wide (1-2 m depth by 9 m width) with very little flow (< 1 cubic feet per second). Under such conditions, the stream water did not mix, so it resembled conditions from a pond (lentic) rather than a stream (lotic). A restoration project at this site removed the riparian vegetation on the right bank in order to lower the floodplain and increase flood protection, which might have temporarily allowed more light to reach the stream. Over time the restored riparian community will provide more shade for this reach, reducing temperatures and decreasing the potential for nuisance algae conditions. In sum, the weight of evidence at this site does not indicate an exceedance of the narrative biostimulatory objective at this site.

3.3.2.b Toxicity

Four lines of evidence show the River water quality is not toxic to human or wildlife and that beneficial uses are supported. Although the River is not listed for nutrient-related toxicity, we compiled existing data and collected new data to confirm that waters were not toxic to wildlife or humans. The water quality data were below appropriate drinking water quality standards for nitrate and nitrite (Table 6), so municipal drinking water beneficial uses were supported. In addition, the waters were not toxic to wildlife as indicated by new criteria for total ammonia recently published by U.S. EPA (2013) so aquatic life beneficial uses were supported (Table 6). The number of samples for nitrite, nitrate and ammonia meet the minimum sample sizes ($n > 28$) from Table 4.1 in the Listing Policy (State Water Board 2004).

3.3.3 Spatial variation

The nutrient data to support this analysis were collected throughout the River's watershed (Figure 3). The sample locations were along the main stem and in tributaries of varying stream orders. Perennial streams compose the majority of the sample locations because they have water during the summer when algae growth peaks, but a handful of non-perennial streams were monitored as well. Collections of algae cover and benthic chlorophyll *a* from 2011-2012 could be completed only from the wadeable sections of the main stem where the depth was 1m or less during the summer. This prohibited measurements on the main stem below Yountville, preventing quantification of algal biomass in the lower 9 miles of the non-tidal main stem.

Although the lowest 21 miles of the main stem were included in the original 303(d) listing as being impaired by nutrients, this section is tidally influenced and was not assessed in this report because freshwater Water Quality Objectives and numeric guidance do not apply to this segment. At present the Water Board could not identify any relevant data or appropriate guidelines to evaluate the biostimulatory substances narrative in the tidal portion of the River. Therefore, this segment was excluded from analysis in this delisting (Figure 1). The Water Board plans to reassess this listing in the tidal Napa River subsequent to the conclusion of the San Francisco Bay numeric nutrient endpoint project. That work is expected to generate guidelines/standards for identifying nutrient impairment in brackish and salt waters.

3.3.4 Temporal variation

Neither inter-annual (between years) nor intra-annual (across seasons) variability strongly affected the nutrient results. A previous analysis of water chemistry in the Napa watershed showed small differences in nutrient concentrations across seasons (SFEI 2005). The River met applicable toxicity Water Quality Objectives and evaluation guidelines for nutrients in all seasons and across all years. Nutrient concentrations did not substantially differ across the dry season. For example, in 2012 nutrient concentrations collected in June were only slightly higher than samples from August and September.

Similarly, Napa River benthic algal biomass did not exhibit significant temporal variation during the study period. In 2011 and 2012 algal biomass was collected only once in the late dry season (August – September), when maximum algal biomass was expected based on the Mediterranean climate and previously collected data in our Region. Increasing summer temperatures and decreased stream flow generally lead to maximal algae growth during that time frame before temperatures cool and early winter rains in October and November scour the stream bed, reducing the standing crop of benthic algae. Reference stream monitoring by SWAMP demonstrated that algal biomass can change substantially throughout a season and was greatest during in August and September (Water Board 2012). For example, benthic algal biomass measured using chlorophyll *a* at 3 perennial streams with minimal human disturbance increased from an average of 25 mg/m^2 in April/May to 37 mg/m^2 in June/July to 51 mg/m^2 in August/September. Maximum benthic algae chlorophyll *a* results from that study were 100 mg/m^2 for a perennial stream and 169 mg/m^2 in a non-perennial stream, which generally reinforce Tetra Tech's 150 and 200 mg/m^2 chlorophyll *a* thresholds for COLD and WARM, respectively (Tetra Tech 2006).

Benthic algal biomass indicators from the current monitoring effort did not change significantly between 2011 and 2012. Although chlorophyll *a* was nearly the same (Figure 4), and benthic algae measured using percent macroalgae cover was just slightly significantly higher in 2011 (Figure 5). However, some intra-annual variation was observed in percent cover measurements that were collected by estimating algae cover approximately once a month for three months in 2012. Two stream reaches showed some changes in observed percent cover. N-09 increased from 31 percent to 46 percent to 61 percent, showing increased growth throughout the dry season. N-55 in contrast showed a slight decrease in percent cover over time from 7 percent to 0 percent a month later.

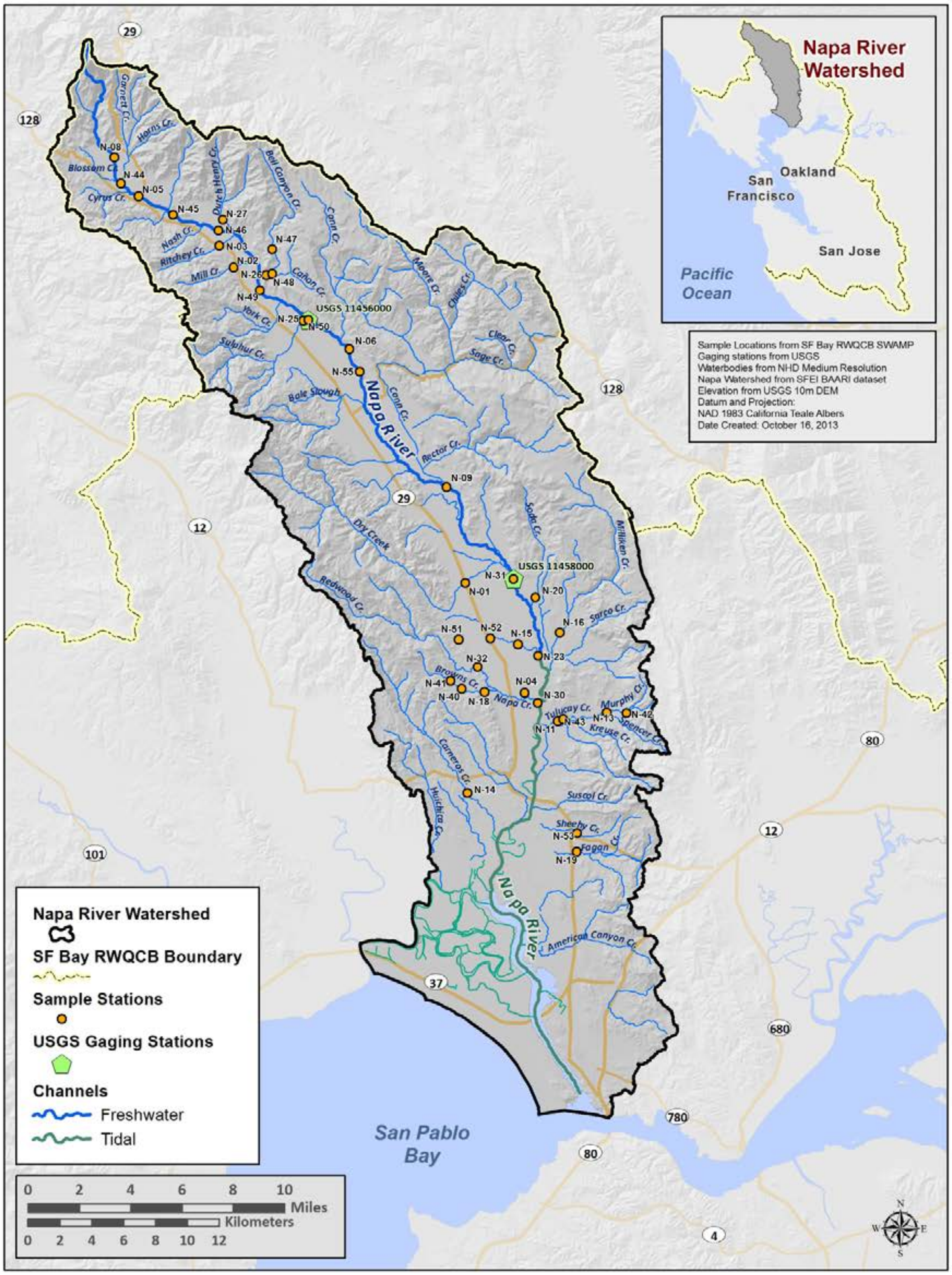

Figure 3. Map of all sample stations within the Napa River watershed. Precise sample locations can be seen in Table 9.

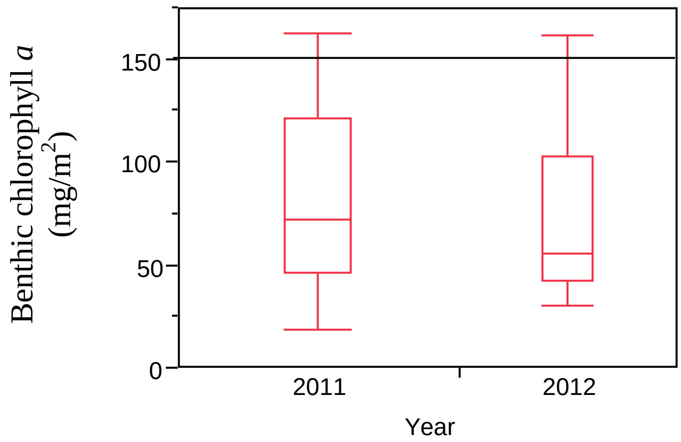

Figure 4. Box plot of benthic algae chlorophyll *a* levels in Napa River for 2011 and 2012. The evaluation guideline is 150 mg/m^2. The box plots represent the 25th to 75th percentiles and the whiskers represent the 10th and 90th percentiles. The line in the middle of the box shows the median observed value.

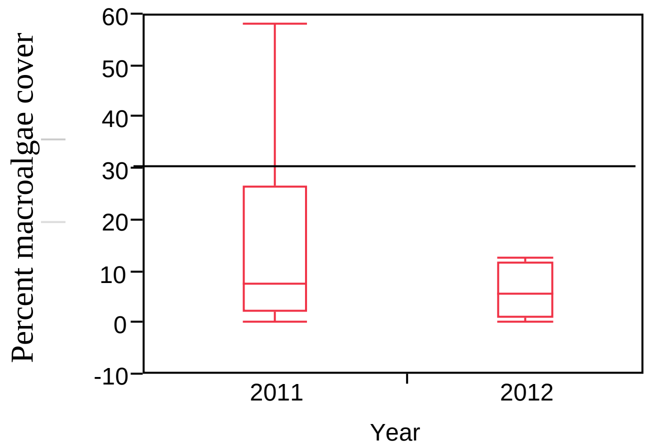

Figure 5. Box plot of benthic algae percent macroalgae cover levels in Napa River for 2011 and 2012. The evaluation guideline is 30 percent cover. Box plots represent the 25th to 75th percentiles and the whiskers represent the 10th and 90th percentiles. The line in the middle of the box shows the median observed value.

3.4 Flow Data

This report does not rely on flow data to evaluate the eight lines of evidence. However, two U.S. Geological Survey stations are present in the watershed, and data from 1960 – 2012 were analyzed to examine long-term flow trends (http://waterdata.usgs.gov/usa/nwis/rt; Table 8). Between 1960 and 2010, the average annual flow in cubic feet per second (cfs) did not show a consistent increase or decrease in flow over time (linear regression, slope < 1 cfs/year). Stream gage data confirmed the River's strong seasonality, with winter base flows ranging from 50-100 cfs and decreasing to 0-10 cfs in summer. Storm flows were 10-100 times winter base flows and surpassed 10,000 cfs. Flow (instantaneous) was measured at all sample locations during the late dry season in 2011 and 2012 (Table 9). These August and September flows were generally low (mean = 1.37 cfs) and ranged from 0.02 to 6.56 cfs. In general, tributaries carried less flow than the main stem.

Table 8. US Geological Survey flow monitoring information in Napa River.

Station information	GPS location	Period of record	Sampling frequency*
USGS 11458000 NAPA R NR NAPA CA	38.368333 -122.302222	1960-2012	Annual average
USGS 11456000 NAPA R NR ST HELENA CA	38.511389 -122.454722	1930-2012	Annual average

*Sampling frequency currently every 15 minutes, but annual flow average was used to determine potential flow changes over time.

3.5 Habitat Quality Data

Water Board staff collected physical habitat conditions in 2011 and 2012 according to the bioassessment protocol. The environmental variables most related to eutrophication are shade, stream temperature, and depth. In general, Napa streams are well shaded; the mean densiometer reading of canopy cover over the stream was 71 percent. Temperature readings during the late morning hours between 9 and 11 AM averaged 16.8°C (they ranged from 14.4 - 21.8°C). The average reach-wide depth at all sampling locations was 0.25 m. Overall, streams within Napa are well-shaded, but locations with open canopy, warmer temperatures, and shallow waters are more likely to produce algae blooms.

3.6 Data Analysis Summary

The three direct lines of evidence based on algal biomass (benthic chlorophyll *a*, water column chlorophyll *a*, and percent macroalgae cover) show the narrative water quality objective in the Basin Plan for biostimulatory substances was not exceeded (Table 6, 10, Water Board 2013). At the two sites with high algae levels (N-09 and N-55), secondary indicators of eutrophication (i.e., pH and dissolved oxygen) were not symptomatic of eutrophication. Most portions of the Napa River are well shaded (mean densiometer readings = 71 percent), and current levels of shade are important for preventing algae blooms. Four lines of evidence show that waters are not toxic to humans or wildlife, thus nutrients are not having a direct environmental impact on beneficial uses. No significant seasonal or inter-annual changes in water quality were observed that would affect this recommendation for delisting. This analysis supports delisting the Napa River non-tidal reach.

Table 9. Inventory of water quality monitoring stations in Napa River watershed

Station	Description	Latitude	Longitude	Sampling events							
				Oct 2002	Jan 2003	July 2003	May 2004	July 2009	Aug/Sept 2011	June 2012	Aug/Sept 2012
N-01	Dry Ck. @ Railroad Bridge	38.36500	-122.33813		x	x					
N-02	Mill Ck. @ the old Bale Mill	38.53992	-122.51067	x	x	x			x	x	x
N-03	Ritchey Ck. nr. Ranger Station	38.55175	-122.52124	x	x	x		x	x	x	x
N-04	Napa Ck. @ Jefferson	38.30054	-122.29339	x	x	x	x	x			
N-05	Napa R. @ Calistoga Community Center	38.57876	-122.58044	x	x	x	x	x			
N-06	Napa R. @ Zinfandel Lane	38.49549	-122.42560	x	x	x	x	x	x	x	x
N-08	Napa R. @ Tubbs Lane	38.60040	-122.59892		x	x					
N-09	Napa R. @ Yountville Ecopreserve	38.41890	-122.35326	x	x	x		x	x	x	x
N-11	Tulukay Ck. @ Terrace Court (close to N 44)	38.28852	-122.26935		x	x	x		x	x	x
N-13	Murphy Ck. @ "Stone Bridge" on Coombsville Road	38.29389	-122.23418	x	x	x	x	x			
N-14	Carneros Ck. @ Withers	38.24648	-122.33288		x	x					
N-15	Salvadore channel @ Garfield Park	38.33119	-122.29916	x	x	x	x				
N-16	Milliken Ck. @ Hedgeside Avenue	38.33827	-122.26945	x	x	x					
N-18	Brown Valley Ck. @ "Little Stone Bridge"	38.30389	-122.32224	x	x	x	x	x			
N-19	Fagan Ck. @ Kelly Rd.	38.21495	-122.25325	x	x	x					
N-20	Soda Ck. @ Silverado Trail	38.35792	-122.28727		x						
N-23	Napa R. @ Trancas St.	38.32508	-122.28435	x	x	x					
N-25	Sulphur Ck. @ Lower Bridge near Trailer Park	38.51083	-122.45929	x	x	x					
N-26	Bell Canyon Ck. @ Silverado	38.53617	-122.48703	x	x	x	x	x			
N-27	Dutch Henry Ck. @ Larkmead Lane Bridge	38.56665	-122.51919		x						
N-30	Napa R. @ 3rd St.	38.29818	-122.28370	x	x	x					
N-31	Napa R. @ Oak Knoll Ave.	38.36795	-122.30347	x	x	x				x	
N-32	Redwood Ck. @ Redwood Road	38.31785	-122.32750		x	x			x	x	
N-40	Browns Valley Ck. @ Buhman Ave.	38.30528	-122.33877				x	x			
N-41	Browns Valley Ck. @ Morningside Dr.	38.30957	-122.34670				x				
N-42	Murphy Ck. @ Shadybrook Ln.	38.29388	-122.21987				x	x			
N-43	Tulukay Ck. @ Shurtleff Ave. (close to N11)	38.28970	-122.26532				x				
N-44	Napa R. @ Heather Oaks Park	38.58567	-122.59333				x				
N-45	Napa R. @ Dunaweal Ln.	38.56873	-122.55527				x		x	x	x
N-46	Napa R. @ Larkmead Ln.	38.56057	-122.52203				x				

Station	Description	Latitude	Longitude	Sampling events							
				Oct 2002	Jan 2003	July 2003	May 2004	July 2009	Aug/Sept 2011	June 2012	Aug/Sept 2012
N-47	Bell Canyon Ck. @ Crystal Springs Rd.	38.55053	-122.48308				x				
N-48	Canon Ck. @322 Glass Mountain Rd.	38.53702	-122.48267				x				
N-49	Napa R. @ Lodi Ln.	38.52727	-122.49108				x				
N-50	Napa R. @ Pope St. Saint Helena	38.51137	-122.45567				x		x	x	
N-51	Salvadore Channel @ 2280 Dry Ck. Rd.	38.33307	-122.34195				x				
N-52	Salvadore Channel @ 121 near school	38.33423	-122.31901				x	x	x	x	x
N-53	Shehey Creek @ N Kelly Road & Executive way (Sh-1)	38.22540	-122.25320					x			
N-55	Napa River at Frogs Leap	38.48287	-122.41758								x
	Total number of samples			16	23	21	21	12	9	10	8

Table 10. Napa River water quality summary

	Years of collection	Seasons	No. of samples	Bench-mark	Units	Mean	25th	Median	75th	Number of exceedances
Chlorophyll *a*	2011, 2012	Summer/ early fall	16	150	mg/m^2	77	43	62	107	**2/16**
Percent macroalgae cover	2011, 2012	Summer/ early fall	17	30	%	13	2	7	18	**2/17**
Ammonia, total	2002, 2003, 2004, 2009, 2011, 2012	Winter, summer, fall	120	0.26	mg/L	0.028	0.007	0.013	0.041	**0/120**
Ammonia, unionized	2002, 2003, 2004, 2009, 2011, 2012	Winter, summer, fall	6	0.025	mg/L	0.0012	0.0004	0.0009	0.0019	**0/6**
Nitrate	2002, 2003, 2004, 2009, 2011, 2012	Winter, summer, fall	120	n/a	mg/L	0.600	0.095	0.348	0.859	**0/120**
Nitrite	2002, 2003, 2004, 2009, 2011, 2012	Winter, summer, fall	120	1	mg/L	0.008	0.001	0.002	0.006	**0/120**
Nitrite+ nitrate	2002, 2003, 2004, 2009, 2011, 2012	Winter, summer, fall	120	10	mg/L	0.608	0.098	0.349	0.884	**0/120**
Total nitrogen	2002, 2003, 2004, 2009, 2011, 2012	Winter, summer, fall	120	n/a	mg/L	0.97	0.40	0.68	1.24	**n/a**
Ortho-phosphate	2002, 2003, 2004, 2009, 2011, 2012	Winter, summer, fall	120	n/a	mg/L	0.072	0.022	0.049	0.086	**n/a**
Total phosphorus	2002, 2003, 2004, 2009, 2011, 2012	Winter, summer, fall	116	n/a	mg/L	0.07	0.04	0.07	0.09	**n/a**

4 Sonoma Creek

4.1 Project Definition

4.1.1 Background

In 1986, the Sonoma Creek (Creek) main stem was identified on California's Clean Water Act Section 303(d) List as impaired by excessive levels of nutrients, resulting in eutrophication (excessive algal growth). In this report, the terms "Sonoma Creek" and "Creek" refer to the main stem of the Creek as well as to its tributaries within the Sonoma watershed. The listing encompassed 33 miles[5] of stream length as measured by the National Hydrography Dataset (U.S. Geological Survey 2013) between the Creek mouth and the top of the watershed (Figure 6). The Creek lies within the jurisdiction of the Water Board and drains to San Pablo Bay, a portion of the San Francisco Bay. The original listing largely stemmed from concerns over domestic wastewater treatment plant discharges to the creek, particularly during periods of low flow, and from observations of excessive algal growth.

The primary effect of excess nutrients on the Creek is eutrophication (Carpenter et al. 1998); that is, the stimulation of excessive algal growth. Phosphorus and nitrogen are the nutrients usually responsible for eutrophication, as these are usually growth-limiting in uncontaminated surface waters. Eutrophication in Bay Area streams, including the Creek and neighboring Napa River, usually takes the form of algae that grow attached to the bottom substrate (periphyton), as opposed to suspended in the water column (phytoplankton). Excessive periphyton growth can smother bottom habitat and depress dissolved oxygen concentrations in bottom gravels and in the water column. Dissolved oxygen is a critical water quality condition that can affect survival of protected salmonids, such as steelhead trout (*Oncorhynchus mykiss*) and Chinook salmon (*Oncorhynchus tshawytscha*), in these waters. Because the Bay Area has a Mediterranean climate, excessive algal growth is typically a dry season phenomenon that occurs during the summer and early fall months prior to the rainy season.

4.1.2 Proposed Delisting

We are proposing to delist the non-tidal Creek main stem for nutrient impairment upstream from Hwy 121 (SFEI), which totals 23 miles of stream length according to the National Hydrography Dataset (U.S. Geological Survey 2013). The Water Board has observed general improvement in water quality conditions in the 30 years since the Creek was listed as impaired for nutrients. Additionally, in 2006, the State Water Board released draft numeric endpoints for nutrients and other tools to predict acceptable nutrient concentrations (Tetra Tech 2006). These tools allow for numeric review of whether narrative Water Quality Objectives are being met and beneficial uses supported.

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[5] The most recent (2010) Integrated Report (http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml) lists the entire Sonoma Creek main stem which encompasses 30 miles, but the current stream length measured using the National Hydrography Dataset is 33 miles.

This project:

1) compiled all known existing data related to nutrients and algae growth in the watershed;
2) collected additional data on benthic algae in a manner consistent with the State Water Board's nutrient numeric endpoint guidance (Tetra Tech 2006);
3) created eight lines of evidence to evaluate all relevant available data; and
4) proposes to refine the nature and scope of the beneficial use impairment in Sonoma Creek based on its findings.

This delisting report does not include a proposal to modify the nutrient listing for the tidal portion of the Creek (10 miles) because guidelines and standards for such an evaluation do not yet exist. The Water Board is developing a model to understand nutrients in tidal areas of the Bay, and when that process is complete, we plan to evaluate the tidal portion of the River.

4.1.3 Analysis Supporting Delisting

Data allowing us to consider delisting the Creek for nutrients were collected between 2002 and 2012. This assessment included examination of nuisance algae levels caused by excess nutrients resulting in eutrophication, and toxicity resulting from ammonia, nitrate, and nitrite. Eight lines of evidence were produced using the following analytes: ammonia, nitrate, nitrite, benthic chlorophyll *a*, percent macroalgae cover, and pH. Data used to create these lines of evidence were collected by the San Francisco Estuary Institute (SFEI) (2002-2004), Water Board staff (2009), and SWAMP staff (2011-2012). Additionally, continuous monitoring dissolved oxygen data were collected at a subset of sites during the 2011-2012 sampling effort.

New water quality policy, along with tools to measure and evaluate excess algae levels, have allowed staff to conduct a rigorous and standardized analysis of algae levels and water quality conditions in the Creek. The analysis presented in this report relied on guidance set forth in 2004 by the State Water Board's 303(d) Listing Policy (Listing Policy) in regards to sample size, analysis approach, and data quality assurance (State Water Board 2004). SWAMP recently created standardized sampling methods to quantify algal biomass (Fetscher et al. 2009), and quality assurance and quality control procedures for field crews and laboratories collecting these data (SWAMP 2008). Subsequently, the Water Board collected algal biomass and nutrient data from 2011-2012 using these novel sampling techniques. Algal biomass data were reviewed against the State Water Board's guidance thresholds (Tetra Tech 2006). Therefore, the current evaluation of water quality standard attainment is more sophisticated and relies on a better dataset compared to analyses that were possible during the original 1986 listing.

Current water quality conditions in the Creek (2002-2012) show that nutrient-related numeric and narrative Water Quality Objectives are being met and potentially impacted beneficial uses are supported in this water body. The eight lines of evidence did not show exceedances beyond what is specified in the Listing Policy (State Water Board 2004). Therefore, we conclude that water quality conditions have improved since the original listing in 1986. No algae cover data were available from the time of the listing, so a direct comparison between current and past conditions was not possible. Additionally, no historical nutrient data could be identified for comparison.

4.1.4 Rationale for Reduced Algae Growth

The reduction in nuisance algae levels was probably a cumulative effect of NPDES permit restrictions on wastewater discharges, changes in land use in the Creek's watershed over the past 30 years, and improved agricultural best management practices (BMPs). Few water quality controls were in place before the federal Clean Water Act or the 1975 San Francisco Bay Basin Water Quality Control Plan (Basin Plan) (Water Board 1975). Historical conditions could generally be described as having included higher levels of cattle grazing (probably with direct access to streams and tributaries), more dairies and confined animal feeding operations (i.e., milking cows) with limited best management practices, and limited requirements on the wastewater treatment plant discharging into the non-tidal portion of the Creek. Nutrient loads from these sources have been reduced through activities described below.

The Creek was identified as having poor water quality conditions and was designated as Water Quality Limited in the 1975 Basin Plan (Water Board 1975). The Basin Plan's narrative description of past conditions and sources focused on contributions of biological oxygen-demanding substances from agricultural lands and municipal wastewater treatment facilities. The Creek was initially designated as an Effluent Limited Segment in the 1976 Clean Water Act 305(b) report for coliforms but not until 1986 was the Creek placed on the 303(d) list of impaired water bodies for nutrients causing eutrophic conditions (State Water Board 1976, 1986). Although point source and non-point sources of nutrients were identified in the original listing (Table 11), the wastewater treatment plant was considered to be a major contributor of nutrients at the time. However, over the past 30 years, improvements to and changed practices at the wastewater treatment plant has significantly reduced discharges and nutrient impacts in discharges to the Creek.

By the 1980s, NPDES permits issued by the Water Board to the wastewater treatment plant has included specific language prohibiting discharge during the "dry season," when the minimum 10:1 river water to discharge dilution ratio could not be achieved as dictated by the 1982 Basin Plan (Water Board 1982).[6] This discharge prohibition significantly reduced nutrient loading into receiving waters at a time when flows are naturally low because of the summer drought occurring in this region's Mediterranean climate. Wastewater treatment plants in the Sonoma and Napa watersheds that discharged to shallow waters stored or recycled 100 percent of their discharge during the dry season and also employed those same techniques during the wet season when the 10:1 ratio could not be achieved. This resulted in no dry season discharges, and only occasional discharges during the rainy season, when the impacts of nutrient discharges are limited because environmental conditions result in very limited algal growth and rapid flushing of nutrients into the Bay. Current NPDES permits require dilution ratios of up to 50:1, so treatment plants are currently discharging even less frequently into the Creek during the winter season. Additionally, over the past 30 years, the one plant that has continued discharging to a slough within the non-tidal Creek sections (Sonoma Valley County Sanitary District's plant) has improved treatment BMPs and added treatment technologies to reduce nitrogen inputs.

[6] The exact dates of the dry season varied slightly in each permit, but it was generally from May 1 – October 31.

Shifts in agriculture practices have likely also played a role in reducing nutrient loads to the River. Guidance provided by the U.S. Department of Agriculture National Resources Conservation Service and by local Resource Conservation Districts has improved agricultural BMPs for grazing animals and confined animal facilities. Examples include the development of Farm Conservation Plans, Nutrient Management Plans, Waste Management Systems, and Ranch Water Quality Control Plans (reviewed in Lewis et al. 2011). The implementation of such plans in the San Francisco Bay Region resulted in fewer nutrient inputs and less sediment erosion into water bodies (Larson et al. 2005; Lewis et al. 2011). Additionally, crop reports produced by the Sonoma County Agricultural Commissioner show that cattle and calf production decreased substantially from 237,865 centum weight (CWT) in 1970 to 157, 634 CWT in 2011. (http://www.countyofSonoma.org/AgCommissioner/CropReport/). CWT is a measure of weight in 100-lb units. Decreased production of cattle occurred because of reductions in cattle on rangelands and a reduction in the number of confined animal facilities.

Since the 1970s, vineyard acreage has increased in all of Sonoma County from 12,597 to 60,184 acres (http://www.countyofSonoma.org/AgCommissioner/CropReport/), an increase of about 67 square miles. However, nutrient runoff from vineyards is low (Rosenstock et al. 2013), and a portion of the increase in vineyard acreage was conversion from other agricultural land uses with greater potential to contribute nutrients to the Creek. Additionally, there are active watershed programs that reduce the water quality impacts from vineyards. In 2002, the Napa Valley Vintners Association, the Napa County Grapegrowers Association and the Napa County Farm Bureau brought the Fish-Friendly Farming program to Napa County, and since then implementation has expanded to the Sonoma Creek watershed (http://www.fishfriendlyfarming.org/). Although the program is new to Sonoma County, vintners have expressed interest in the program and have started to enroll. This program teaches the use of sediment control and bank stabilization BMPs - efforts that will also reduce sediment-bound nutrient discharges to streams.

We did not find evidence of significant changes to physical conditions in the watershed that were likely to lead to algae blooms. For example, increases in water temperature, decreases in water depth, decreases in riparian shade cover, and decreases in stream flow can all increase algae growth. An analysis of annual steam flow between 1955 and 2012 from the one U.S. Geological Survey station along the Creek showed no consistent change over time. The U.S. Geological Survey did not collect temperature data over the same time period, so a historical temperature analysis could not be performed.

Table 11. 1986 U.S. EPA 303(d) listing information for Sonoma Creek related to nutrients and eutrophic conditions.

Segment name & description	Beneficial uses evaluated*	Objective violated	Source
Sonoma Creek main stem	WARM COLD MUN AG REC-1 REC-2*	Nutrients resulting in eutrophication	Point and non-point sources

* The original 1986 listing included WARM, SPWN, and MIGR as the beneficial uses affected. The beneficial uses noted in this table are for uses currently applied to this water body with numeric Water Quality Objectives or evaluation guidelines. Beneficial Use designations are described in Table 1.

4.2. Watershed Description

The Sonoma Creek watershed is located in the California Coast Ranges north of San Pablo Bay (Figure 6) and covers an area of approximately 165 square miles. The main stem of the Creek flows approximately 33 miles in a southeasterly direction through the Sonoma Valley before discharging to San Pablo Bay. Although the original listing only focused on the Creek main stem, numerous tributaries enter the main stem from the mountains that rise abruptly on both sides of the valley. The combined length of the Creek main stem and its tributaries is over 247 miles. We conducted a watershed-based water quality assessment, examining conditions in both the tributaries and the non-tidal main stem. The results of this assessment and the subsequent lines of evidence are discussed in Section 4.3.2.

Table 12. Land use in the Sonoma Creek watershed.

Land use*	Percentage of watershed
Forest / Open Space	3.1%
Rangeland	11.3%
Agriculture-vineyard*	27.0%
Agriculture-other	24.1%
Urban-Commercial & Industrial	7.2%
Urban-Open	6.5%
Urban-Other	1.6%
Urban-Residential	17.1%
Water & Wetlands	2.2%

*Land use from Association of Bay Area Governments (2006) except vineyard area from Heaton 2007 (http://knowledge.sonomacreek.net/node/110).

This watershed has a Mediterranean climate with warm, dry summers and cool, wet winters (Gasith and Resh 1999). Average annual rainfall ranges from approximately 25 to 38 inches in the Sonoma Valley, and the large majority of rainfall occurs from November through April, with the heaviest rainfall occurring from December through February (Gilliam 2002). This rainfall regime results in two distinct seasons in the watershed. During the winter wet season, stream flow and pollutant loading are dominated by precipitation-driven surface runoff. In contrast, during the dry summer months, groundwater inflow and minor runoff from watershed activities are dominant. Major land cover types in the watershed are agriculture, which is largely composed of vineyard use (27%), and grassland/rangeland (11 percent). Developed land (e.g., residential, industrial, and commercial) accounts for approximately 32 percent of the watershed (Association of Bay Area Governments, 2006; Table 12). The population of the Sonoma Creek watershed is about 42,877.

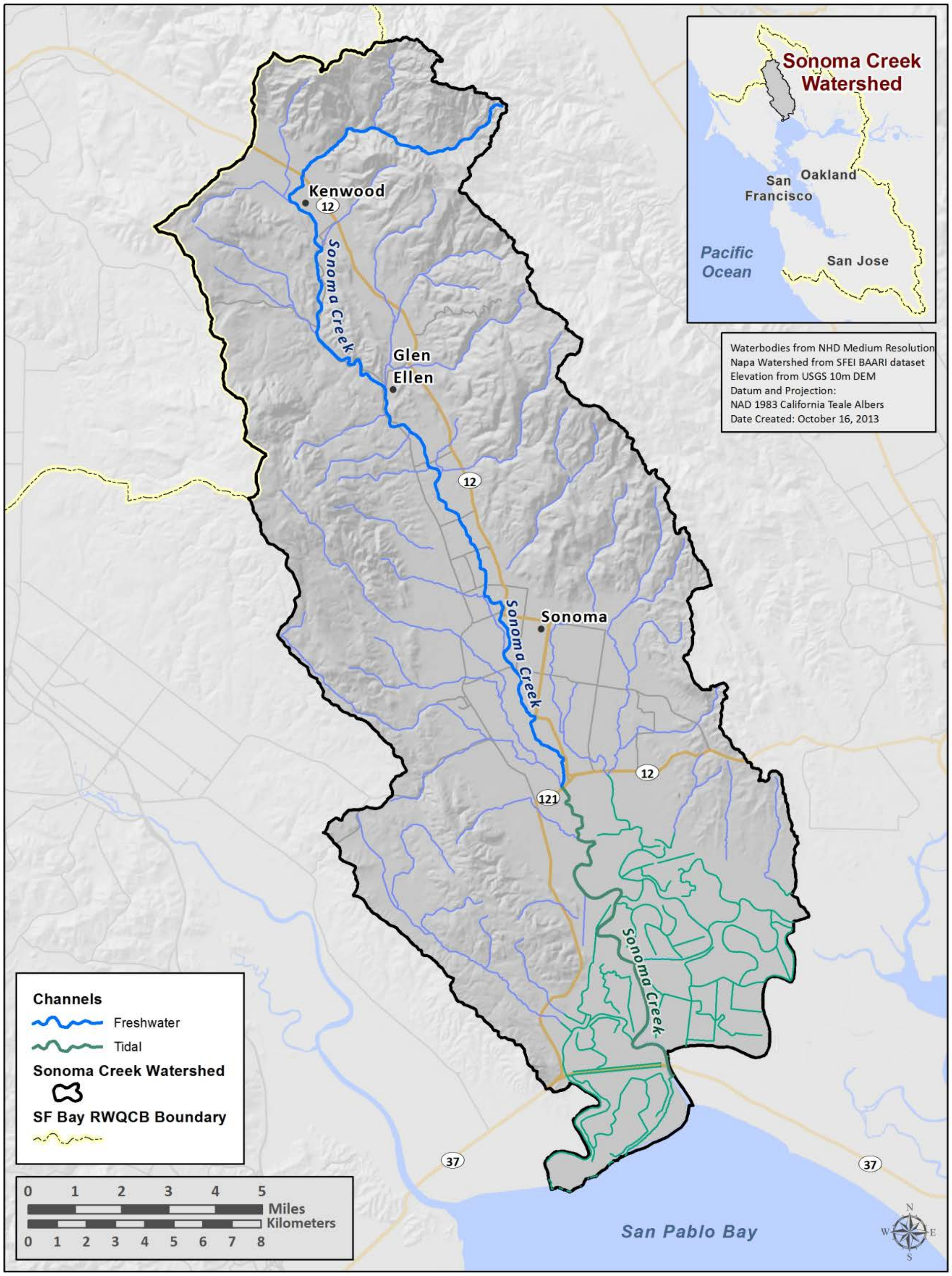

Figure 6. Map of the Sonoma Creek watershed

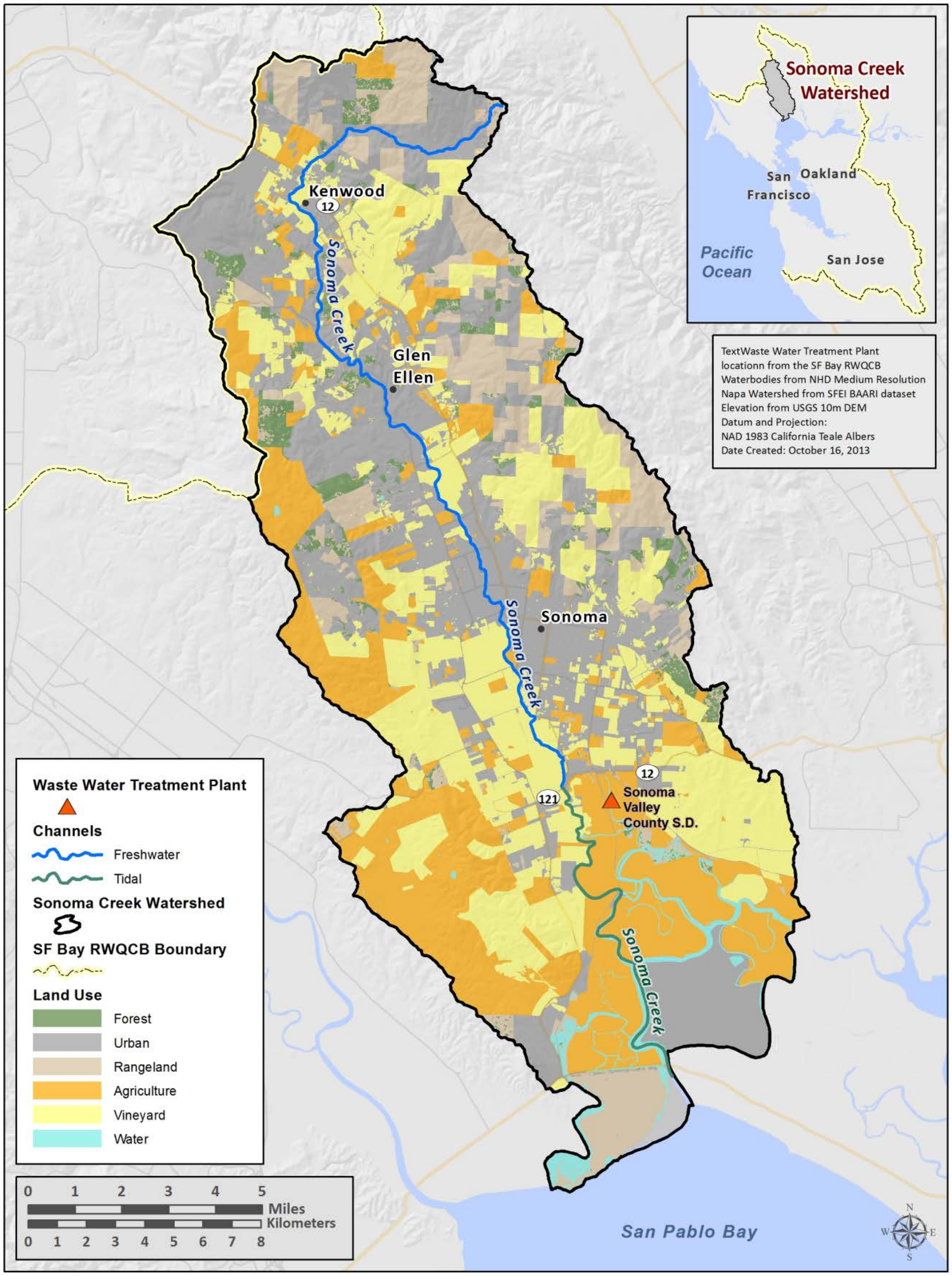

Figure 7. Map of land use and potential nutrient sources in the Sonoma Creek watershed.

4.3 *Water Quality Data*

4.3.1 Data quality

Data to support this delisting were collected over multiple years (2002-2012) by different sampling crews and analyzed by multiple laboratories (Table 5). All data used as lines of evidence are considered to be of high quality. Data collected from 2011-2012 are either SWAMP-compliant, or qualified as determined by the SWAMP Quality Assurance Program Plan (2008). Data collected from 2009 were analyzed by a U.S. EPA lab, so these samples underwent the QC testing required by U.S. EPA labs. Nutrient data collected from 2002-2004 were analyzed for precision and accuracy. Laboratory duplicate samples showed a precision range of < 30 percent, which we consider to be of acceptable quality because it is just above SWAMP guidance of a relative percent difference of 25 percent (SWAMP 2008, 2013). For 2002-2004 pH data, SFEI did not produce a Sampling and Analysis Plan or Quality Assurance Project Plan that could confirm the reliability of the equipment used, pH standards, number of points used for calibration, adequate frequencies pre- and post-measurement calibrations, and established measurement quality objectives for drift. For these reasons, we determined these data to be unusable for the pH line of evidence analysis.

4.3.2 Lines of evidence

Four lines of evidence support removing the original listing for eutrophication and four lines of evidence show that nutrient toxicity is not present (Table 13).

4.3.2.a Eutrophication

Three direct lines of evidence for biostimulation of algae and a fourth indirect line of evidence demonstrate that Water Quality Objectives are not exceeded and designated beneficial uses are supported. The three direct lines of evidence are algal biomass indicators represented by benthic chlorophyll *a* and percent macroalgae cover (attached + unattached) collected using the SWAMP Bioassessment protocol (Ode 2007, Fetscher et al. 2009) and water column chlorophyll *a*.

The direct benthic chlorophyll *a* line of evidence showed only one exceedance of evaluation guidelines out of 18 samples collected over two years. We recorded no exceedances for percent macroalgae cover out of 17 samples collected across two years. Relatively fewer data points are available for the algae mass indicators compared to water column chemistry measures (e.g., ammonia, nitrate, and nitrite) because they are more expensive and time consuming to collect. However, fewer data points are necessary to evaluate overall water quality conditions because they are seasonally integrative measures, which represent weeks to months of water quality conditions coalesced into a single data point.

Chlorophyll *a* in the water column was collected by SFEI in 2002 and 2003 and showed no exceedances against the evaluation guideline. Zero of 25 samples exceeded the 15 µg/L evaluation guideline. Therefore, this line of evidence does not support impairment according to the biostimulatory narrative objective.

Table 13. Sonoma Creek Summary of lines of evidence and exceedances of numeric evaluation guidelines.

LOE	Analyte	Numeric evaluation guideline	Number of exceedances	Evaluation metric	Listing factor
1	Benthic biomass chlorophyll *a*	< 150 mg/m^2	1/18	Evaluation Guideline	4.11 weight of evidence
2	Percent macroalgae cover [a]	30%	0/18	Evaluation Guideline	4.11 weight of evidence
3	Nitrite	1 mg/L	0/86	Water Quality Objective	4.1 toxicant
4	Nitrate+ Nitrite	10 mg/L	0/86	Water Quality Objective	4.1 toxicant
5	Ammonia, un-ionized	0.025 mg/L	0/6 [b]	Water Quality Objective	4.1 toxicant
6	Ammonia, Total	0.1-1.6 mg/L	0/86	U.S. EPA Criterion	4.1 toxicant
7	pH[c]	6.5-8.5 units	0/27	Water Quality Objective	4.1 toxicant
8	Water column chlorophyll *a*	15 µg/L	0/25	Evaluation Guideline	4.11 weight of evidence

[a] metric calculated from the SWAMP bioassessment protocol from 105 observations along a 150m section of stream.
[b] 86 unique samples analyzed by year.
[c] Only pH data collected using the SWAMP QAPrP were incorporated into this assessment.

Table 14. Sonoma Creek Water quality parameters at the one site with chlorophyll *a* algae exceedances listed in LOE 1 of Table 13.

Sample site	Year	Season	Benthic chlorophyll *a*	% Macroalgae cover	% Riparian cover	Dissolved oxygen median (mg/L)
S-36	2011	Late summer	259 mg/m^2	29.5	44	7.54
S-36	2012	Late summer	27 mg/m^2	13.3	54	6.02

At the one site with an exceedance of the chlorophyll *a* evaluation guideline (S-36) other algal biomass or eutrophication indicators did not demonstrate a consistent problem over time (Table 14). For example, in 2011 the benthic chlorophyll *a* level was well above the 150 mg/m^2 guideline for COLD and above the 200 mg/m^2 guideline for WARM, yet the chlorophyll *a* level from the following year (2012) was well below both thresholds. Additionally, the percent macroalgae cover (based on 105 sample points along a 150 m section of stream) was below the 30 percent evaluation guideline in both years. Secondary indicators, such as continuously monitored dissolved oxygen, showed that water quality conditions were adequate for aquatic life uses WARM and COLD based on guidance from Tetra Tech (2006). Also the strong daily (diel) swing of dissolved oxygen, which occurs in severely eutrophic waters, was not observed, nor was highly oxygenated water above 13 mg/L observed, a eutrophication indicator proposed by the Central Coast Water Board (2010). Fisheries data from the Sonoma RCD show that fish conditions for spawning and migration are supported in this watershed, but there is not enough information to determine population trends (CEMAR 2013). This reach is not publicly accessible, so it was not possible to evaluate whether REC-1 and REC-2 beneficial uses were affected by algae blooms. The geomorphology of the stream reach is a wide channel, so there is less shading from tall upland trees compared to other portions of the Creek where the stream is incised or has been partially channelized. In sum, the weight of evidence at this site does not indicate an exceedance of the narrative biostimulatory objective at this location.

4.3.2.b Toxicity

Four lines of evidence show that Creek water quality is not toxic to human or wildlife and that beneficial uses are supported. Although the Creek is not listed for nutrient-related toxicity, we compiled existing data and collected new data to confirm that waters were not toxic to wildlife or humans. The water quality data were below appropriate drinking water quality standards for nitrate and nitrite (Table 13), so municipal beneficial uses were supported. In addition, the waters were not toxic to wildlife as indicated by the evaluation guideline for total ammonia recently proposed by U.S. EPA (2013), so aquatic life beneficial uses were supported (Table 13). The number of samples for nitrite, nitrate and ammonia meet the minimum sample sizes ($n > 28$) from Table 4.1 in the Listing Policy (State Water Board 2004).

4.3.3 Spatial variation

The nutrient data to support this analysis were collected throughout the Creek's watershed (Figure 8). The sample locations were along the main stem and in tributaries of varying stream orders. Perennial streams compose the majority of the sample locations because they have water during the summer when algae growth peaks, but a handful of non-perennial streams were monitored, as well. Collections of algae cover and benthic chlorophyll *a* from 2011-2012 could be completed only from the wadeable sections of the main stem where the depth was 1m or less during the summer. The lowest sample point was approximately 1.5 miles upstream of the tidal boundary at State Highway 121, so we were effectively able to sample the entire length of the main stem.

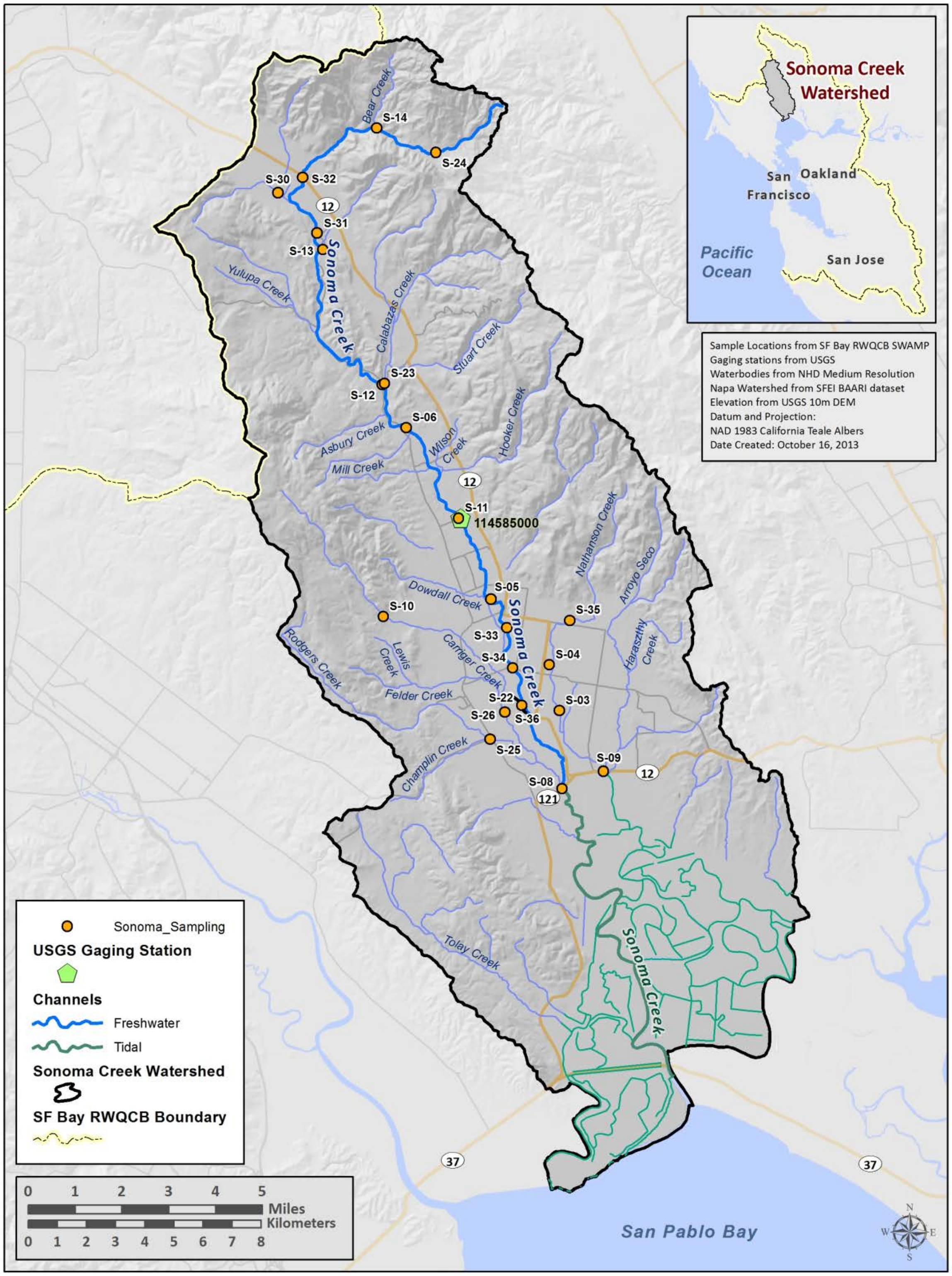

Figure 8. Map of all sample stations within the Sonoma Creek watershed

Although the lowest ten miles of the main stem were included in the original 303(d) listing as being impaired by nutrients, this section is tidally influenced and was not assessed in this report because freshwater Water Quality Objectives and numeric guidance do not apply to this segment. At present, we could not identify any relevant data or appropriate guidelines to evaluate the biostimulatory substances narrative objective in the tidal portion of the Creek. Therefore, this segment was excluded from analysis in this delisting (Figure 6). We plan to reassess this listing in the tidal reach of the Creek subsequent to the conclusion of the San Francisco Bay numeric nutrient endpoint project. That work is expected to generate guidelines/standards for identifying nutrient impairment in brackish and salt waters.

4.3.4 Temporal variation

Neither inter-annual (between years) nor intra-annual (across seasons) variability strongly affected the nutrient results. A previous analysis of water chemistry in the Sonoma Creek main stem and tributaries showed small differences in nutrient concentrations across seasons (SFEI). The Creek met applicable toxicity Water Quality Objectives and evaluation guidelines for nutrients in all seasons and across all years. Nutrient concentrations did not substantially differ across the dry season. For example, in 2012 nutrient concentrations collected in June were only slightly higher than samples from August and September.

Similarly, Creek benthic algal biomass did not exhibit significant temporal variation during the study period. In 2011 and 2012, algal biomass was collected only once in the late dry season (August – September) when maximum algal biomass was expected based on the Mediterranean climate and previously collected data in our Region. Increasing summer temperatures and decreased stream flow generally lead to maximal algae growth during that time frame before temperatures cool and early winter rains in October and November scour the stream bed, reducing the standing crop of benthic algae. Reference stream monitoring by SWAMP found that algal biomass can change substantially throughout a season and was greatest during August and September (Water Board 2012). For example, benthic algal biomass measured using chlorophyll *a* at three perennial streams with minimal human disturbance increased from an average of 25 mg/m^2 in April/May to 37 mg/m^2 in June/July to 51 mg/m^2 in August/September. Maximum benthic algae chlorophyll *a* results from that study were 100 mg/m^2 for a perennial stream and 169 mg/m^2 in a non-perennial stream, which generally reinforce Tetra Tech's 150 and 200 mg/m^2 chlorophyll *a* thresholds for Cold Freshwater Habitat and Warm Freshwater Habitat, respectively (Tetra Tech 2006).

Benthic algal biomass indicators from the current monitoring effort did show minor differences between 2011 and 2012. Although chlorophyll *a* was nearly the same (Figure 9), benthic algae measured by percent macroalgae cover slightly lower in 2012 although this difference was not statistically significant (Figure 10). However, some intra-annual variation was observed in percent cover measurements that were collected by estimating algae cover approximately once per month for three months in 2012. Three stream reaches showed little change in observed percent cover (mean change 4 percent). However, one site that also happened to be the only site with an exceedance of this metric (S-36), showed a substantial decrease from 46 percent in early summer to 0 percent macroalgae cover in fall, which resulted because the shallow portions of the Creek dried out during that time period so the filamentous algae was no longer counted as being in the stream.

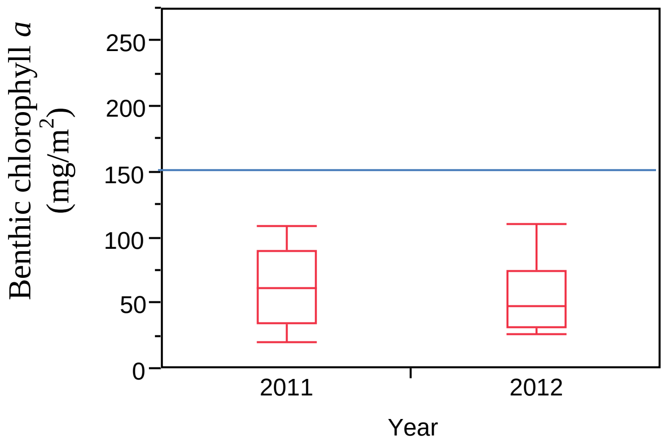

Figure 9. Box plot of chlorophyll *a* levels for 2011 and 2012. The evaluation guideline is 150mg/m^2. The box plots represent the 25th to 75th percentiles and the whiskers represent the 10th and 90th percentiles. The line in the middle of the box shows the median observed value.

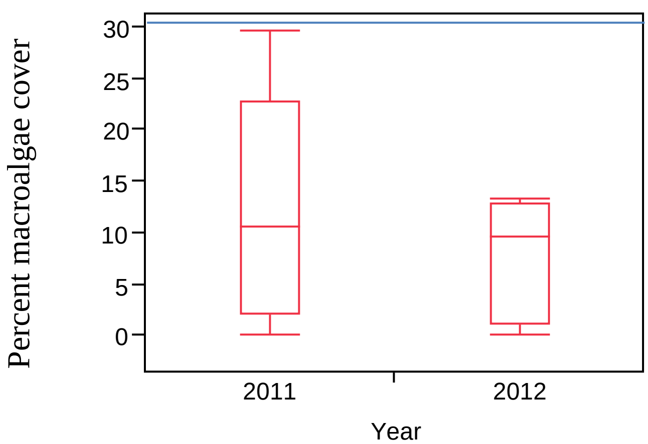

Figure 10. Box plot of percent macroalgae cover levels for 2011 and 2012. The evaluation guideline is 30 percent cover. The box plots represent the 25th to 75th percentiles and the whiskers represent the 10th and 90th percentiles. The line in the middle of the box shows the median observed value.

Table 15. Inventory of water quality monitoring stations in Sonoma Creek.

Station	Description	Latitude	Longitude	Sampling events							
				Oct 2002	Jan 2003	July 2003	May 2004	July 2009	Aug/Sep 2011	June 2012	Aug/Sep 2012
S-03	Nathanson Ck. @ Watmaugh just west of 5th Street	38.26457	-122.45307		x	x	x	x			
S-04	Nathanson Ck. @ Nathanson Park Napa Rd. to Larkin To Fine	38.27860	-122.45748		x	x	x				
S-05	Sonoma Ck. @ Maxwell Park near access from Riverside Drive	38.29840	-122.48120	x	x	x	x	x	x	x	x
S-06	Sonoma Ck. near Sonoma Developmental Center	38.35070	-122.51627	x	x	x		x	x	x	x
S-08	Sonoma Ck. @ Hwy 121	38.24047	-122.45130	x	x	x					
S-09	Schell Ck. @ Hwy 121	38.24625	-122.43508		x	x		x			
S-10	Carriger Ck. @ Marilyn Goode's property	38.29211	-122.52320	x	x						
S-11	Sonoma Ck. @ Agua Caliente	38.32318	-122.49470	x	x	x					
S-12	Sonoma Ck. @ Glen Allen (above confluence with Calabazas)	38.36376	-122.52617	x	x	x		x	x	x	x
S-13	Sonoma Ck. @ 986 Warm Springs Rd. 986 Warm Springs Road	38.40492	-122.55097	x	x	x	x	x	x	x	x
S-14	Sonoma Ck. @ Goodspeed Bridge (above Bear Creek confluence)	38.44295	-122.53110	x	x	x	x	x	x	x	x
S-22	Sonoma Ck. @ Watmaugh	38.26580	-122.46783		x	x	x	x			
S-23	Calabazas Ck. @ Glen Allen (from Henno Road)	38.36411	-122.52526		x	x					
S-24	Sonoma Ck. Sugarloaf State Park near Robert Ferguson Observatory	38.43593	-122.50738		x	x		x	x	x	x
S-25	Rogers Ck. @ Arnold Drive	38.25515	-122.48002		x						
S-26	Carriger Ck. @ Watmaugh	38.26358	-122.47450		x	x					
S-30	Unnamed Ck. @ Lawndale Ave.	38.42220	-122.56925				x		x	x	x
S-31	Sonoma Ck. @ Mound Ave	38.41010	-122.55352				x				
S-32	Sonoma Ck. @ Hwy 12 near Hoff St	38.42703	-122.55968				x		x	x	x
S-33	Sonoma Ck. @ Andrieux St.	38.28970	-122.47463				x				
S-34	Sonoma Ck. @ Leveroni Rd.	38.27732	-122.47178				x				
S-35	Nathanson Ck. @ 4th St.	38.29248	-122.44993				x				
S-36	Sonoma Ck. @ Watmaugh	38.26580	-122.46783						x	x	x
	Total number of samples			8	16	14	12	9	9	9	9

4.4 Flow Data

This report does not rely on flow data for its major analyses. However, one U.S. Geological Survey station is present in the watershed, and data from 1955– 2012 were analyzed to examine long-term flow trends (http://waterdata.usgs.gov/usa/nwis/rt; Table 16). Between 1955 and 2012, the average annual flow in cubic feet per second (cfs) did not show a consistent increase or decrease in flow over time (linear regression, slope < 1 cfs/year). Stream gage data confirmed the Creek's strong seasonality, with winter base flows ranging from 40-400 cfs and decreasing to <1-5 cfs in summer. Storm flows were 100 times winter base flows and surpassed 10,000 cfs. Flow (instantaneous) was measured at all sample locations during the late dry season in 2011 and 2012 (Table 15). These August and September flows were low (mean = 1.55 cfs) and ranged from 0.03 to 5.5cfs. In general tributaries carried less flow than the main stem.

Table 16. USGS flow monitoring information.

Station information	GPS location	Period of record	Sampling frequency*
USGS 11458500 SONOMA C A AGUA CALIENTE CA	38.323333 -122.493333	1955-2012	Annual average, daily average

*Sampling frequency currently every 15 minutes, but annual flow average was used to determine potential flow changes over time.

4.5 Habitat Quality Data

Water Board staff collected physical habitat conditions in 2011 and 2012 according to the SWAMP bioassessment protocol. The environmental variables most related to eutrophication are shade, stream temperature, and depth. In general, Sonoma Creek watershed streams are well shaded; the mean densiometer reading of canopy cover over the stream was 79 percent. Temperature readings during the late morning hours between 9 and 11 AM averaged 16.4°C (ranging from 13.6-20.9°C). The average reach-wide depth at all sampling locations was 0.21 m. Overall the Creek is well shaded, but locations with open canopy, warmer temperatures, and shallow waters are more likely to produce algae blooms.

4.6 Data Analysis Summary

The three direct lines of evidence based on algal biomass (benthic chlorophyll *a*, water column chlorophyll *a*, and percent macroalgae cover) show the narrative water quality objective in the Basin Plan for biostimulatory substances was not exceeded (Table 13, 15; Water Board 2013). At the site with high algae levels (S-36), secondary indicators of eutrophication (i.e., pH and dissolved oxygen) were not symptomatic of eutrophication. Most portions of the Creek are well-shaded (mean densiometer readings were 79 percent), and current levels of shade are important for preventing algae blooms. Four lines of evidence show that the waters are not toxic to humans or wildlife, thus nutrients are not having a direct environmental impact on beneficial uses. No significant seasonal or inter-annual changes in water quality were observed that would affect this recommendation for delisting. This analysis supports delisting the Creek's non-tidal reach.

Table 17. Sonoma Creek water quality summary

	Years of collection	Seasons	No. of samples	Bench-mark	Units	Mean	25th	Median	75th	Number of exceedances
Chlorophyll *a*	2011, 2012	Summer/ early fall	18	150	mg/m^2	65	33	49	77	**1/18**
Percent macroalgae cover	2011, 2012	Summer/ early fall	18	30	%	10	2	10	14	**0/18**
Ammonia, total	2002, 2003, 2004, 2009, 2011, 2012	Winter, summer, fall	86	0.26	mg/L	0.032	0.041	0.014	0.008	**0/86**
Ammonia, unionized	2002, 2003, 2004, 2009, 2011, 2012	Winter, summer, fall	6	0.025	mg/L	0.0013	0.0005	0.0012	0.0022	**0/6**
Nitrate	2002, 2003, 2004, 2009, 2011, 2012	Winter, summer, fall	86	n/a	mg/L	0.726	1.377	0.413	0.175	**0/86**
Nitrite	2002, 2003, 2004, 2009, 2011, 2012	Winter, summer, fall	86	1	mg/L	0.008	0.009	0.001	0.001	**0/86**
Nitrite+ nitrate	2002, 2003, 2004, 2009, 2011, 2012	Winter, summer, fall	86	10	mg/L	0.734	1.378	0.441	0.178	**0/86**
Total nitrogen	2002, 2003, 2004, 2009, 2011, 2012	Winter, summer, fall	86	n/a	mg/L	1.09	1.57	0.89	0.48	**n/a**
Ortho-phosphate	2002, 2003, 2004, 2009, 2011, 2012	Winter, summer, fall	86	n/a	mg/L	0.079	0.094	0.057	0.037	**n/a**
Total phosphorus	2002, 2003, 2004, 2009, 2011, 2012	Winter, summer, fall	82	n/a	mg/L	0.08	0.09	0.08	0.05	**n/a**

5 Expectation of Long-term Beneficial Use Attainment – Napa River and Sonoma Creek

While the Napa River and Sonoma Creek are currently meeting standards and supporting beneficial uses associated with nutrients, the many implementation measures being taken under multiple Water Board programs are likely to further decrease controllable sources of nutrients and ensure that nutrients do not cause future impairments.

The actions below address point sources:

- **NPDES permits for municipal wastewater treatment facilities.** These facilities are regulated via individual National Pollutant Discharge Elimination System (NPDES) permits. A discharge prohibition in effect since 1982 forbids discharge of effluent to surface wasters during the dry season (May 1 - Oct 31). Consequently many facilities in the North Bay only discharge for a few days during the winter and reuse or recycle all of their effluent nearly all the time.
- **General Waste Discharge Requirement and Waiver of Waste Discharge Requirements for confined animal facilities.** Confined animal facilities (CAFs) may be a nutrient source in localized parts of the watersheds. Four diary CAFs in the Sonoma Creek watershed and no dairy CAFs in the Napa River watershed were identified to enroll in the Water Board's general waste discharge requirement (WDR) for confined animal facilities (Order No. R2-2003-0093) or waiver of waste discharge requirements (WDRs) for confined animal facilities (Resolution No. R2-2003-0094), which were both initiated in 2003. However, other CAFs (e.g., horse facilities, goat dairies) may still be identified in the watersheds and may be subject to future regulation. The 2003 WDR specified BMPs for manure pond siting, size and construction, management of stormwater across the facilities, and BMPs for discharging waste to land. In addition, CAFs were required to develop a waste management plan and operation and management plan. The wavier of WDRs required similar BMPs for manure ponds and discharge to the general WDR. Both the CAF waiver of WDRs and CAF WDR are in the process of being updated and reissued by the Water Board.
- **NPDES permit for municipal/urban runoff.** The following dischargers to the freshwater reach of the Napa River or Sonoma Creek are permitted under the Phase II NPDES municipal stormwater permit (State Water Board Order No. 2013-0001-DWQ): Napa and Sonoma counties and the cities of Calistoga, Napa, St. Helena, Yountville, and Sonoma. The Phase II permit requires implementation of management practices to reduce the adverse effects of stormwater runoff and includes requirements for continuous improvement. It includes requirements to address nutrients, including requirements to address illicit discharges and pollution prevention, for example, via reductions of landscape overwatering and requirements for erosion and sediment control.

The actions below address non-point sources:

- **The State Water Board approved a Water Quality Control Policy for Siting, Design, Operation and Maintenance of Onsite Wastewater Treatment Systems (OWTS Policy).** The OWTS Policy addresses pathogen and nutrient impacts from septic systems through multiple actions. The OWTS Policy sets standards for OWTS that are constructed or replaced, that are subject to a major repair, and that have affected, or will affect, groundwater or surface water to a degree that makes it unfit for drinking water or other uses or cause a health or other public nuisance condition. The OWTS Policy also includes minimum operating requirements for OWTS that may include siting, construction, and performance requirements; requirements for OWTS near certain waters on the section 303(d) list; requirements authorizing local agency implementation of the requirements; corrective action requirements; minimum monitoring requirements; exemption criteria; requirements for determining when an existing OWTS is subject to major repair; and a conditional waiver of waste discharge requirements. Because OWTS Policy requirements are broadly consistent with the Water Board's existing requirements for septic systems, we would expect control of discharges from such systems to be maintained consistent with current standards.
- **Waiver of waste discharge requirements (WDRs) for grazing operations.** In 2011, the Water Board approved the Conditional Waiver of Waste Discharge Requirements for Grazing Operations in the Napa River and Sonoma Creek watersheds (Order No. R2-2011-0060) to reduce pathogen, sediment, and nutrient inputs into these water bodies. This waiver of WDRs requires evaluation of operating practices; development of comprehensive site-specific pathogen and sediment control measures; an implementation schedule for installation of identified management measures; and, submittal of annual progress reports documenting actions undertaken to reduce or eliminate animal waste and sediment runoff. This waiver of WDRs also contains conditions that include basic visual monitoring and compliance monitoring reporting. It contains the requirement to submit an annual certification of compliance. Additionally, landowners/operators of the ranch facility are required to develop and implement a Ranch Water Quality Plan that includes an assessment of facility conditions, an inventory of resources and management practices, and a schedule for implementation of new management practices that reduce nonpoint source pollution due to grazing.
- **General waste discharge requirement for vineyards.** Although vineyards in this region use low levels of nitrogen and often apply this via drip irrigation so surface runoff of fertilizer is low (Rosenstock et al. 2013), efforts to reduce sediment erosion into streams will also result in reduced nutrient loading from these sources. Water Board staff is in the process of developing a general WDR for vineyards in the Napa and Sonoma watersheds to control sediment erosion.

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Staff Report
Appendix A

Water Quality Data

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Napa River Nutrient Delisting Water Quality Data

Site Code	Sample Date	Sample Time	Nitrate as N (mg/L)	Nitrite as N (mg/L)	Nitrate + Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	OrthoPhosphate as P,Dissolved (mg/L)	Phosphorus as P,Total (mg/L)	Total Nitrogen (mg/L)	pH***	Temperature (°C)	Ammonia as N,Total (mg/L)	EPA Chronic Total Ammonia Nitrogen threshold (mg/L)	un-ionized ammonia NH3 Calc (mg/L)	Water Column Chl-a (mg/L)
N-01	1/7/2003	16:30	0.498	0.002	0.500		0.017	0.024	0.307	9.1	**	0.004	0.156	0.001	0
N-01	7/8/2003	14:26	0.332	0.001	0.333		0.009	0.028	0.484	8.5	**	0.007	0.370	0.001	
N-02	10/3/2002	12:00	0.003	0.000	0.003		0.081	0.089	0.065	8.2	**	0.004	0.672	0.000	0
N-02	1/8/2003	10:30	0.300	0.000	0.300		0.031	0.022	0.629	9.2	**	0.004	0.133	0.001	0
N-02	7/8/2003	19:50	0.071	0.000	0.071		0.074	0.088	0.138	9.0	**	0.003	0.167	0.001	
N-02	8/23/2011	11:35	0.110	*0.001*	0.111	0.334	0.060	0.078	0.445	7.90	15.92	0.0877	1.162	0.002	
N-02	6/14/2012	9:15	0.240	*0.001*	0.241	0.325	0.105	0.079	0.566	7.93	14.97	0.0840	1.186	0.002	
N-02	9/13/2012	10:45	0.033	*0.001*	0.034	0.368	0.081	0.085	0.402	8.15	14.65	0.0430	0.875	0.002	
N-03	10/3/2002	11:37	0.005	0.000	0.005		0.068	0.088	0.129	8.1	**	0.005	0.773	0.000	0
N-03	1/8/2003	10:53	0.023	0.000	0.023		0.040	0.038	0.059	9.2	**	0.004	0.138	0.001	0
N-03	7/8/2003	19:30	0.016	0.000	0.016		0.072	0.084	0.136	9.0	**	0.005	0.169	0.001	
N-03	7/9/2009	11:24	0.060	*0.025*	0.085	1.80	*0.250*	0.090	1.885	*	**	0.021	0.884	0.001	
N-03	8/2/2011	10:42	0.020	*0.001*	0.021	0.295	0.070	0.082	0.316	7.94	14.45	0.0462	1.210	0.001	
N-03	6/14/2012	8:40	0.193	*0.001*	0.194	0.327	0.087	0.079	0.521	7.82	15.41	0.0740	1.333	0.001	
N-03	8/15/2012	10:10	0.046	*0.001*	0.047	0.321	0.095	0.091	0.368	7.99	17.57	0.0430	0.922	0.001	
N-04	10/2/2002	11:50	0.249	0.005	0.254		0.019	0.049	0.424	8.4	**	0.017	0.493	0.001	1
N-04	1/7/2003	12:22	0.921	0.000	0.921		0.022	0.045	1.008	9.3	**	0.005	0.116	0.002	0
N-04	7/8/2003	13:08	0.433	0.004	0.436		0.010	0.025	0.641	8.0	**	0.012	0.884	0.000	
N-04	5/5/2004	15:39	0.887	0.008	0.895		0.024	0.033	1.055	*	**	0.022	0.884	0.001	
N-04	7/9/2009	9:10	0.480	*0.025*	0.505	1.40	*0.250*	0.050	1.905	*	**	*0.008*	0.884	0.000	
N-05	10/3/2002	10:55	0.008	0.000	0.008		0.073	0.075	0.180	7.7	**	0.018	1.285	0.000	1
N-05	1/8/2003	11:13	1.378	0.009	1.387		0.050	0.061	1.406	9.0	**	0.013	0.179	0.003	0
N-05	7/8/2003	19:00	0.092	0.001	0.093		0.044	0.081	0.305	8.6	**	0.020	0.334	0.002	
N-05	5/6/2004	10:05	0.322	0.001	0.324		0.038	0.038	0.485	*	**	0.013	0.884	0.000	
N-05	7/9/2009	11:40	0.370	*0.025*	0.395	0.82	*0.250*	0.090	1.215	*	**	*0.008*	0.884	0.000	
N-06	10/2/2002	16:50	0.027	0.001	0.028		0.031	0.073	0.286	8.4	**	0.029	0.485	0.002	2
N-06	1/8/2003	8:54	2.071	0.013	2.084		0.045	0.059	2.098	9.2	**	0.013	0.136	0.005	0
N-06	7/8/2003	17:00	1.206	0.009	1.215		0.017	0.035	1.578	8.6	**	0.016	0.312	0.002	
N-06	5/6/2004	13:40	1.246	0.003	1.249		0.027	0.041	2.379	*	**	0.011	0.884	0.000	
N-06	7/9/2009	10:43	0.860	*0.025*	0.885	0.19	*0.250*	0.030	1.075	*	**	*0.008*	0.884	0.000	
N-06	8/24/2011	11:40	0.870	0.010	0.880	0.359	0.030	0.069	1.239	7.06	19.12	0.0781	1.949	0.000	
N-06	6/14/2012	10:45	0.836	0.102	0.938	0.321	0.071	0.046	1.259	7.08	18.61	0.1260	1.997	0.001	
N-06	8/14/2012	10:06	0.970	*0.001*	0.971	0.201	0.023	0.039	1.172	7.24	20.04	0.1630	1.678	0.001	
N-08	1/8/2003	11:35	0.610	0.004	0.614		0.017	0.042	0.751	9.0	**	0.006	0.167	0.002	1
N-08	7/8/2003	18:35	0.025	0.000	0.025		0.023	0.033	0.193	8.9	**	0.005	0.212	0.001	
N-09	10/2/2002	16:00	0.000	0.000	0.000		0.018	0.046	0.323	8.7	**	0.007	0.302	0.001	2
N-09	1/8/2003	12:50	2.199	0.009	2.208		0.046	0.071	2.414	8.9	**	0.018	0.212	0.004	0

Napa River Nutrient Delisting Water Quality Data

Site Code	Sample Date	Sample Time	Nitrate as N (mg/L)	Nitrite as N (mg/L)	Nitrate + Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	OrthoPhosphate as P,Dissolved (mg/L)	Phosphorus as P,Total (mg/L)	Total Nitrogen (mg/L)	pH***	Temperature (°C)	Ammonia as N,Total (mg/L)	EPA Chronic Total Ammonia Nitrogen threshold (mg/L)	un-ionized ammonia NH3 Calc (mg/L)	Water Column Chl-a (mg/L)
N-09	7/8/2003	20:45	0.936	0.005	0.941		0.024	0.046	1.125	8.9	**	0.019	0.208	0.004	
N-09	7/9/2009	10:18	0.060	*0.025*	0.085	1.30	*0.250*	0.050	1.385	*	**	0.027	0.884	0.001	
N-09	8/25/2011	10:25	0.470	0.009	0.479	0.284	0.050	0.074	0.763	7.68	19.27	0.0438	1.224	0.001	
N-09	6/14/2012	11:30	0.506	0.099	0.605	0.261	0.089	0.058	0.866	7.63	19.24	0.1230	1.293	0.002	
N-09	9/11/2012	10:05	*0.001*	*0.001*	0.002	0.432	*0.004*	0.071	0.434	7.82	16.59	*0.0200*	1.235	0.000	
N-11	1/7/2003	11:27	3.159	0.003	3.162		0.110	0.130	3.273	9.0	**	0.010	0.187	0.002	0
N-11	7/8/2003	11:10	1.919	0.001	1.921		0.075	0.086	2.133	8.8	**	0.003	0.225	0.001	
N-11	5/5/2004	18:50	2.900	0.043	2.943		0.072	0.081	3.362	*	**	0.004	0.884	0.000	
N-11	8/15/2011	10:25	0.440	*0.001*	0.441	0.387	0.070	0.072	0.828	6.60	15.46	*0.0030*	2.809	0.000	
N-11	6/14/2012	15:00	0.645	0.099	0.744	0.285	0.072	0.089	1.029	7.00	16.90	0.0820	2.304	0.000	
N-11	8/21/2012	9:49	0.264	*0.001*	0.265	0.402	0.115	0.088	0.667	6.61	15.94	0.0820	2.719	0.000	
N-13	10/2/2002	10:20	0.104	0.000	0.104		0.198	0.174	0.300	8.5	**	0.007	0.376	0.001	0
N-13	1/7/2003	10:48	0.609	0.007	0.616		0.085	0.090	0.720	9.0	**	0.004	0.167	0.001	0
N-13	7/8/2003	10:42	0.185	0.001	0.186		0.181	0.164	0.323	8.1	**	0.003	0.750	0.000	
N-13	5/5/2004	18:05	0.348	0.000	0.348		0.156		0.481	*	**	0.007	0.884	0.000	
N-13	7/9/2009	9:35	0.090	*0.025*	0.115	0.73	*0.250*	0.160	0.845	*	**	*0.008*	0.884	0.000	
N-14	1/7/2003	9:47	0.706	0.000	0.706		0.070	0.097	1.195	9.3	**	0.005	0.121	0.002	0
N-14	7/8/2003	10:00	0.001	0.001	0.000		0.026	0.087	0.320	7.9	**	0.010	1.030	0.000	
N-15	10/2/2002	13:50	0.097	0.000	0.097		0.014	0.026	0.333	8.5	**	0.008	0.379	0.001	1
N-15	1/7/2003	13:39	2.308	0.004	2.312		0.027	0.050	2.767	9.2	**	0.011	0.131	0.004	0
N-15	7/8/2003	14:14	0.781	0.004	0.785		0.014	0.025	1.072	8.7	**	0.014	0.292	0.002	
N-15	5/6/2004	14:48	1.731	0.006	1.737		0.006	0.014	2.519	*	**	0.028	0.884	0.001	
N-16	10/3/2002	12:30	0.018	0.000	0.018		0.022	0.033	0.249	7.9	**	0.004	0.962	0.000	0
N-16	1/7/2003	14:59	0.845	0.002	0.846		0.013	0.028	1.011	9.1	**	0.010	0.156	0.003	0
N-16	7/8/2003	15:30	0.092	0.002	0.093		0.029	0.051	0.339	8.9	**	0.017	0.193	0.004	
N-18	10/2/2002	13:15	0.029	0.000	0.029		0.012	0.044	0.280	8.3	**	0.003	0.582	0.000	9
N-18	1/7/2003	12:49	0.674	0.000	0.674		0.019	0.041	1.002	9.2	**	0.002	0.144	0.001	0
N-18	7/8/2003	13:24	0.348	0.002	0.349		0.010	0.030	0.586	8.9	**	0.007	0.193	0.002	
N-18	5/5/2004	16:02	0.848	0.003	0.850		0.017	0.037	1.083	*	**	0.014	0.884	0.000	
N-18	7/9/2009	13:08	0.115	*0.025*	0.140	1.25	*0.250*	0.040	1.390	*	**	*0.008*	0.884	0.000	
N-19	10/2/2002	8:50	0.152	0.005	0.156		0.055	0.093	0.604	8.1	**	0.040	0.750	0.002	0
N-19	1/7/2003	17:08	1.595	0.007	1.602		0.037	0.092	2.025	8.6	**	0.020	0.334	0.002	0
N-19	7/8/2003	9:10	0.163	0.003	0.166		0.007	0.051	0.488	8.4	**	0.026	0.509	0.002	
N-20	1/7/2003	15:26	0.599	0.004	0.603		0.023	0.022	0.973	9.2	**	0.002	0.130	0.001	0
N-23	10/2/2002		0.008	0.000	0.008		0.031	0.097	0.332	8	**	0.004	1.300	0.000	18
N-23	1/7/2003	14:20	1.835	0.006	1.841		0.058	0.092	2.129	9.0	**	0.028	0.187	0.007	0
N-23	7/8/2003	15:00	0.393	0.006	0.399		0.019	0.042	0.608	8.9	**	0.010	0.212	0.002	

Napa River Nutrient Delisting Water Quality Data

Site Code	Sample Date	Sample Time	Nitrate as N (mg/L)	Nitrite as N (mg/L)	Nitrate + Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	OrthoPhosphate as P,Dissolved (mg/L)	Phosphorus as P,Total (mg/L)	Total Nitrogen (mg/L)	pH***	Temperature (°C)	Ammonia as N,Total (mg/L)	EPA Chronic Total Ammonia Nitrogen threshold (mg/L)	un-ionized ammonia NH3 Calc (mg/L)	Water Column Chl-a (mg/L)
N-25	10/2/2002	17:30	0.001	0.001	0.002		0.065	0.099	0.303	8.3	**	0.043	0.536	0.003	3
N-25	1/8/2003	9:55	0.706	0.005	0.711		0.035	0.058	1.080	9.1	**	0.076	0.158	0.022	0
N-25	7/8/2003	17:31	0.132	0.005	0.137		0.026	0.062	0.327	8.3	**	0.019	0.563	0.001	
N-26	10/3/2002	9:55	0.522	0.001	0.524		0.041	0.050	0.449	8.5	**	0.009	0.431	0.001	0
N-26	1/8/2003	12:20	1.586	0.002	1.588		0.040	0.037	1.882	8.7	**	0.009	0.269	0.001	0
N-26	7/8/2003	17:56	0.979	0.002	0.981		0.052	0.064	1.226	8.5	**	0.012	0.423	0.001	
N-26	5/6/2004	11:05	0.970	0.003	0.973		0.046		1.115	*	**	0.013	0.884	0.000	
N-26	7/9/2009	11:08	0.100	*0.025*	0.125	0.16	*0.250*	0.060	0.285	*	**	*0.008*	0.884	0.000	
N-27	1/8/2003	11:59	0.375	0.001	0.376		0.037	0.032	0.351	8.7	**	0.002	0.307	0.000	0
N-30	10/2/2002	11:20	0.096	0.007	0.103		0.087	0.104	0.730	7.6	**	0.086	1.487	0.001	7
N-30	1/7/2003	10:25	1.720	0.003	1.723		0.059	0.089	1.992	9.4	**	0.049	0.103	0.024	0
N-30	7/8/2003	11:48	0.185	0.004	0.190		0.028	0.131	0.538	9.4	**	0.058	0.110	0.026	9
N-31	10/2/2002	18:25	0.014	0.000	0.015		0.053	0.063	0.110	8.2	**	0.008	0.705	0.000	0
N-31	1/7/2003	15:50	1.341	0.004	1.344		0.055	0.074	1.778	9.4	**	0.028	0.104	0.013	0
N-31	7/8/2003	16:01	0.536	0.004	0.540		0.046	0.073	0.765	9.0	**	0.012	0.185	0.003	
N-31	6/21/2012	13:50	0.237	0.001	0.238	0.153	0.096	0.055	0.391	7.85	20.66	0.131	0.914	0.004	
N-32	1/7/2003	13:12	0.649	0.000	0.649		0.022	0.061	0.686	8.9	**	0.002	0.215	0.000	0
N-32	7/8/2003	13:47	0.095	0.003	0.098		0.007	0.012	0.192	8.6	**	0.005	0.351	0.001	
N-32	8/16/2011	11:15	0.120	*0.001*	0.121	0.470	*0.004*	0.015	0.591	7.98	16.85	0.0605	0.980	0.002	
N-32	6/14/2012	14:00	0.307	0.001	0.308	0.2380	0.004	0.020	0.546	8.31	19.82	0.0790	0.484	0.006	
N-40	5/5/2004	16:17	0.456	0.002	0.458		0.020	0.026	0.574	*	**	0.011	0.884	0.000	
N-40	7/9/2009	12:59	0.140	*0.025*	0.165	2.20	*0.250*	0.050	2.365	*	**	*0.008*	0.884	0.000	
N-41	5/5/2004	16:45	0.857	0.001	0.858		0.015	0.022	0.938	*	**	0.006	0.884	0.000	
N-42	5/5/2004	17:45	0.489	0.001	0.490		0.196		0.592	*	**	0.004	0.884	0.000	
N-42	7/9/2009	9:45	0.240	*0.025*	0.265	0.22	*0.250*	0.210	0.485	*	**	*0.008*	0.884	0.000	
N-43	5/5/2004	18:20	2.957	0.000	2.958		0.071	0.097	3.306	*	**	0.015	0.884	0.000	
N-44	5/6/2004	9:44	0.254	0.002	0.256		0.057	0.069	0.430	*	**	0.010	0.884	0.000	
N-45	5/6/2004	10:17	1.303	0.001	1.304		0.186	0.203	1.399	*	**	0.013	0.884	0.000	
N-45	8/31/2011	11:30	0.100	*0.001*	0.101	0.344	0.060	0.115	0.445	7.42	19.22	0.0707	1.565	0.001	
N-45	6/14/2012	7:50	0.258	*0.001*	0.259	0.246	0.011	0.106	0.505	7.47	18.13	0.1090	1.613	0.001	
N-45	8/27/2012	10:50	*0.001*	*0.003*	0.004	0.664	0.101	0.156	0.668	7.47	15.74	0.0418	1.882	0.000	
N-46	5/6/2004	10:43	1.000	0.003	1.003		0.131	0.315	1.183	*	**	0.016	0.884	0.001	
N-47	5/6/2004	11:30	0.040	0.001	0.041		0.020		0.338	*	**	0.016	0.884	0.001	
N-48	5/6/2004	11:55	0.773	0.001	0.775		0.073	0.156	1.273	*	**	0.012	0.884	0.000	
N-49	5/6/2004	12:12	0.490	0.002	0.492		0.056	0.071	0.505	*	**	0.011	0.884	0.000	
N-50	5/6/2004	12:30	0.423	0.003	0.425		0.047	0.050	1.222	*	**	0.016	0.884	0.001	
N-50	8/29/2011	10:40	0.100	*0.001*	0.101	0.820	0.090	0.111	0.921	7.47	21.08	0.0838	1.333	0.001	

Napa River Nutrient Delisting Water Quality Data

Site Code	Sample Date	Sample Time	Nitrate as N (mg/L)	Nitrite as N (mg/L)	Nitrate + Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	OrthoPhosphate as P,Dissolved (mg/L)	Phosphorus as P,Total (mg/L)	Total Nitrogen (mg/L)	pH***	Temperature (°C)	Ammonia as N,Total (mg/L)	EPA Chronic Total Ammonia Nitrogen threshold (mg/L)	un-ionized ammonia NH3 Calc (mg/L)	Water Column Chl-a (mg/L)
N-50	6/14/2012	10:00	0.184	0.001	0.185	0.310	0.095	0.079	0.495	7.44	20.97	0.113	1.376	0.001	
N-51	5/6/2004	14:10	0.002	0.006	0.008		0.007	0.024	0.410	*	**	0.014	0.884	0.000	
N-52	5/6/2004	14:30	1.565	0.000	1.565		0.016	0.031	2.499	*	**	0.040	0.884	0.001	
N-52	7/9/2009	12:44	2.600	*0.025*	2.625	*0.03*	*0.250*	0.090	2.650	*	**	*0.008*	0.884	0.000	
N-52	8/9/2011	10:50	1.410	*0.001*	1.411	0.586	0.040	0.074	1.997	7.38	18.17	0.0580	1.726	0.000	
N-52	6/14/2012	13:25	0.137	0.104	0.241	0.366	0.096	0.093	0.607	7.50	21.84	0.1000	1.238	0.001	
N-52	8/9/2012	9:50	1.450	*0.001*	1.451	0.541	0.062	0.094	1.992	7.63	18.79	0.0520	1.332	0.001	
N-53	7/9/2009	8:36	0.060	*0.025*	0.085	2.30	*0.250*	0.100	2.385	*	**	0.029	0.884	0.001	
N-55	9/4/2012	10:15	0.072	*0.001*	0.073	0.610	0.039	0.056	0.683	7.50	17.99	0.0431	1.586	0.000	

* Denotes missing data where a mean pH of 8.0 was used for ammonia criteria calculations

** Denotes missing data where a mean temperature of 17oC was used for ammonia criteria calculations

***pH data from 2002-2004 time range was collected with unknown equipment and without explicit quality assurance project protocol with defined measurement quality objective.
Therefore, these data were not used for the pH line of evidence.

Values in italics were non-detects and the value half way between 0 and the minimum detection limit (MDL) was used for all calculations

Napa River Nutrient Delisting Benthic Algal Biomass and Environmental Data

Site Code	Sample Time	Sample Time	Percent macroalgae cover	Benthic algae chlorophyll a (mg/m2)	Average water depth (m)	Flow Discharge (Q, m3/s)	Avergae velocity (m/s)	Average shade and canopy cover (%)
N-02	08/23/11	11:35	2.9	18	0.065	0.033	0.23	94
N-02	09/13/12	10:45	0.0	43	0.081	0.004	0.03	95
N-03	08/15/12	10:10	0.0	69	0.048	0.004	0.03	94
N-03	08/02/11	10:42	0.0	47	0.099	0.013	0.04	91
N-06	08/24/11	11:40	9.5	72	0.278	0.186	0.15	65
N-06	08/14/12	10:06	10.5	*	0.299	0.016	0.01	72
N-09	08/25/11	10:25	58.1	162	0.284	0.116	0.07	74
N-09	09/11/12	10:05	45.7	41	0.354	0.011	0.01	65
N-11	08/15/11	10:25	7.6	108	0.357	0.002	0.00	90
N-11	08/21/12	9:49	4.8	103	0.301	0.000	0.00	89
N-32	08/16/11	11:15	29.5	136	0.094	0.010	0.02	77
N-45	08/27/12	10:50	3.8	30	0.332	0.001	0.00	75
N-45	08/31/11	11:30	1.9	50	0.288	0.026	0.01	76
N-50	08/29/11	10:40	1.9	43	0.281	0.114	0.04	48
N-52	08/09/11	10:50	23.8	84	0.189	0.016	0.03	72
N-52	08/09/12	9:50	12.4	56	0.200	0.003	0.00	85
N-55	09/04/12	10:15	6.7	161	0.624	0.010	0.00	41
* Data point rejected based on quality control								

Sonoma Creek Nutrient Delisting Water Quality Data

Site Code	Sample Date	Sample Time	Nitrate as N (mg/L)	Nitrite as N (mg/L)	Nitrate + Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	OrthoPhosphate as P,Dissolved (mg/L)	Phosphorus as P,Total (mg/L)	Total Nitrogen (mg/L)	pH***	Temperature (°C)	Ammonia as N,Total (mg/L)	EPA Chronic Total Ammonia Nitrogen threshold (mg/L)	un-ionized ammonia NH3 Calc (mg/L)	Water Column Chl-a (mg/L)
S-03	1/6/2003	11:02	1.530	0.003	1.534		0.095	0.111	2.504	9.5	**	0.009	0.103	0.005	0
S-03	7/7/2003	10:35	0.887	0.008	0.895		0.024	0.033	1.055	8.9	**	0.022	0.943	0.001	
S-03	5/5/2004	14:40	0.773	0.001	0.775		0.073	0.156	1.273	*	**	0.012	0.943	0.000	
S-03	7/9/2009	9:17	*0.025*	*0.025*	0.050	0.64	*0.250*	0.240	0.690	*	**	0.036	0.943	0.001	
S-04	1/6/2003	11:50	1.375	0.001	1.376		0.072	0.090	1.761	8.7	**	0.008	0.297	0.001	0
S-04	7/7/2003	11:00	0.696	0.009	0.705		0.053	0.064	0.986	8.7	**	0.032	0.943	0.001	
S-04	5/5/2004	13:39	1.303	0.001	1.304		0.186	0.203	1.399	*	**	0.013	0.943	0.000	
S-05	10/1/2002	12:15	2.049	0.004	2.052		0.066	0.085	2.305	8.5	**	0.013	0.943	0.000	0
S-05	1/6/2003	12:40	1.454	0.001	1.455		0.054	0.068	1.619	9.1	**	0.005	0.166	0.001	0
S-05	7/7/2003	12:35	1.530	0.005	1.536		0.015	0.015	1.593	9.5	**	0.020	0.943	0.001	
S-05	5/5/2004	11:40	1.246	0.003	1.249		0.027	0.041	2.379	*	**	0.011	0.943	0.000	
S-05	7/9/2009	9:52	*0.025*	*0.025*	0.050	0.11	*0.250*	0.090	0.160	*	**	*0.008*	0.943	0.000	
S-05	9/12/2011	11:05	0.139	*0.001*	0.140	0.766	0.064	0.107	0.906	7.67	18.59	0.0103	1.293	0.000	
S-05	6/21/2012	12:05	0.198	*0.001*	0.199	0.230	0.109	0.076	0.429	7.97	20.11	0.0700	0.805	0.003	
S-05	8/29/2012	8:45	0.060	*0.001*	0.061	0.174	0.069	0.083	0.235	7.83	17.34	0.0327	1.162	0.001	
S-06	10/1/2002	15:40	1.561	0.006	1.568		0.077	0.095	1.792	8.6	**	0.025	0.943	0.001	0
S-06	1/6/2003	14:08	1.495	0.001	1.496		0.049	0.071	1.694	9.6	**	0.005	0.098	0.003	0
S-06	7/7/2003	14:05	0.589	0.008	0.597		0.056	0.066	0.885	9.1	**	0.045	0.943	0.001	
S-06	7/9/2009	10:11	*0.025*	*0.025*	0.050	0.22	*0.250*	0.080	0.270	*	**	*0.008*	0.943	0.000	
S-06	9/13/2011	11:55	0.175	*0.001*	0.176	0.718	0.060	0.103	0.894	8.01	17.73	0.0900	0.887	0.003	
S-06	6/21/2012	11:15	0.359	0.098	0.457	0.356	0.107	0.110	0.813	8.18	18.22	0.0820	0.663	0.004	
S-06	8/28/2012	10:20	0.044	*0.001*	0.045	0.567	0.075	0.081	0.612	8.08	18.32	0.0418	0.769	0.002	
S-08	10/1/2002	10:00	0.489	0.001	0.490		0.196		0.592	7.5	**	0.004	0.943	0.000	12
S-08	1/6/2003	9:58	1.521	0.001	1.522		0.059	0.113	1.976	9.3	**	0.011	0.135	0.004	0
S-08	7/7/2003	9:45	0.456	0.002	0.458		0.020	0.026	0.574	8.4	**	0.011	0.943	0.000	1
S-09	1/6/2003	10:30	2.154	0.009	2.163		0.168	0.206	4.076	9.1	**	0.064	0.175	0.017	0
S-09	7/7/2003	10:10	2.227	0.003	2.230		0.059	0.066	2.326	8.9	**	0.010	0.943	0.000	
S-09	7/9/2009	9:06	*0.025*	*0.025*	0.050	0.67	*0.250*	0.230	0.720	*	**	0.025	0.943	0.001	
S-10	10/1/2002	14:15	0.348	0.000	0.348		0.156		0.481	8.4	**	0.007	0.943	0.000	0
S-10	1/6/2003	13:12	0.093	0.000	0.093		0.044	0.060	0.288	9.2	**	0.004	0.140	0.001	0
S-11	10/1/2002	15:00	0.286	0.011	0.297		0.069	0.098	0.861	8.9	**	0.014	0.943	0.000	0
S-11	1/6/2003	13:40	1.442	0.001	1.443		0.048	0.063	1.467	9.4	**	0.006	0.110	0.003	0
S-11	7/7/2003	13:35	0.203	0.000	0.203		0.043	0.055	0.272	9.2	**	0.004	0.943	0.000	
S-12	10/1/2002	16:15	2.957	0.000	2.958		0.071	0.097	3.306	8.5	**	0.015	0.943	0.000	0
S-12	1/6/2003	14:46	1.611	0.001	1.613		0.050	0.076	1.897	9.4	**	0.006	0.117	0.003	0
S-12	7/7/2003	14:30	2.900	0.043	2.943		0.072	0.081	3.362	9.7	**	0.004	0.943	0.000	
S-12	7/9/2009	10:22	0.210	*0.025*	0.235	0.15	*0.250*	0.080	0.385	*	**	*0.008*	0.943	0.000	

Site Code	Sample Date	Sample Time	Nitrate as N (mg/L)	Nitrite as N (mg/L)	Nitrate + Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	OrthoPhosphate as P,Dissolved (mg/L)	Phosphorus as P,Total (mg/L)	Total Nitrogen (mg/L)	pH***	Temperature (°C)	Ammonia as N,Total (mg/L)	EPA Chronic Total Ammonia Nitrogen threshold (mg/L)	un-ionized ammonia NH3 Calc (mg/L)	Water Column Chl-a (mg/L)
S-12	9/6/2011	11:30	0.170	0.009	0.179	0.573	0.060	0.094	0.752	8.14	16.49	0.0857	0.789	0.003	
S-12	6/21/2012	10:35	0.559	0.099	0.658	0.352	0.111	0.080	1.010	8.26	17.58	0.0780	0.607	0.004	
S-12	8/22/2012	9:55	0.229	*0.001*	0.230	0.193	*0.004*	0.085	0.423	8.09	17.03	0.0420	0.823	0.002	
S-13	10/1/2002	17:21	0.016	0.000	0.016		0.072	0.084	0.136	8.8	**	0.005	0.943	0.000	1
S-13	1/6/2003	15:48	1.616	0.004	1.619		0.045	0.072	1.780	9.3	**	0.003	0.123	0.001	0
S-13	7/7/2003	15:15	0.536	0.009	0.545		0.041	0.073	0.790	8.8	**	0.034	0.943	0.001	
S-13	5/5/2004	9:35	1.000	0.003	1.003		0.131	0.315	1.183	*	**	0.016	0.943	0.000	
S-13	9/7/2011	11:27	1.160	0.010	1.170	0.382	0.060	0.096	1.552	8.07	15.54	0.0581	0.934	0.002	
S-13	6/21/2012	10:00	1.200	*0.001*	1.201	0.209	0.111	0.088	1.410	8.08	15.20	0.1260	0.941	0.004	
S-13	8/8/2012	10:05	1.070	*0.001*	1.071	0.327	0.056	0.077	1.398	8.05	15.40	*0.0200*	0.971	0.001	
S-13	7/9/2009	10:39	1.600	*0.025*	1.625	*0.03*	*0.250*	0.085	1.650	*	**	*0.008*	0.943	0.000	
S-14	10/1/2002	18:00	1.105	0.019	1.124		0.062	0.094	1.399	8.6	**	0.041	0.943	0.001	0
S-14	1/6/2003	16:51	0.166	0.000	0.166		0.033	0.056	0.251	9.5	**	0.002	0.101	0.001	0
S-14	5/5/2004	10:40	0.254	0.002	0.256		0.057	0.069	0.430	*	**	0.010	0.943	0.000	
S-14	7/9/2009	11:15	0.110	*0.025*	0.135	*0.03*	*0.250*	0.080	0.160	*	**	*0.008*	0.943	0.000	
S-14	8/10/2011	10:15	0.250	*0.002*	0.252	0.396	0.040	0.065	0.648	8.22	14.45	0.0590	0.793	0.002	
S-14	6/21/2012	8:35	0.272	*0.001*	0.273	0.700	0.096	0.058	0.973	8.32	14.03	0.0700	0.692	0.004	
S-14	9/5/2012	10:15	0.112	*0.001*	0.113	0.377	0.062	0.066	0.490	8.16	13.57	0.0292	0.923	0.001	
S-14	7/7/2003	15:45	0.072	0.000	0.072		0.026	0.035	0.152	8.6	**	0.006	0.943	0.000	
S-22	1/6/2003	11:20	1.388	0.001	1.389		0.053	0.076	1.693	9.3	**	0.008	0.128	0.003	0
S-22	7/7/2003	11:15	0.586	0.009	0.595		0.038	0.151	0.836	8.7	**	0.009	0.943	0.000	
S-22	5/5/2004	14:19	1.565	0.000	1.565		0.016	0.031	2.499	*	**	0.040	0.943	0.001	
S-22	7/9/2009	9:28	*0.025*	*0.025*	0.050	0.23	*0.250*	0.080	0.280	*	**	*0.008*	0.943	0.000	
S-23	1/6/2003	15:07	1.381	0.001	1.382		0.042	0.050	1.558	9.2	**	0.006	0.146	0.002	0
S-23	7/7/2003	14:40	0.970	0.003	0.973		0.046		1.115	9.0	**	0.013	0.943	0.000	
S-24	1/6/2003	16:25	0.079	0.000	0.079		0.025	0.046	0.154	9.5	**	0.001	0.106	0.001	0
S-24	7/7/2003	16:35	0.857	0.001	0.858		0.015	0.022	0.938	8.9	**	0.006	0.943	0.000	
S-24	7/9/2009	11:01	*0.025*	*0.025*	0.050	0.06	*0.250*	0.050	0.110	*	**	*0.008*	0.943	0.000	
S-24	8/1/2011	11:20	0.200	*0.001*	0.201	0.622	0.030	0.037	0.823	7.94	14.78	0.0439	1.184	0.001	
S-24	6/21/2012	7:55	0.175	*0.001*	0.176	0.583	0.086	0.043	0.759	7.98	13.78	0.0870	1.194	0.002	
S-24	8/13/2012	9:10	0.223	*0.001*	0.224	0.461	0.049	0.046	0.685	7.70	15.91	0.0400	1.487	0.001	
S-25	1/6/2003	18:05	1.546	0.004	1.550		0.094	0.152	2.711	9.4	**	0.012	0.120	0.005	0
S-26	1/7/2003	8:50	1.498	0.002	1.500		0.075	0.117	1.729	9.6	**	0.010	0.098	0.005	0
S-26	7/7/2003	11:35	0.848	0.003	0.850		0.017	0.037	1.083	9.0	**	0.014	0.943	0.000	
S-30	5/5/2004	10:05	0.002	0.006	0.008		0.007	0.024	0.410	*	**	0.014	0.943	0.000	
S-30	8/8/2011	10:15	0.280	0.010	0.290	0.632	0.020	0.106	0.922	7.61	16.64	0.0644	1.561	0.001	
S-30	6/21/2012	9:00	0.404	*0.001*	0.405	0.565	*0.004*	0.050	0.970	7.60	16.08	0.1360	1.635	0.002	

Sonoma Creek Nutrient Delisting Water Quality Data

Site Code	Sample Date	Sample Time	Nitrate as N (mg/L)	Nitrite as N (mg/L)	Nitrate + Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	OrthoPhosphate as P,Dissolved (mg/L)	Phosphorus as P,Total (mg/L)	Total Nitrogen (mg/L)	pH***	Temperature (°C)	Ammonia as N,Total (mg/L)	EPA Chronic Total Ammonia Nitrogen threshold (mg/L)	un-ionized ammonia NH3 Calc (mg/L)	Water Column Chl-a (mg/L)
S-30	8/16/2012	9:07	0.272	*0.001*	0.273	0.315	*0.004*	0.051	0.588	7.88	16.61	0.0400	1.142	0.001	
S-31	5/5/2004	11:02	0.322	0.001	0.324		0.038	0.038	0.485	*	**	0.013	0.943	0.000	
S-32	5/5/2004	10:18	1.731	0.006	1.737		0.006	0.014	2.519	*	**	0.028	0.943	0.001	
S-32	8/30/2011	10:25	0.190	*0.001*	0.191	0.701	0.030	0.074	0.892	7.70	15.30	0.0576	1.547	0.001	
S-32	6/21/2012	9:25	0.302	*0.001*	0.303	0.437	*0.004*	0.052	0.740	7.93	16.13	0.2580	1.101	0.006	
S-32	9/6/2012	10:25	0.021	*0.001*	0.022	0.322	0.027	0.058	0.344	7.97	14.03	0.0360	1.192	0.001	
S-33	5/5/2004	12:20	0.423	0.003	0.425		0.047	0.050	1.222	*	**	0.016	0.943	0.000	
S-34	5/5/2004	14:00	0.490	0.002	0.492		0.056	0.071	0.505	*	**	0.011	0.943	0.000	
S-35	5/5/2004	13:12	0.040	0.001	0.041		0.020		0.338	*	**	0.016	0.943	0.001	
S-36	9/14/2011	10:50	0.207	0.009	0.216	0.615	0.051	0.093	0.831	7.77	18.45	0.1100	1.165	0.002	
S-36	6/21/2012	13:00	0.232	*0.001*	0.233	0.341	0.107	0.072	0.574	8.06	20.88	0.1160	0.672	0.005	
S-36	8/23/2012	8:45	0.235	*0.001*	0.236	0.144	0.057	0.073	0.380	7.67	18.32	*0.0200*	1.316	0.000	

* Denotes missing data where a mean pH of 8.0 was used for ammonia criteria calculations

** Denotes missing data where a mean temperature of 17oC was used for ammonia criteria calculations

***pH data from 2002-2004 time range was collected with unknown equipment and without explicit quality assurance project protocol with defined measurement quality objective.
Therefore, these data were not used for the pH line of evidence.

Values in italics were non-detects and the value half way between 0 and the minimum detection limit (MDL) was used for all calculations

Sonoma Creek Nutrient Delisting Benthic Algal Biomass and Environmental Data

Site Code	Sample Time	Sample Time	Percent macroalgae cover	Benthic algae chlorophyll a (mg/m2)	Average water depth (m)	Flow Discharge (Q, m3/s)	Avergae velocity (m/s)	Average shade and canopy cover (%)
S-05	08/29/12	8:45	9.5	31	0.459	0.014	0.00	73
S-05	09/12/11	11:05	16.2	45	0.293	0.155	0.05	60
S-06	09/13/11	11:55	28.6	108	0.312	0.120	0.05	59
S-06	08/28/12	10:20	13.3	37	0.365	0.010	0.00	72
S-12	09/06/11	11:30	10.5	34	0.159	0.107	0.09	87
S-12	08/22/12	9:55	12.4	48	0.167	0.015	0.01	90
S-13	09/07/11	11:27	4.8	71	0.195	0.090	0.10	90
S-13	08/08/12	10:05	0.0	110	0.195	0.030	0.03	91
S-14	08/10/11	10:15	1.9	35	0.098	0.046	0.15	95
S-14	09/05/12	10:15	1.9	96	0.105	0.001	0.00	98
S-24	08/13/12	9:10	9.5	30	0.143	0.001	0.00	93
S-24	08/01/11	11:20	1.9	20	0.125	0.010	0.03	94
S-30	08/08/11	10:15	17.1	62	0.200	0.015	0.03	71
S-30	08/16/12	9:07	1.0	50	0.181	0.001	0.00	70
S-32	09/06/12	10:25	1.0	53	0.184	0.002	0.00	86
S-32	08/30/11	10:25	0.0	61	0.198	0.007	0.01	85
S-36	09/14/11	10:50	29.5	259	0.206	0.157	0.11	44
S-36	08/23/12	8:45	13.3	27	0.216	0.007	0.00	54

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Appendix C

Comment Letters

Comment Letters
Napa River and Sonoma Creek Nutrient Delisting

December 16, 2013- January 15, 2014

TABLE OF CONTENTS

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January 15, 2014

Mr. Kevin Lunde
San Francisco Bay Regional
Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612
email: klunde@waterboards.ca.gov

RE: Proposed revisions to the 303(d) List of Impaired Water Bodies in the San Francisco Bay Region, Napa River and Sonoma Creek watersheds

Dear Mr. Lunde:

This office represents Ms Chris Malan and the Living Rivers Council (LRC), an advocacy group that uses expert-informed opinion to help guide natural resource policy and regulatory processes and to restore the health of the Napa River and its watershed, regarding this matter.

My clients object to the Board's approval of the these proposed revisions to the list of impaired waters on the ground that the Board has not complied with, or apparently even attempted to apply, the environmental review procedures of the California Environmental Quality Act (CEQA) to this decision.

These proposed revisions are discretionary decisions that will affect the physical environment, therefore, the Board must demonstrate compliance with CEQA before approving the proposed revisions.

Thank you for your attention to this matter.

Very truly yours,

Tom Lippe

Thomas N. Lippe

cc: Ms Chris Malan
Living Rivers Council

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January 10, 2014

Mr. Kevin Lunde
San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612

Re: Proposal to Remove the Napa River and Sonoma Creek from the California Impaired Water Bodies (303d) List for Nutrient Pollution

Dear Kevin,

I am commenting on the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) proposal to remove the Napa River and Sonoma Creek from the California 303d impaired waterbodies list (SFBRWQCB 2013). I am providing these comments on behalf of Ms. Chris Malan and the Living Rivers Council (LRC) (www.livingriverscouncil.org), an advocacy group that uses expert-informed opinion to help guide natural resource policy and regulatory processes and to restore the health of the Napa River and its watershed. I am a consulting fisheries biologist and watershed scientist with 25 years experience in Pacific salmon watershed analysis, including extensive study of the Napa River for LRC for the last several years (Higgins 2006, 2007, 2008a, 2009, 2010). In sum, I do not find the case you are presenting for delisting these waterbodies for nutrient impairment compelling.

Executive Summary

We appreciate the SFBRWQCB staff providing raw data from 2011 and 2012 for the Napa River and Sonoma Creek, but those data and other data presented on your website indicate that many locations show signs of impairment consistent with nuisance algae blooms and nutrient pollution. Poorly buffered Pacific coast freestone streams, such as the Napa River and Sonoma Creek, can manifest nuisance algae blooms with very low levels of phosphorous and nitrogen (Welch et al. 1998). Therefore, lack of high levels of these nutrients does not mean that these waterbodies are not impaired. Also, phosphorous levels measured by the SFBRWQCB commonly exceed levels recognized as those needed to stimulate nuisance levels of algae blooms (Welch et al. 1998).

While the de-listing justification document (SFBRWQCB 2013) states that chlorophyll a data suggest lack of impairment, there are notable exceptions at key mainstem locations on both the Napa River and Sonoma Creek indicative of nuisance algae blooms (N-09, N-55, S-06, S-13, S-36). Overall significance of chlorophyll a data are also difficult to judge because there is no description of shade conditions at monitoring locations that might suppress algal growth.

Continuous raw datasets from 2011-2012 also show dissolved oxygen levels that do not support steelhead trout and COLD beneficial uses at several sites in both basins and are not consistent with de-listing (N-09, N-55, S-36). Data provided by the SFBRWQCB show lethal or near lethal levels for steelhead of dissolved ammonia (>0.025 mg/l) at two locations (N-30, N-25), which clearly is not supporting COLD beneficial use or supportive of delisting arguments.

Stillwater and Dietrich (2002) found that a number of tributaries of the Napa River lost surface flow seasonally and also that a number of stream segments were becoming stagnant and incapable of supporting steelhead juveniles. The SFBRWQCB (2013) report does not reference this study or use data derived there-from, when such comparisons are useful in understanding potential nutrient pollution in the Napa River. SFBRWQCB (2013) also does not fully disclose flow conditions in tributaries where monitoring occurs and refers to streams that lack surface flow as intermittent, when many were historically perennial (Higgins 2010). If streams lack surface flow, then water quality samples do not represent ambient stream conditions but rather site conditions in an isolated segment or pool.

The justification (SFBRWQCB 2013) claims that samples are geographically representative, but there are substantial reaches of both Sonoma Creek and the Napa River that were not monitored. The assumption that nutrient inputs are low in summer overlooks the potential for groundwater conveyance of nutrients from septic systems or agricultural waste that has filtered into the groundwater. Therefore, reaches not sampled could have elevated nutrient levels and be subject to nuisance blooms.

The report (SFBRWQCB 2013) states that there are no Napa River flow trends in recent decades, but we were able to discern a decreasing trend at two Napa River gauges by using the Mann-Kendall time series trend test for 30-day minimums. Declining flow trends we discerned increase the potential for stagnation and associated algae blooms that constitute nutrient pollution as noted in my previous comments for LRC arguing for a Napa River flow impairment designation on the 303d list (Higgins 2010).

My Qualifications

I have been a consulting fisheries biologist and watershed scientist with an office in Arcata, California since 1988. In my 25 year career I have written chapters or elements for several large northern California fisheries and watershed restoration plans, including the Klamath River (Kier Associates 1991), South Fork Trinity River (Pacific Watershed Associates 1994), and Garcia River (Mendocino Resource Conservation District 1992). I also served as lead author of the northwestern California status review of Pacific salmon species on behalf of the Humboldt Chapter of the American Fisheries Society (Higgins et al. 1992).

From 1994-2004 I helped create and populate a regional fisheries, water quality and watershed database known as the Klamath Resource Information System or KRIS (www.krisweb.com). This database covers 2/3 of northwestern California and working on this project has helped me under relationships between watershed management and the response of aquatic ecosystems.

From 2004 to 2010 I worked for the environmental departments of five Lower Klamath Basin Indian Tribes on building a case for Klamath Hydropower Project dam removal and also for better enforcement of the Clean Water Act in order to better protect Tribal Trust resources (see www.klamathwaterquality.com). This involved extensive water quality and nutrient pollution analysis. I assisted with creation of the *Water Quality Control Plan Hoopa Valley Indian Reservation (HVT 2008)*, including setting nutrient standards for the Klamath River.

My previous work for LRC in the Napa River involves TMDL review and timber harvests and vineyard conversions comments, as noted above. I also studied the Napa River when I addressed the problems of over-appropriation and illegal diversion of water in northwestern California on behalf of the Redwood Chapter of the Sierra Club (Higgins 2008b) in commenting on the *Policy for Maintaining Instream Flows in Northern California Coastal Streams* (SWRCB WRD 2008).

From 2006-2010 I supplied technical assistance to the National Marine Fisheries Service to support recovery planning for California south coast and south central coast steelhead (Kier Assoc. and NMFS 2008a) and southern Oregon-northern California coho salmon (Kier and NMFS 2008b). In this capacity I assisted with assimilation of water quality and fish habitat data to assess existing habitat quality and also in setting thresholds for tolerances based on the scientific literature.

The above career experience makes me qualified to judge suitability of Napa River waters for salmonids and also to understand whether a robust case for de-listing the river and Sonoma Creek for nutrients has been provided.

Review of Justification Data and Arguments

The SFBRWQCB (2013) uses 8 different data types or lines of argument for justifying dropping Sonoma Creek and the Napa River from the California 303d list of impaired waterbodies for nutrients. They are ammonia, nitrate, nitrite, benthic chlorophyll a, percent macro-algae cover, pH, dissolved oxygen, and water column chlorophyll a. Not all lines of evidence are reviewed below because only some were inconsistent with de-listing.

Chlorophyll Data

Two types of data involving chlorophyll a were used to test for whether levels had reached those indicative of pollution 1) milligrams of chlorophyll a per square meter of the stream bottom (mg/m^2), and 2) the amount of chlorophyll a in the water column. Since the latter is more appropriate for measuring photosynthetic activity in lakes, it is not discussed further below.

The amount of algae growing on the stream bed can be used as an indicator of pollution and the SFBRWQCB (2013) chose 150 mg/l as the level of impairment based on Tetra Tech (2006). However, Horner et al. (1983) found that 100 mg/l of chlorophyll a could compromise beneficial uses of Pacific coastal streams. Therefore, we display sites on the Napa River (Figure 1) and Sonoma Creek (Figure 2) where values greater than 100 mg/m^2 were measured. The fact that stations at key locations on the main branches of both waterbodies manifest nuisance levels of algae in both 2011 and 2012 is not consistent with delisting them for nutrient pollution. While SFBRWQCB (2013) states that other signs of nutrient pollution that compromise beneficial uses at these sites is not indicated, dissolved oxygen levels are consistent with nutrient pollution and impairment (see below).

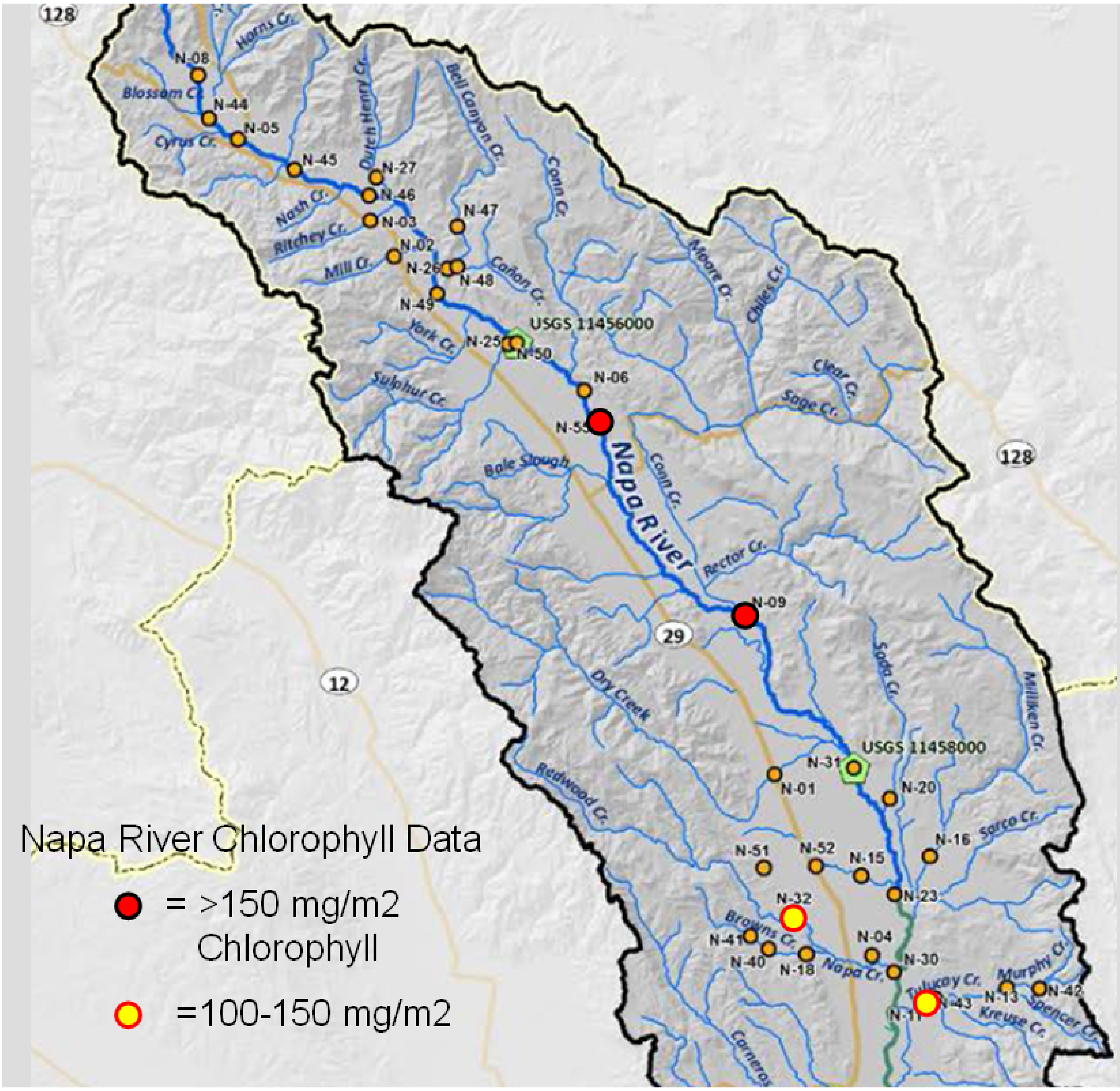

Figure 1. Napa River sites where chlorophyll a was in excess of 100 mg/l. Data from SFBRWQCB (2013).

No problems with algae blooms or high levels of chlorophyll a occur in shaded locations (Welch et al. 1998): “Periphyton in small, shaded streams are usually limited by light and are not likely to reach nuisance levels in response to nutrient enrichment (Purcell 1994).” With regard to the Napa River, the justification report (SFBRWQCB 2013) acknowledges that “Overall the river is well-shaded, but locations with open canopy, warmer temperatures, and shallow waters are more likely to produce algae blooms” and also that the average shade is 71%. Since the report gives no indication of shade at specific monitoring sites, there is no way for the reader to discern whether the low chlorophyll a results are low simply because most monitoring sites were shaded. Similar questions and analytical problems exist for Sonoma Creek chlorophyll a data. Despite the claim that geographic distribution of sites is sufficient (SFBRWQCB 2013), impairment at sites N-55 and N-09 suggest that sites in between the two stations with high chlorophyll a values might manifest similar problems.

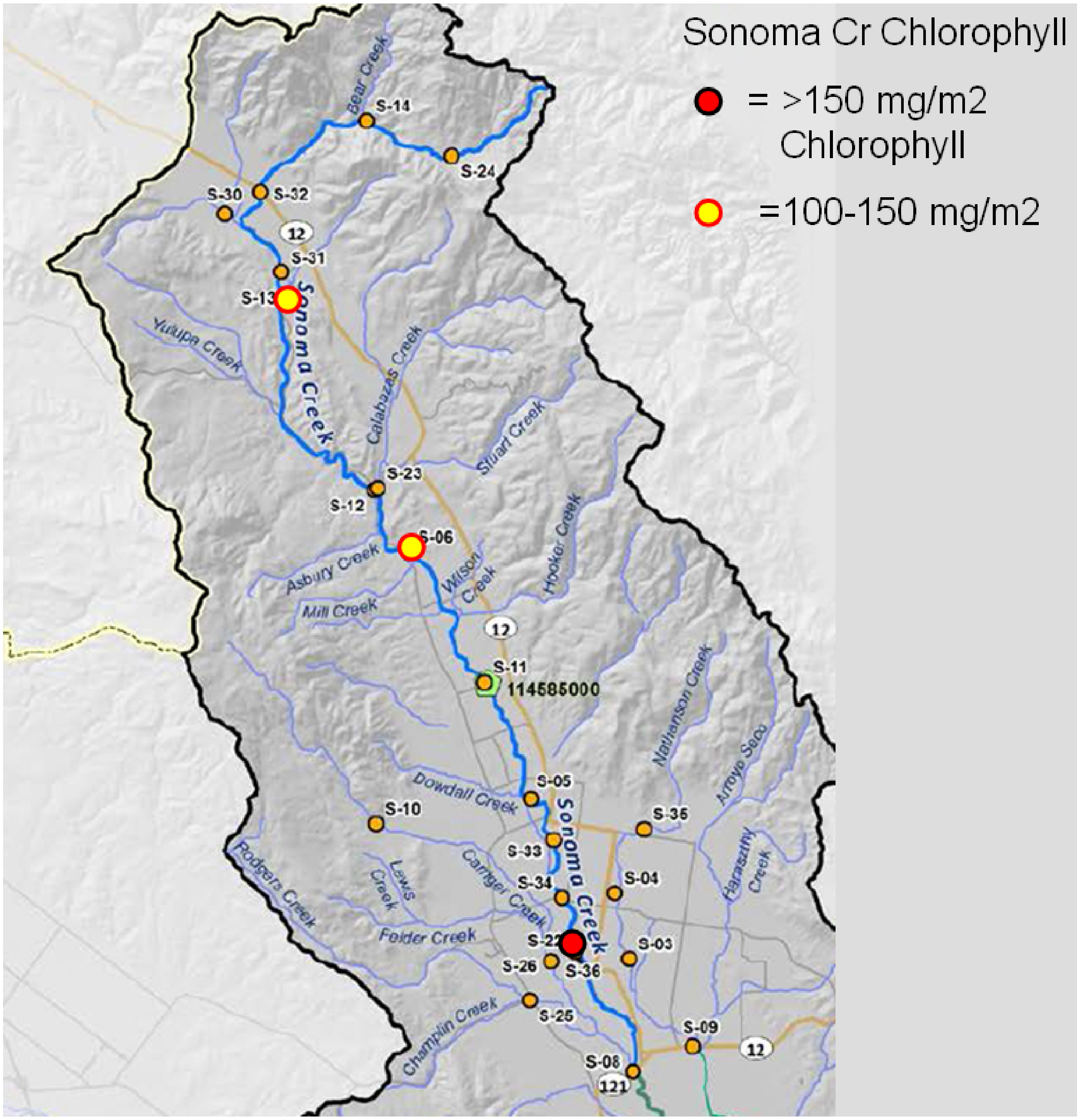

Figure 2. Sonoma Creek sites where chlorophyll a was in excess of 100 mg/l.

<u>Percent Substrate Cover by Algae</u>

The justification report (SFBRWQCB 2013) recognizes benthic algae covers more than 30% of the stream bottom that it is likely impaired with regard to nutrients. Not surprisingly, the sites that exceed chlorophyll a values of 100-150 mg/ m^2 also exhibit algal percent cover values of near 30% or greater (N-09, S-36, S-06, N-32). According to the justification (SFBRWQCB 2013), algae cover at “N-09 increased from 31 percent to 46 percent to 61 percent, showing increased growth throughout the dry season,” which indicates high dry season nutrient availability. There are curious results at N-55 where chlorophyll a levels are 161 mg/m^2 but percent cover is less than 7%, but the low D.O. data there are consistent with nutrient impairment and also at sites N-09 and S-36.

Nutrient Criteria

The justification for delisting the Napa River and Sonoma Creek for nutrients (SFBRWQCB 2013) provides data on a nitrogen and phosphorous in different forms to assess levels of nutrient pollution. Discussion here focuses on phosphorous because the levels reported are actually higher than those needed to stimulate nuisance algae blooms at most stations in both basins according to criteria from Welch et al. (1998). Also, dissolved ammonia is discussed because values exceed those known to support salmonids at three locations.

Phosphorous (P): The justification report (SFBRWQCB 2013) states that "the exact nutrient levels at which algal growth limitation begins to occur vary, but are generally less than 0.5 mg/L for total nitrogen or 0.1 mg/L for total phosphorus (Bowie et al. 1985)". Welch et al. (1998) acknowledge that it is difficult to set a lower limit for nutrients in poorly buffered Pacific coastal streams, but found that just 7 to 20 µg of soluble reactive phosphorous (SRP) could trigger nuisance algae blooms. SRP is the equivalent of the SBRWQCB (2013) parameter Ortho-Phosphate as dissolved Phosphorous (mg/L), which has values ranging from 0.004 to 0.250 mg/l. The 0.250 mg/l is the equivalent of 250 ug/l or ten times the amount noted as potentially triggering problems by Welch et al. (1998). The 20 µg/l SRP threshold was exceeded at 79% of the sites in the Napa River and Sonoma Creek, which means dissolved phosphorous is not likely limiting algae blooms and aquatic plant growth in either basin.

Dissolved Ammonia: Plants can readily assimilate ammonium as a source of nitrogen for growth, but at high pH and high water temperatures ammonium may be converted to dissolved or unionized ammonia (Goldman and Horn 1983) that is highly lethal to fish species (U.S. EPA 1986). The justification (SFBRWQCB 2013) states that "The Basin Plan specifies an annual median numeric water quality objective for un-ionized ammonia (NH3), the form of ammonia that is toxic to aquatic life (Water Board 2013). This objective is 0.025 mg/L. No annual measures exceeded this objective." Site N-30 on the lower Napa River at the convergence with Napa Creek had values of 0.026 and 0.024 mg/L on two dates in 2003 and station N-20 on Sulphur Creek attained nearly lethal levels of 0.022 mg/l in the same year. Given that ammonia samples were collected on only a relatively small number of dates, it is likely that even higher concentrations occurred on un-sampled dates. Therefore, these sites manifest highly stressful or lethal conditions for salmonids and data are not consistent with de-listing.

pH

The probe data provided by the SFBRWQCB staff for the 2011 and 2012 period show only modest indications of photosynthetic activity with few pH values over 8.5 (Table 2). The data range narrowly with minimum and maximum values for all sites 6.79 to 8.59. Curiously companion D.O. data for N-09, N-55, S-36, N-32 and S-05 show depressions indicating algal bloom activity and nocturnal respiration or high biological oxygen demand.

Data collected by the San Francisco Estuary Institute (SFEI) in 2003 show pH values consistent with eutrophic or highly eutrophic conditions that would be highly stressful or lethal to salmonids (Wilkie and Wood 1995). The justification report says these data are not reliable and there are no values in the dataset from 2009. This leaves just one hand held 2011-2012 pH value except for the seven sites where continuous recorders were deployed in those years.

Table 2. Maximum and minimum annual pH data from probes deployed by SFBRWQC in 2011 and 2012 in Sonoma Creek and the Napa River.

Location	Max_11	Max_12	Min_11	Min_12
S-05	----	7.92	-----	7.51
S-06	8.24	8.26	7.86	7.94
S-12	8.38	8.5	7.89	8.07
S-36	8.01	8.52	7.58	6.79
N-09	7.93	8.35	7.66	7.67
N-32	-----	8.59	-----	7.71
N-55	-----	7.47	-----	7.24

Laboratory studies indicate show that as water reaches a pH of 9.5, salmonids are acutely stressed and use substantial energy to maintain pH balance in their bloodstream (Wilkie and Wood 1995), while pH in the range of 6.0 to 8.0 is normative. Prolonged exposure to pH levels of 8.5 or greater may exhaust ion exchange capacity at gill membranes and lead to increased alkalinity in the bloodstream of salmonids (Wilkie and Wood 1995). Therefore, any pH over 8.5 is potentially stressful to salmonids. Seven locations on Sonoma Creek had pH greater than 9.5 according to SFEI data and only three sites were under 8.5. On the Napa River, only 17 readings of 60 in 2003 were under 8.5. Spot pH readings in 2011-2012 are not useful for judging diel swings of pH symptomatic of nuisance Therefore, pH data are insufficient for understanding nutrient pollution and do not justify delisting.

Dissolved Oxygen

Many aquatic organisms that have co-evolved in the Napa River and Sonoma Creek require high levels of dissolved oxygen (D.O.), including steelhead trout that are designated as COLD water beneficial uses under the Clean Water Act. Juvenile steelhead trout are known to become stressed and growth slows when D.O. drops below 7 mg/l (WDOE 2002) and levels of D.O. below 3 mg/l are considered lethal (NCRWQCB 2005). Raw continuous recorder data sets collected in 2011 and 2012 were provided by SFBRWQCB staff and minimum and maximum values by location are listed in Table 1 and displayed in Figure 3. Charts of results from locations showing conditions limiting for salmonids are in Appendix A and show that critically low D.O. levels were also accompanied by saturation levels that fell below 50% in some cases, which can also cause salmonid stress (NCRWQCB 2005).

Table 1. Minimum and maximum values for D.O. from various Sonoma Creek (S) and Napa River (N) sites for 2011 and 2012 derived from data recorders.

Site	Max_DO_11	Min_DO_11	Max_DO_12	Min_DO_12
S-12	9.98	7.50	10.32	7.30
S-06	10.11	7.31	9.74	7.03
S-36	10.29	5.28	11.78	0.92
N-32	12.70	5.95	12.31	6.21
N-09	9.74	6.16	11.30	1.61
N-55			6.89	0.11

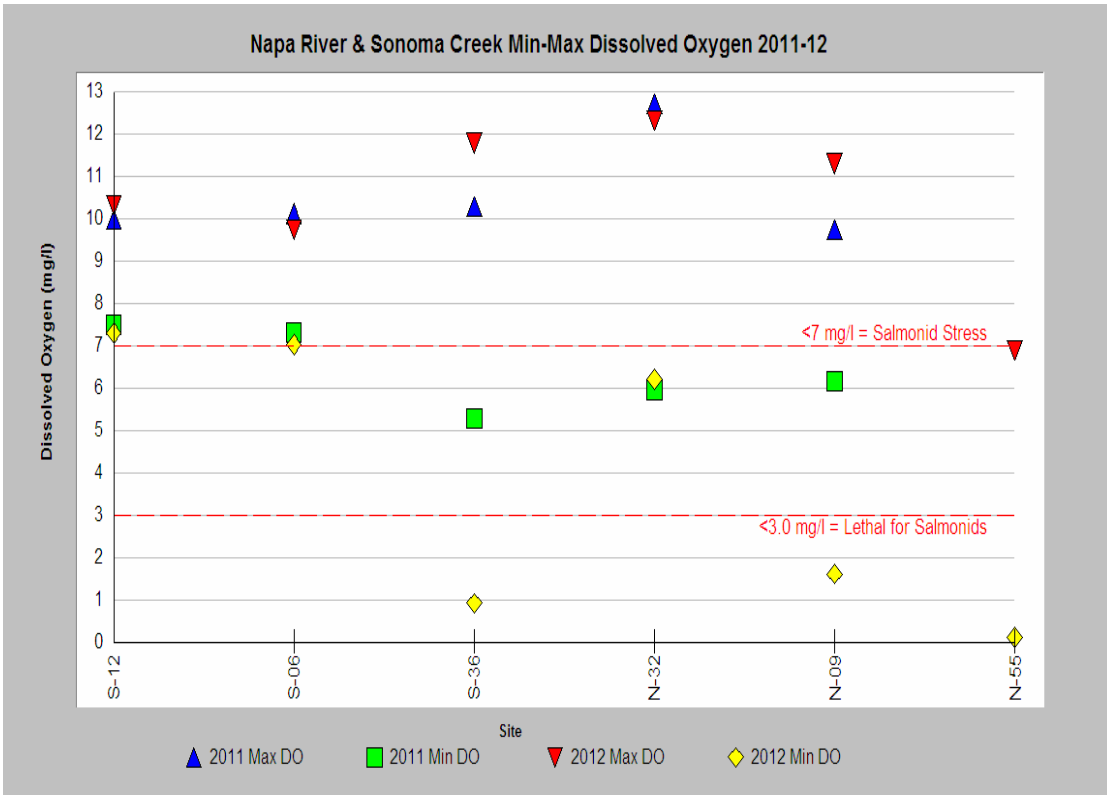

Figure 3. Dissolved oxygen minimum and maximum by year at six sites showing slightly or highly depressed D.O. values. Data from SFBRWQCB. References from WDOE (2002) and NCRWQCB (2005)

Sites S-06 and N-32 had values indicative of salmonid stress (<7 mg/l), while lethal levels of D.O. (<3 mg/l) were measured at sites S-36, N-09 and N-55. Not surprisingly locations like S-06, S-36, N-55 and N-09 also had elevated percent algae cover and/or high chlorophyll a scores consistent with nutrient pollution. Charts from the Excel database for the stations showing the worst D.O. impairment are captured in Appendix A.

Analysis of patterns of D.O. sags at sites S-32, N-09 and N-32 show nocturnal depression suggesting algal respiration that causes stressful conditions for juvenile steelhead (<7 mg/l). Site S-32 is also exhibiting super-saturation of D.O. (maximum DO of 12.3 mg/l on 10/15/2011, which is 137% of saturation at temperature 18.2 °C, see Appendix A), which is indicative of likely diurnal algae blooms.

Flow Trends

Stream flow is an important driver of water quality and fish habitat in the Napa River and Sonoma Creek watersheds. Based on an evaluation of trends in annual stream flow only, SFBRWQCB (2013) stated that there were no trends evident from Napa River flow gauges for the period of record. Solely examining annual flow is inadequate because annual flow largely reflects runoff during the winter and spring, driven by precipitation which is extremely variable from year to year. Water demand for municipal and agricultural uses is low during the months when stream flow is high, and dams and reservoirs capture only a relatively small portion of winter/spring precipitation. In contrast, much of the summer stream flow is withdrawn and used for irrigation. Consequently, the effect of human activities on stream flow is much greater during the summer months than during winter/spring, and it should be expected that long term trends would be much more likely to be detected in summer stream flow than in winter/spring stream flow.

Using available U.S. Geological Survey (USGS) Napa River flow data from Napa (#11458000) and St. Helena (#11456000), an analysis of long-term trends in key metrics of stream flow was conducted using methods similar to those employed by other hydrologic analysis in the region (Madej 2011, Mayer and Naman 2011, Chang et al. 2012). Streamflow metrics calculated for each year included the mean stream flow for each month as well as the minimum 7-day stream flow (i.e., the average stream flow during the 7-day period of the year with the lowest stream flow) and minimum 30-day stream flow. Long-term trends in these metrics were evaluated using the nonparametric Mann–Kendall test, which is commonly used in hydrologic studies (Helsel and Hirsch 2002, Pavelsky and Smith 2006, Mayer and Naman 2011, Chang et al. 2012). Compared to linear regression, the Mann-Kendall test is a more flexible (does not rely on assumptions of normality, constant variance, or linearity) and often more powerful technique for assessing trend (Helsel and Hirsch 2002). A p-value of 0.10 was used as the threshold for statistical significance, the same value used in similar studies (Madej 2011, Chang et al. 2012). The Slope of the trend was calculated using the non-parametric Sen slope estimator method. R software's WQ add-on package was used to run the Mann-Kendall tests and calculate Sen slope. The Mann-Kendall tests do not assess the relative contribution of the various potential causes contributing to the change in streamflow, only their net result. Potential causes include changes in climate (i.e., precipitation patterns and increased air temperature) as well as land and water use (i.e., increased water diversions, groundwater extraction, impoundments, tile drains, and impervious area). The results of the Mann-Kendall trend tests are shown in Table 1.

There are statistically significant declining trends in minimum 30-day average (Figure 4), minimum 7-day average (Figure 5), mean August, and mean September stream flow for the Napa River at St. Helena for both the 1930-2013 and 1960-2013 time periods (Table 1). The steepest drops occurred in mean September and minimum 30-day average stream flow, which both declined at >2% per year over the 1960-2013 period. At the Napa River at Napa gage downstream, declining trends for 1960-2013 were also present in minimum 30-day average (Figure 6) and mean monthly stream flows for September-November (Table 1); while was no statistical trend for minimum 7-day average stream flows at that gage across the entire 1960-2013 period, 7-day average flows have fallen to zero in 12 of 14 years since 2000 (Figure 7).

The only increasing trend was mean June stream flow at the Napa River at Napa gage, which just barely met the threshold for statistical significance (Table 1). No stream flow trends were detected in Sonoma Creek at the Aqua Caliente gage for 1955-2013 except a slight increase in minimum 7-day average flow (Table 1).

The decreases in flow are consistent with what is known about long term water extraction from the Napa River that hydrologist Dennis Jackson (2009) reported. Stillwater and Dietrich (2002) also documented lack of flow and stagnant conditions in the Napa River that was causing conditions limiting juvenile steelhead production. The map of stream flow disruption and stagnation are displayed here as Figure 8.

Table 1. Summary of long-term trends in 14 streamflow metrics at gages in the Napa River and Sonoma Creek watersheds: 7-day minimum flow, 30-day minimum flow, and mean flow for each month. The threshold for statistical significance is a p-value of 0.10.

Gage Name (Gage #)	Time Period Evaluated	Streamflow Metric	Direction of Trend	Sen Slope (cfs/yr)	Sen Slope (%/yr)**	P-value	Statistical Significance Category
NAPA R NR ST HELENA CA (11456000)	1930-2013	Min. 30-day	Decreasing	-0.005	-0.95	0.005	p<0.05
		Min. 7-day	Decreasing	-0.003	-0.73	0.019	p<0.05
		August mean	Decreasing	-0.010	-0.84	0.025	p<0.05
		September mean	Decreasing	-0.008	-0.94	0.005	p<0.05
		Mean for all other months*	no trend				
	1960-2013	Min. 30-day	Decreasing	-0.014	-2.42	0.001	p<0.05
		Min. 7-day	Decreasing	-0.005	-1.27	0.011	p<0.05
		August mean	Decreasing	-0.014	-1.32	0.059	0.05<p<0.10
		September mean	Decreasing	-0.018	-2.25	0.000	p<0.05
		Mean for all other months*	no trend				
NAPA R NR NAPA CA (11458000)	1960-2013	Min. 30-day	Decreasing	-0.014	-1.07	0.056	0.05<p<0.10
		Min. 7-day	no trend				
		June mean	Increasing	0.162	0.86	0.047	p<0.05
		September mean	Decreasing	-0.019	-1.05	0.047	p<0.05
		October mean	Decreasing	-0.050	-0.53	0.060	0.05<p<0.10
		November mean	Decreasing	-0.185	-0.29	0.054	0.05<p<0.10
		Mean for all other months*	no trend				
SONOMA C A AGUA CALIENTE CA (11458500)	1955-2013	Min. 7-day	Increasing	+0.002	+0.48	0.079	0.05<p<0.10
		Min. 30-day	no trend				
		Mean for all months*	no trend				

* To conserve space and increase clarity, only those months with statistically significant trends are listed separately in this table.
** Per-year percent Sen slopes are expressed relative to the median of the entire period, not the beginning of the period.

The SFBRWQCB (2013) termed streams that lack summer surface flow as intermittent, but they were historically perennial (Higgins 2008). The justification (SFBRWQCB 2013) does not provide information on whether monitoring locations are in stream segments that lose surface flow. If they do, then data represent isolated habitats and not ambient water quality conditions of the stream. We are attaching comments related to LRC request for listing of the Napa River for flow and temperature (Higgins 2010) as Appendix B because much of its evidence and many of its arguments are germane to the question at hand.

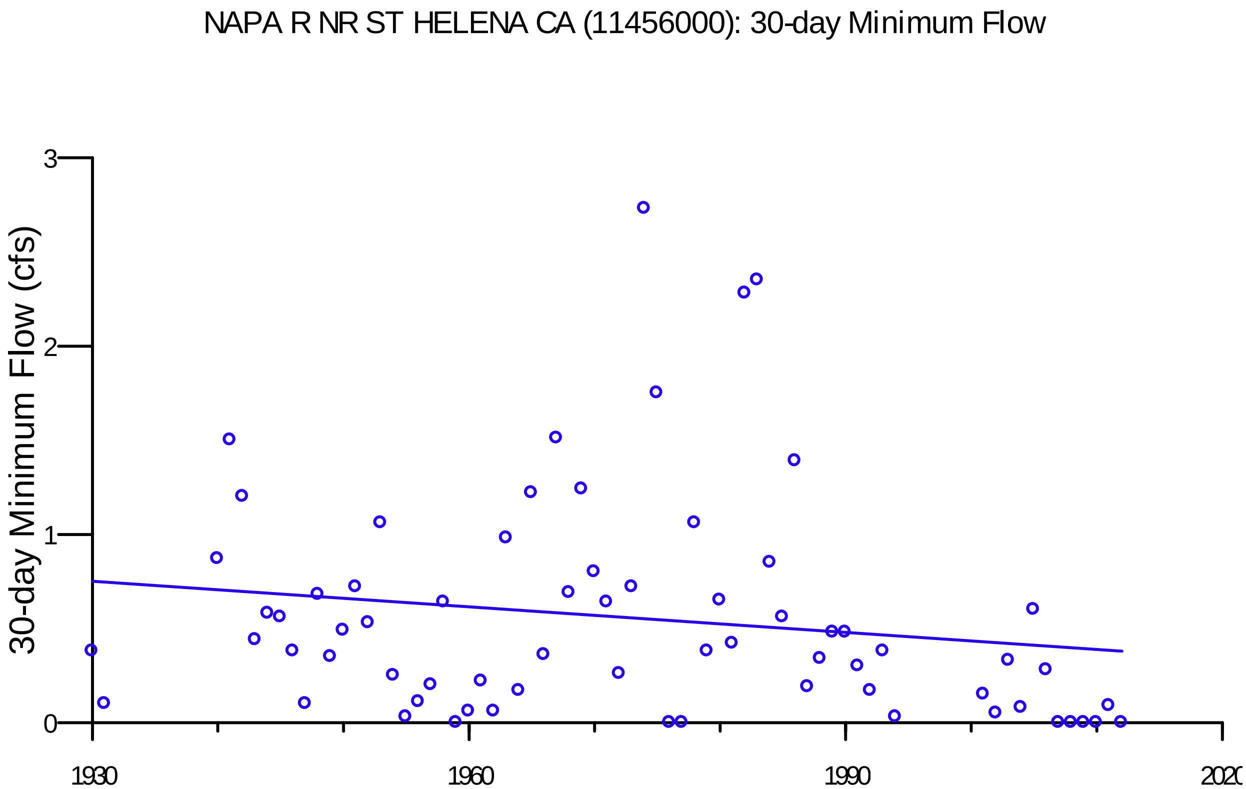

Figure 4. Napa River 30-Day minimum flow trends for the period of record for the USGS St Helena gauge showing a declining trend. The linear trend line is included for graphical purposes only, and its slope differs slightly from the Sen slope shown in Table 1.

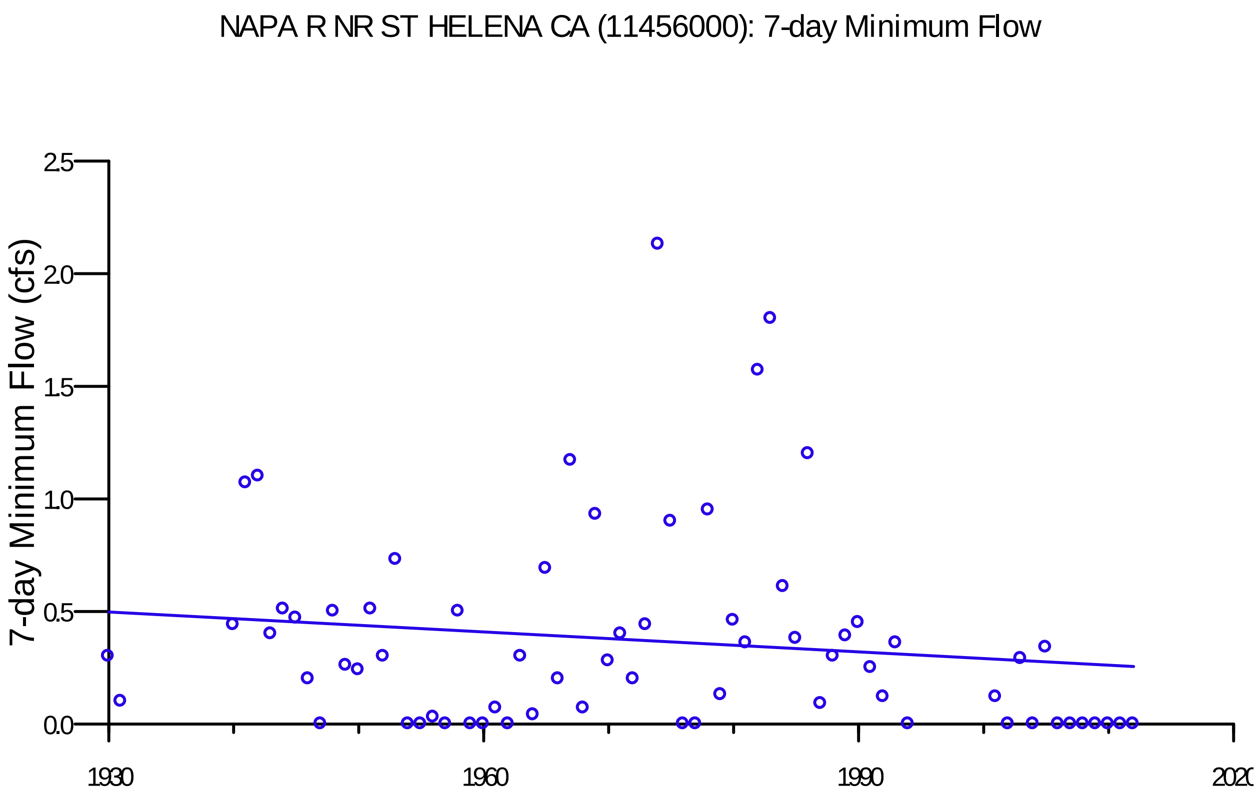

Figure 5. Napa River 7-Day minimum flow trends for the period of record for the USGS St Helena gauge showing a declining trend. The linear trend line is included for graphical purposes only, and its slope differs slightly from the Sen slope shown in Table 1

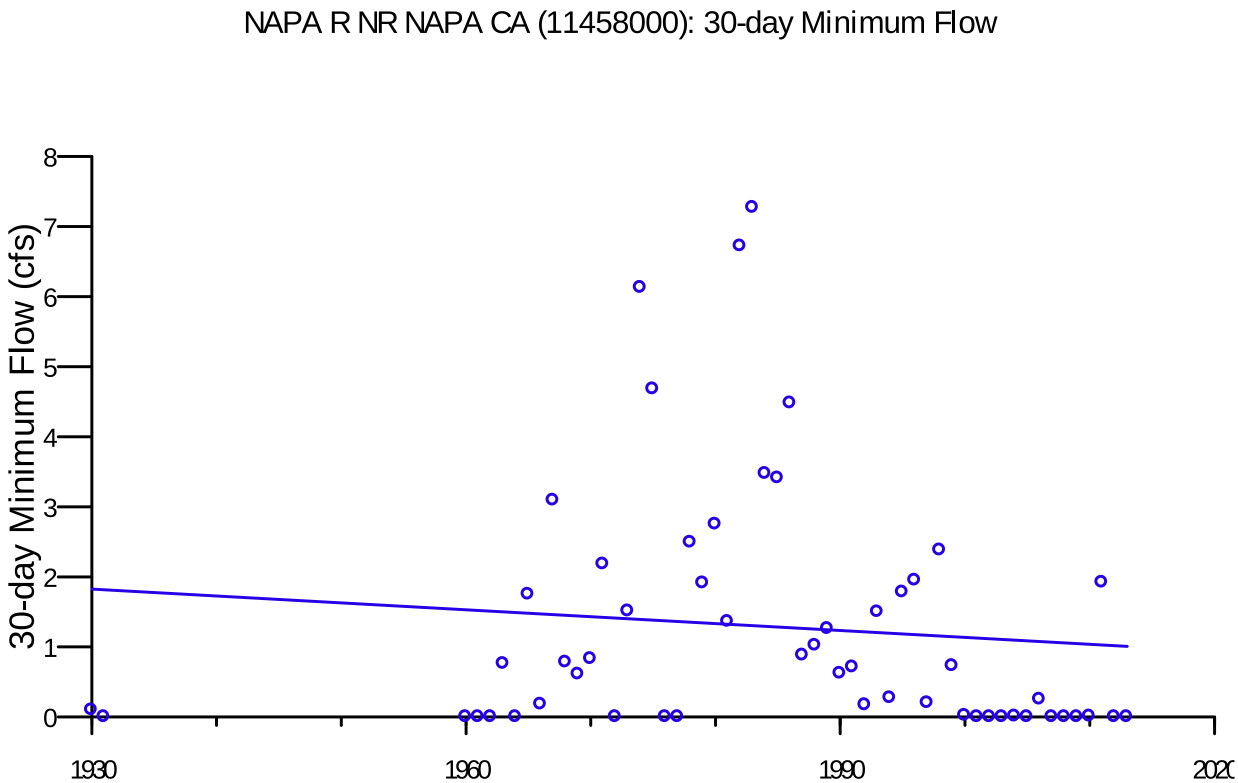

Figure 6. Napa River 30-Day minimum flow trends for the period of record for the USGS Napa gauge showing a declining trend. The linear trend line is included for graphical purposes only, and its slope differs slightly from the Sen slope shown in Table 1.

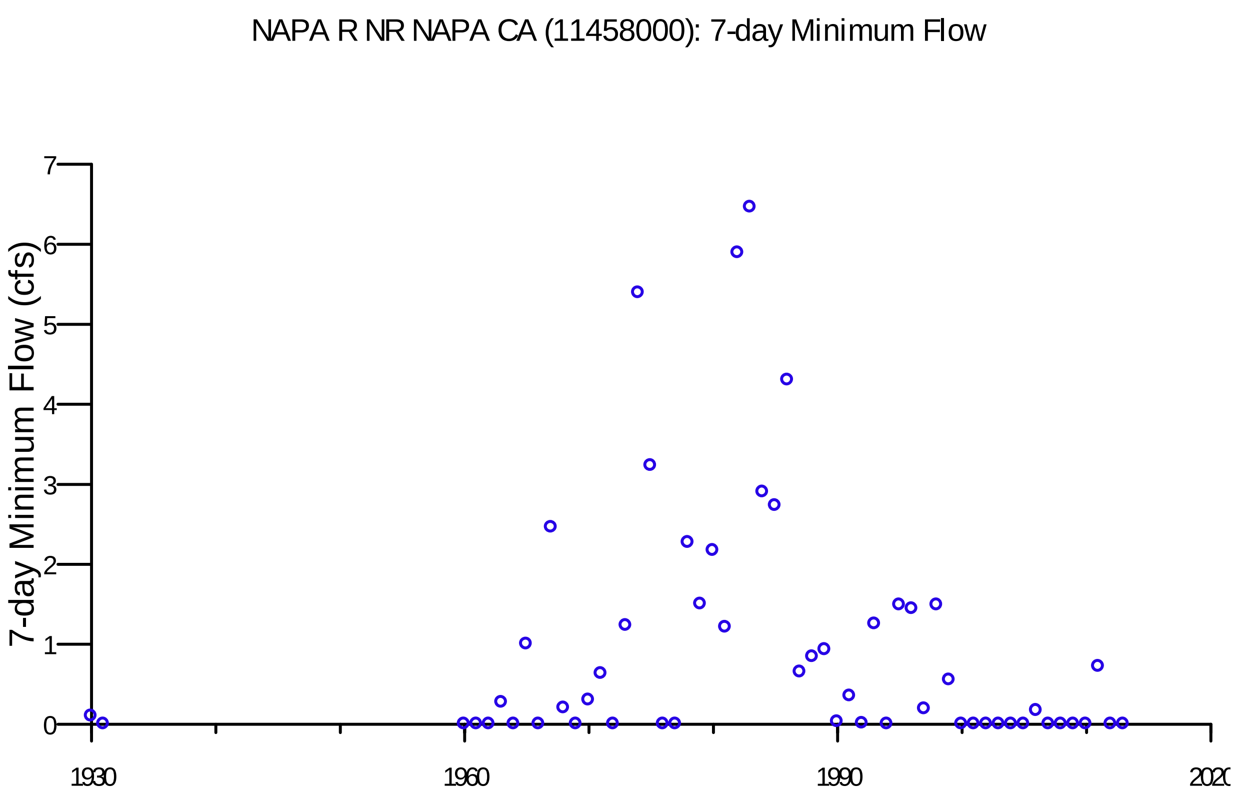

Figure 7. Napa River 7-Day minimum flow trends for the period of record for the USGS Napa gauge.

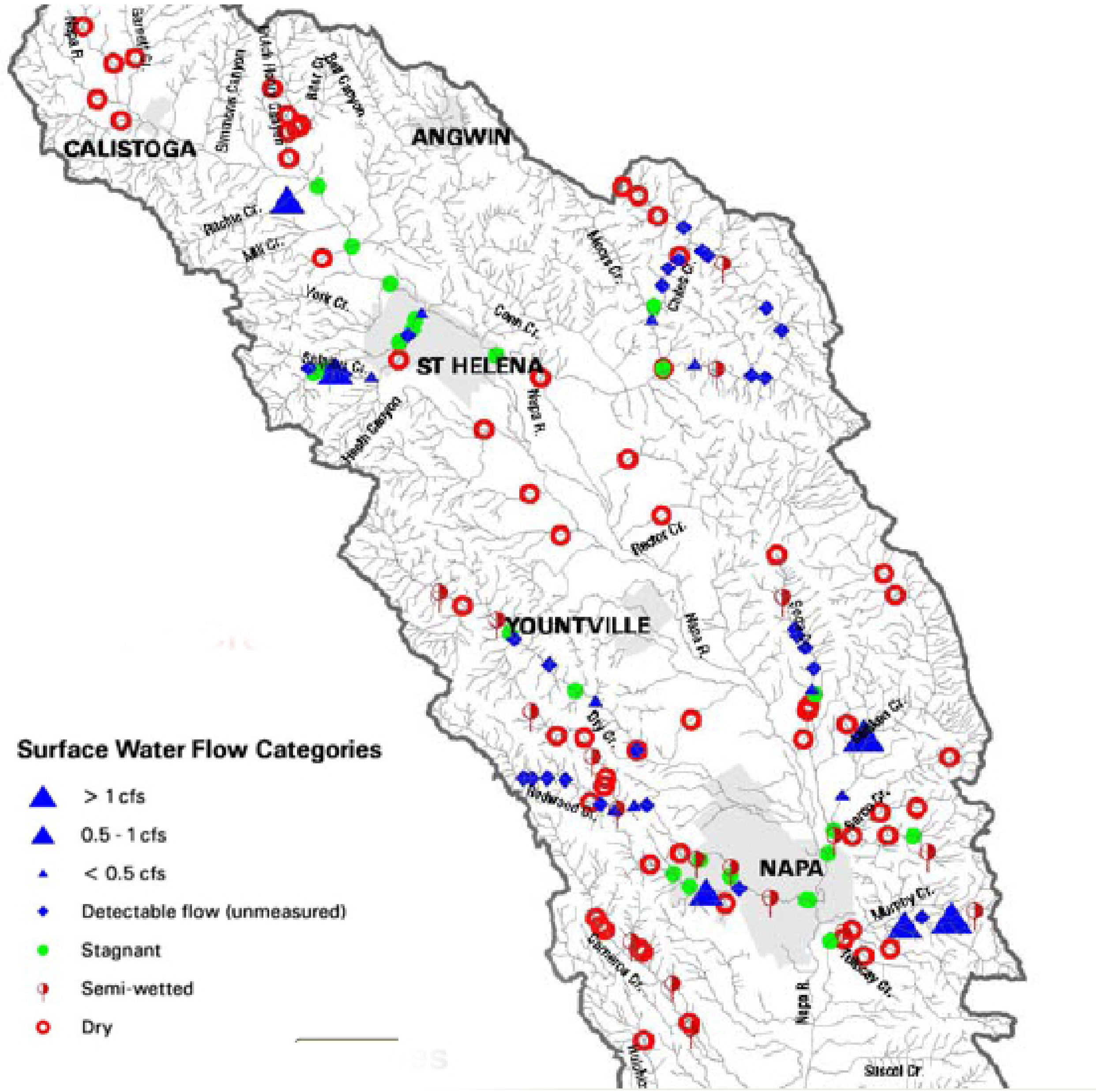

Figure 8. Graphic from Stillwater and Dietrich showing the number of places in the Napa River basin where there were dry stream segments or areas of stream stagnation.

Visual Evidence

The following passage from the justification report (SFBRWQCB 2013) is somewhat ironic:

> "In fact, the evaluation of eutrophic conditions requires the weight of evidence approach because the evaluation process examining a stream's trophic status requires measuring naturally occurring stream organisms (i.e., algae) and determining if the current amount of algae is affecting recreational beneficial uses or water quality parameters that influence aquatic life (e.g., pH, dissolved oxygen)."

In fact, recreational impairment can be visually assessed and Figures 9 shows a photo captured recently by Chris Malan of LRC of the Napa River that shows objectionable algae blooms and the channel choked with vegetation.

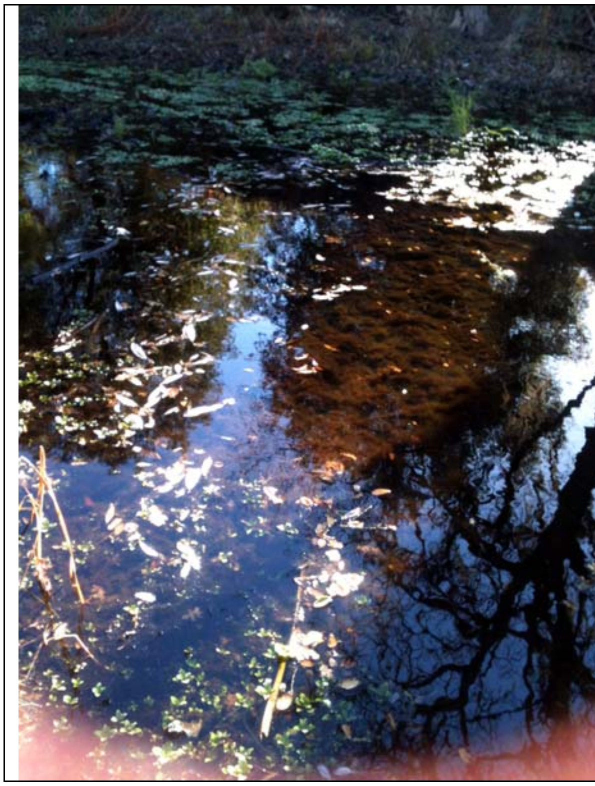

Figure 9. Napa River between at Oakville Road Bridge with floating rafts of vegetation, emergent aquatic vegetation and algae coating the bottom of the stream. These conditions are consistent with high nutrient availability even though the site is partially shaded.

Conclusion

The SFBRWQCB (2013) conclusion to delist the Napa River and Sonoma Creek are not supported by their data and the report does not provide appropriate justification. The flux of flow in the Napa River is now falling to levels where the river has lost its capacity to clean itself and to maintain beneficial uses. The SFBRWQCB needs to take action to restore flow because it is the only means to remediate water quality problems and there is legal precedent for such action. The Board has the authority and to increase flows to meet water quality standards as established in Supreme Court case No. 92-1911 (*Jefferson County PUD and City of Tacoma vs. Washington Dept. of Ecology)*. This case explicitly states that water quality authorities under the Clean Water Act can set water quantities sufficient to abate water quality problems:

> “Petitioners also assert more generally that the Clean Water Act is only concerned with water ‘quality,’ and does not allow the regulation of water ‘quantity.’ This is an artificial distinction. In many cases, water quantity is closely related to water quality; a sufficient lowering of the water quantity in a body of water could destroy all of its designated uses, be it for drinking water, recreation, navigation or, as here, as a fishery. In any event, there is recognition in the Clean Water Act itself that reduced stream flow, i.e., diminishment of water quantity, can constitute water pollution. First, the Act's definition of pollution as "the man made or man induced alteration of the chemical, physical, biological, and radiological integrity of water" encompasses the effects of reduced water quantity (33 U.S.C. § 1362(19)). This broad conception of pollution – one which expressly evinces Congress' concern with the physical and biological integrity of water – refutes petitioners' assertion that the Act draws a sharp distinction between the regulation of water ‘quantity’ and water ‘quality.’ Moreover, §304 of the Act expressly recognizes that water ‘pollution’ may result from ‘changes in the movement, flow, or circulation of any

> navigable waters . . . including changes caused by the construction of dams.’ (33 U.S.C. § 1314(f)). This concern with the flowage effects of dams and other diversions is also embodied in the EPA regulations, which expressly require existing dams to be operated to attain designated uses (40 CFR § 131.10(g)(4)).”

Flow restoration is the only way that the Napa River can come into compliance with the Clean Water Act and be restored to fishable, swimmable and drinkable as required. Flow diminishment tied to increased groundwater withdrawal as documented by Jackson (2009) will confound any attempts of the SFBRWQCB to resolve temperature problems because maintaining cool waters requires higher volume and shorter transit time. Increasing flow would also improve the ability of the Napa River to reduce nitrogen through hyporheic function and also promote connection with cooler groundwater. As noted above, as water warms and pools and shallower habitats stagnate, nuisance algae blooms will continue and worsen. Steelhead trout now inhabit less than 20% of their former habitats in the Napa River basin because of flow diminishment and they too will go extinct if more decisive action in not taken.

The SFBRWQCB (2013) has not provided evidence sufficient for delisting and, in fact, data provided demonstrate nutrient impairment of both the Napa River and Sonoma Creek.

Sincerely,

Patrick Higgins

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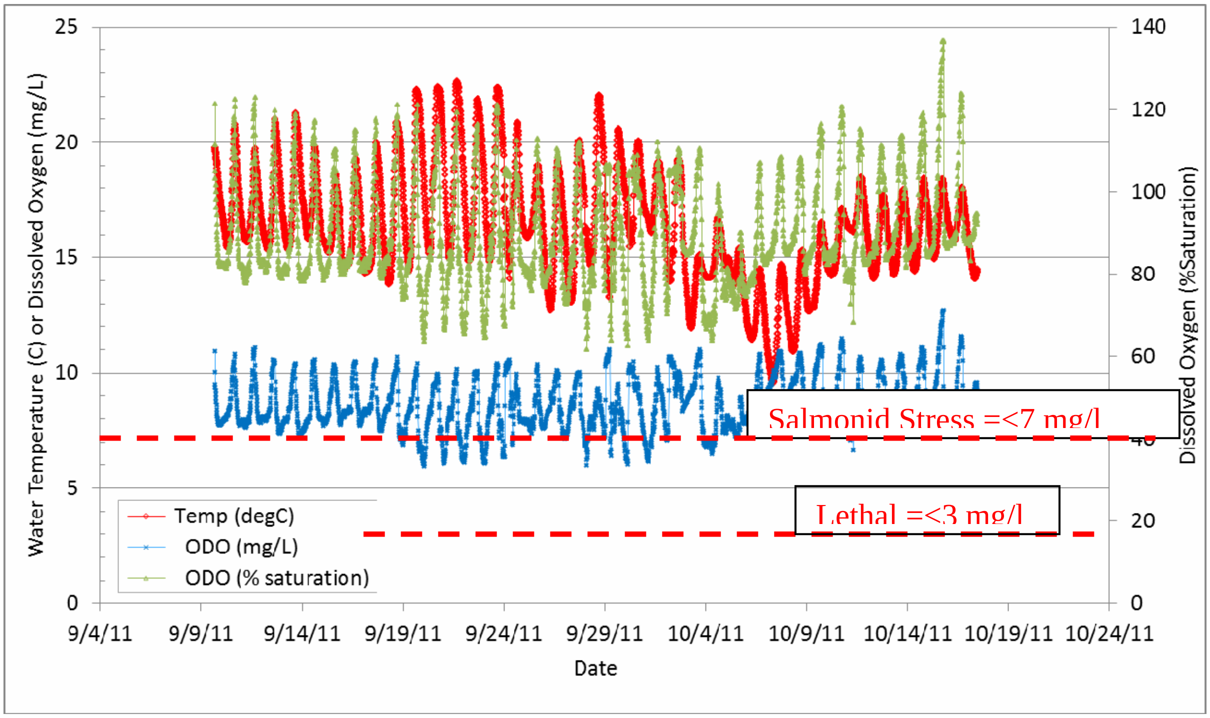
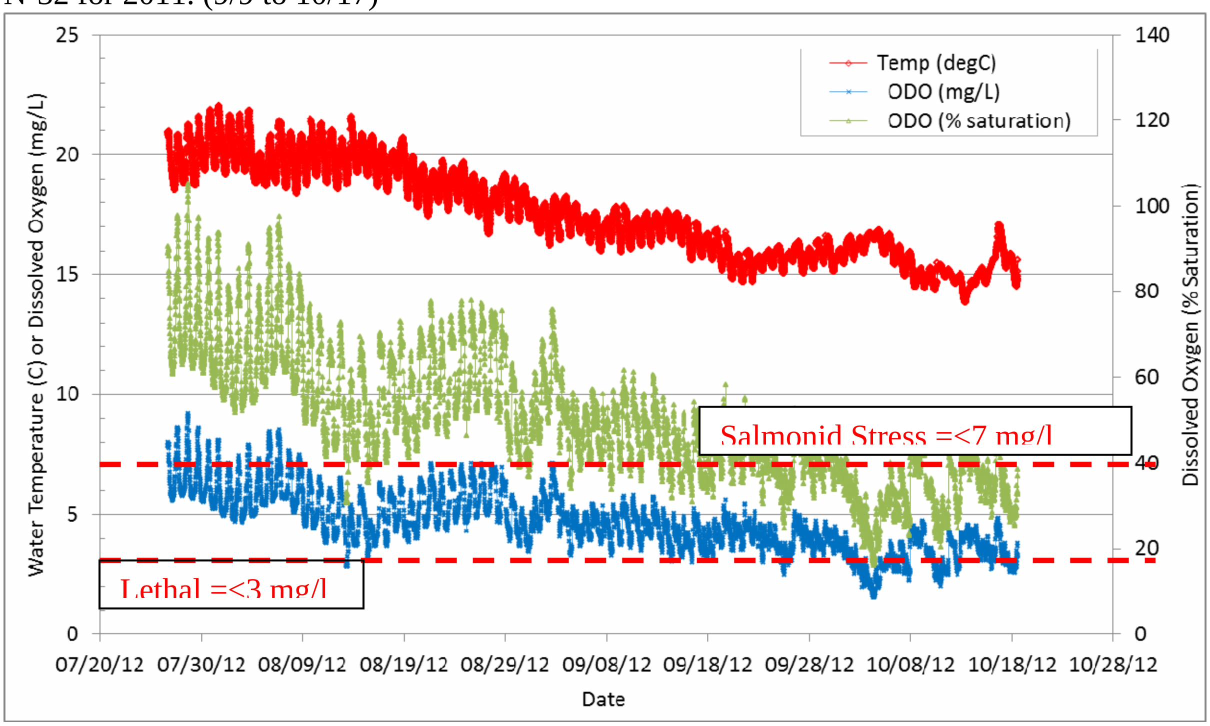
Appendix A

Dissolved oxygen charts from selected Napa River and Sonoma Creek sites showing conditions that do not support beneficial uses. D.O. saturation was calculated based on USGS lookup tables downloaded from: http://water.usgs.gov/software/DOTABLES. Thresholds for D.O. and salmonid health are WDOE (2002) for <7 mg/l as reducing steelhead juvenile growth and NCRWQCB (2005) for lethal designation of 3 mg/l.



N-32 for 2011. (9/9 to 10/17)



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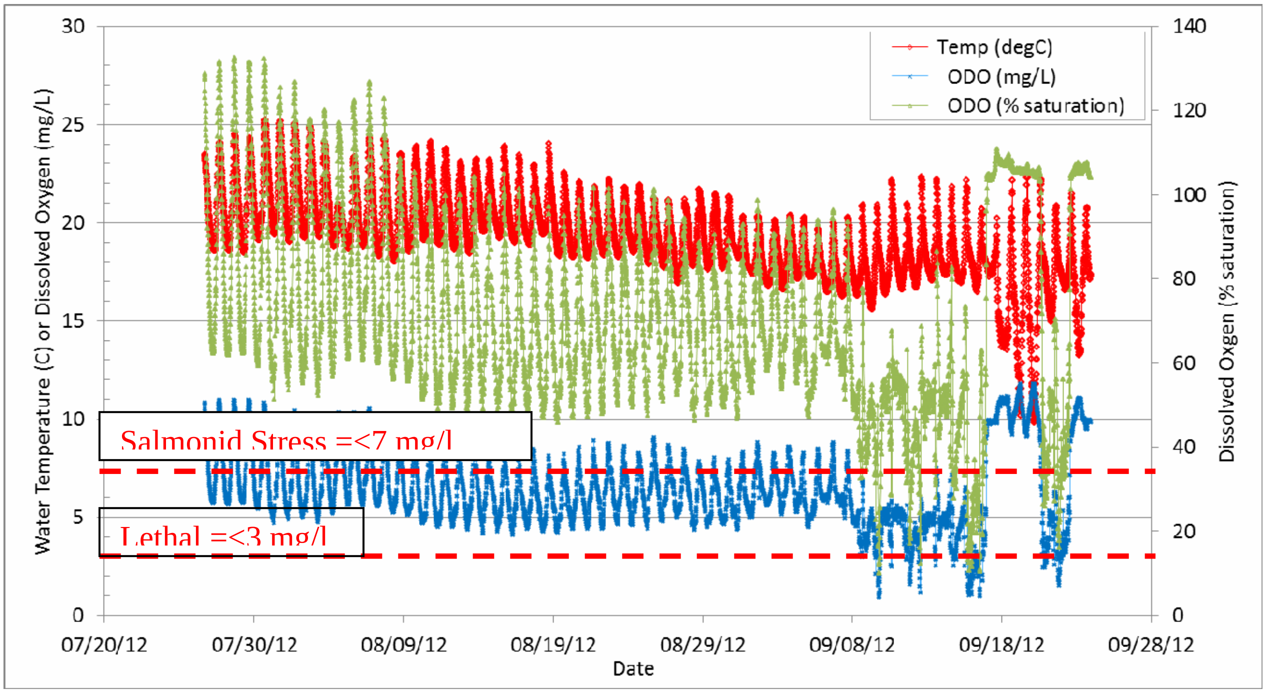
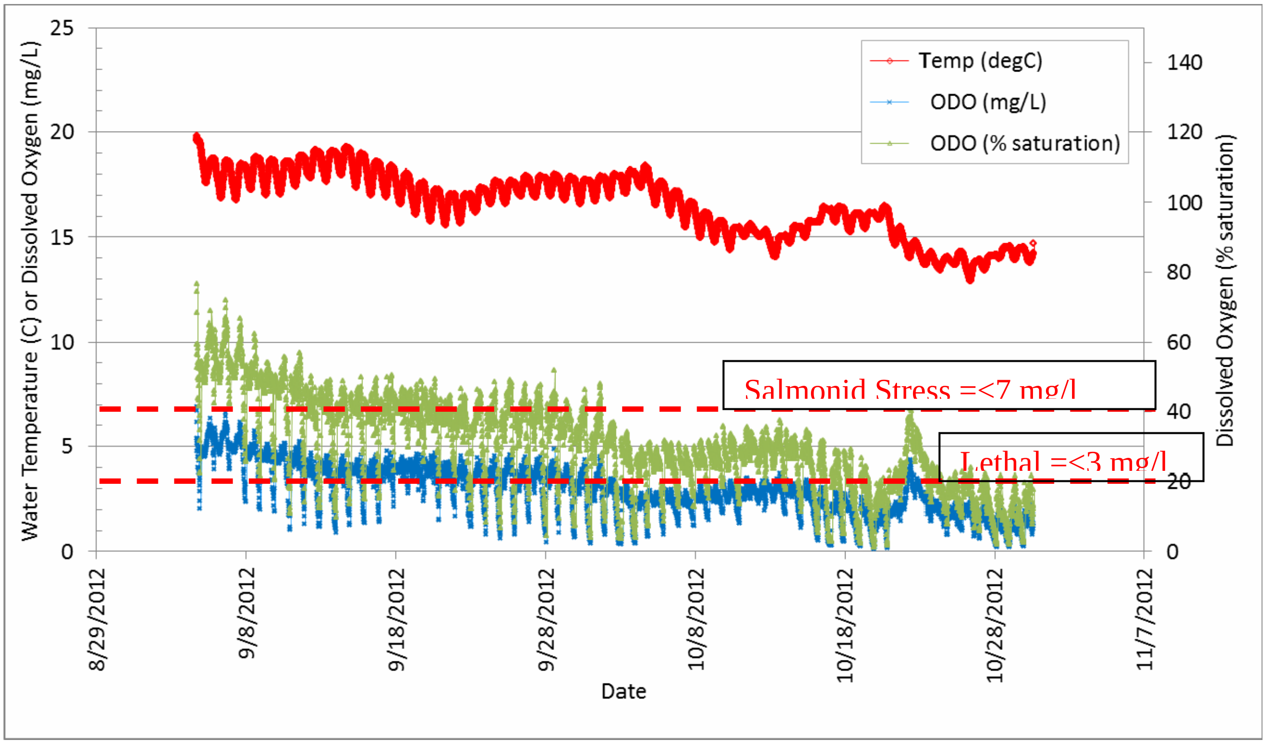


S-36 for 2012 (7/26-9/23/12)



N-55 for 2012 (9/4 to 10/30))

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(707) 822-9428

Mr. Jeffrey Shu
State Water Resources Control Board
Division of Water Quality
P.O. Box 100
Sacramento, CA 95812-0100

Re: Request for Recognition of the Napa River as Flow and Temperature Impaired and Addition to the 2012 California 303d List

Dear Mr. Shu,

These comments are in response to your Notice of Public Solicitation of Water Quality Data and Information for 2012 California Integrated Report [Clean Water Act Sections 305(b) and 303(d)]. I am preparing this request for listing of the Napa River for temperature and flow impairment (including groundwater pumping) for the Living Rivers Council, an advocacy group that uses expert-informed opinion to help guide natural resource policy and regulatory processes and to restore the health of the Napa River and its watershed. Previous listing of more than 100 rivers or stream segments across the nation as impaired due to reduction in flow and groundwater pumping on both the national Clean Water Act 303d list (U.S. EPA 2010) as well as California's (CSWRCB 2006) sets a precedent in recognizing flow depletion as a cause of pollution. I make the case below that the Napa River is temperature impaired because of the reduced volume in mainstem and tributary reaches. Therefore, elevated water temperature problems and loss of cold water fisheries (COLD) beneficial uses cannot be remediated without increasing flows.

I am not submitting new data to argue for this listing of the Napa River because existing data from Stillwater and Dietrich (2003) provide both temperature and flow information sufficient to justify listing for both temperature and flow depletion. I have been studying the Napa River on behalf of the Living Rivers Council since 2006 and I am attaching my previous comments on the Napa River Sediment TMDL (SFBRWQB 2009) and vineyard development projects as an appendix because they also provide arguments that justify the listing request (Higgins 2006a, 2006b, 2007, 2008a, 2008b, 2009, 2010). I am a consulting fisheries biologist with an office in Arcata, California, but I will skip a statement of qualifications here because they are supplied in appendices.

Justification of Listing the Napa River for Flow Impairment

The U.S. EPA (2010) national impaired waterbodies list includes over 101 rivers, stream segments or estuaries where the recognized source of impairment is flow depletion. Causes for listing include flow alteration, hydromodification, pumping and diversion. There is also precedent in California for 303d listing for flow impairment on the Ventura River with pumping and diversion recognized as the causes.

The chronic problems of lack of flow in the Napa River are well studied and extend at least as far back as the 1960s when dams were constructed on the east side of the Napa Valley, blocking access for anadromous fish to approximately 30% of the watershed. Anderson (1969) chronicled problems with insufficient tailwater flows to support steelhead trout below these dams, a condition that persists to this day. USGS flow gauge records from the Napa River show that the mainstem went dry in both the 2001 (Figure 1) and 2004 (Figure 2) water years, which is a very clear case of flow impairment.

While the mainstem Napa River was formerly important nursery area for yearling and older juvenile steelhead (Anderson 1969), today it is more suitable for warmwater species (Stillwater and Dietrich 2002), especially during summer low flow periods. Since steelhead have much higher survival to adulthood in the ocean, if they reside in freshwater for 2-3 years (Barnhart 1989), reduced mainstem rearing habitat poses a major limiting factor on steelhead production in the Napa River. As flow volume decreases, Napa River water is more subject to warming and in the longer term this has caused a shift in the fish community that favors both native and exotic warm water species (Stillwater and Dietrich 2002)(Figure 3). This is evidence of loss of beneficial uses related to cold water fisheries (COLD) and also the need to list the Napa River for temperature and flow impairment.

Stillwater and Dietrich (2004) did extensive stream surveys in the Napa River basin and also found a substantial number of stream reaches that were formerly productive salmonid habitat were dry (Figure 4). Only four stream locations had flows of over 1 cfs and many more had stagnant conditions. These findings are consistent with those of Dewberry (2001, 2003), who also found that low flows or absence of surface flow were limiting the extent of juvenile steelhead rearing habitat. Dewberry (2001, 2003) organized dive counts of steelhead juveniles in many Napa River tributaries in 2001 and 2002 and found that only Dry Creek had consistently high juvenile steelhead standing crops (> 1 fish/meter^2 for >500 meters) in both years. Watersheds of secondary importance included Redwood, Pickle, Richie, Heath, Carneros, Bell and Huichica creeks. Dewberry's (FONR 2004) map of results appears as Figure 5. Even in watersheds where Dewberry (2001, 2003) found high concentrations of steelhead juveniles, there were many reaches in the same creeks with very low densities or no steelhead present. Only 9% of reaches had high concentrations of steelhead in 2001, which was a severe drought year, but these highly productive reaches expanded to only 19% of habitat surveyed in 2002. Steelhead habitat continues to shrink due to increasing water use, and the decline cannot be reversed without restoring flows.

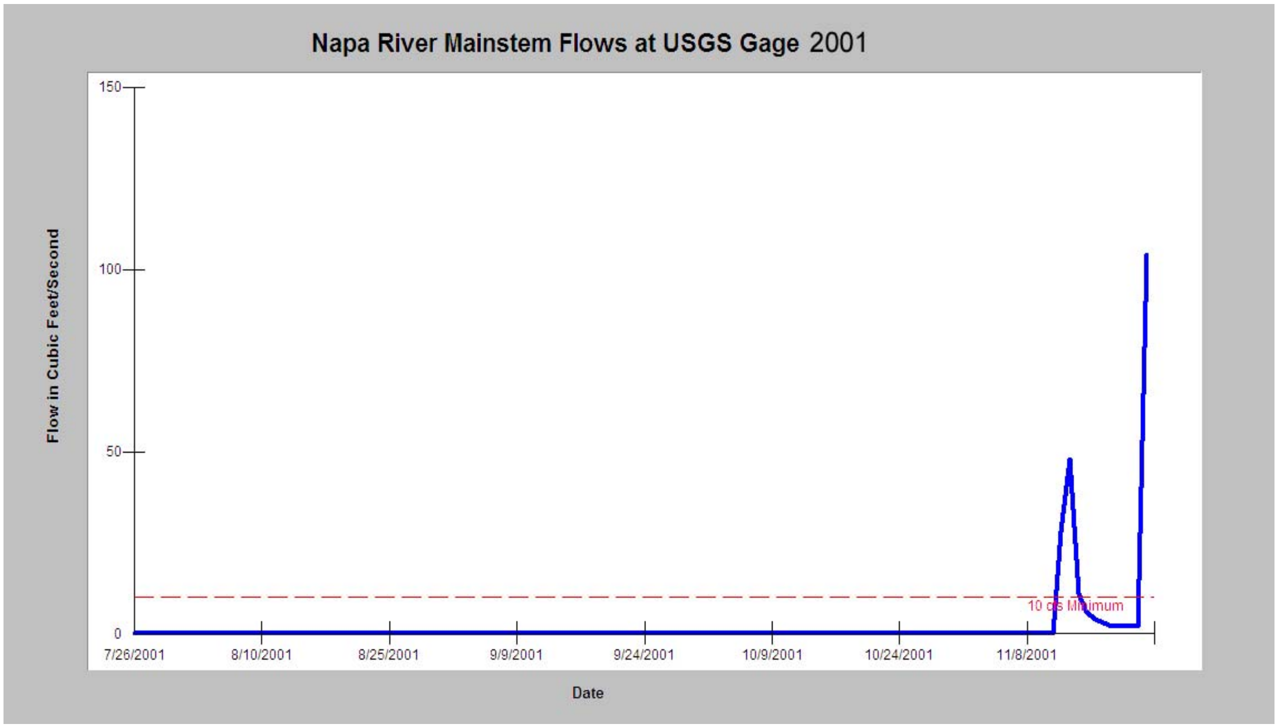


Figure 1. Flow at the USGS Napa River gauge near upstream of Napa show the loss of surface flow throughout the summer and fall of 2001. Data from the CA Data Exchange Center.

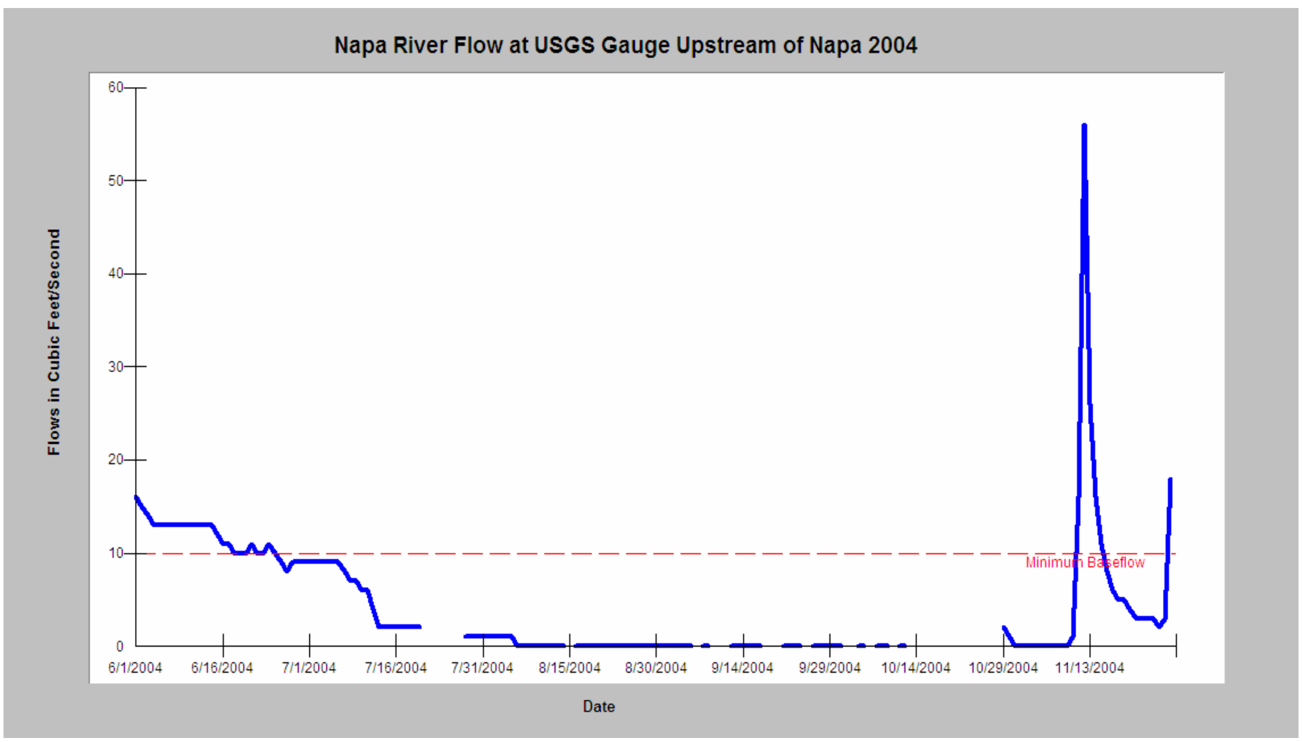


Figure 2. Flow at the USGS Napa River gauge near upstream of Napa shows the loss of surface flow from August through October of 2004. Data from the CA Data Exchange Center.

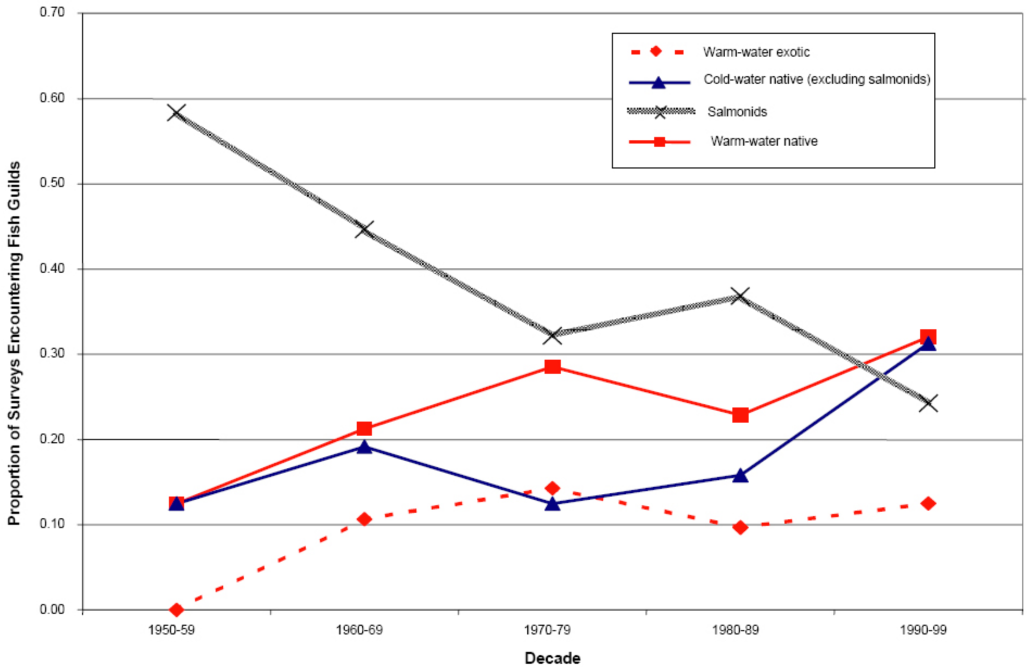


Figure 3. "The average proportion of surveys encountering particular fish guilds (warm-water exotic species, cold-water native species excluding salmonids, salmonids, and warm-water natives) in the mainstem and tributaries of Napa River, by decade." From Stillwater and Dietrich (2002) where is appears as Figure 3-6.

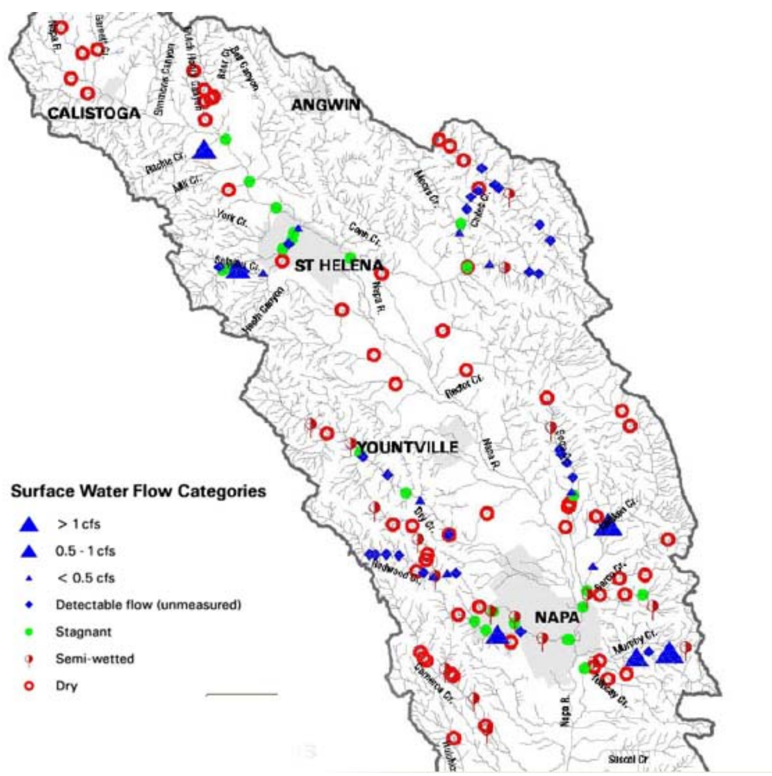


Figure 4. This map image is taken from Stillwater and Dietrich (2002) where it appears as Map 13 and is shown here to illustrate that reaches likely formerly inhabited by salmonids now lack surface flow or are stagnant in other cases because of flow depletion.

Figure 5. Map of reaches of high juvenile steelhead production in the Napa River according to surveys reported by Dewberry (2001, 2003). Map produced by the Friends of the Napa River.

Justification for Listing the Napa River as Temperature Impaired

Stillwater and Dietrich (2002) placed automated temperature probes at over two dozen locations in the Napa River watershed from August 2000 through October 2001 and data from that study are used below to prove temperature impairment with regard to suitability for steelhead.

Water temperature charts below adapted from Stillwater and Dietrich (2002) have thresholds and reference lines indicating showing stressful and lethal levels for Pacific salmon species, including steelhead. The lower reference line is at 20 ^{o} C (68 ^{o} F), which is stressful to all salmonids (McCullough 1999) and in the range known to retard steelhead growth (Sullivan et al. 2001). The higher value is 25 ^{o} C (77 ^{o} F), which Sullivan et al. (2001) considered to be lethal for most Pacific salmon species. The U.S. EPA (2003) set a target for Pacific salmon core rearing areas in the middle and upper reaches of streams at 16 ^{o} C/61 ^{o} F. Migratory routes or non-core rearing areas in middle and lower reaches of salmon streams should maintain temperatures of 18 ^{o} C/64 ^{o} F or less. U.S. EPA (2003) recommends an absolute maximum water temperature of 20 ^{o} C/68 ^{o} F during adult migration or for juvenile migration and rearing.

Mainstem Napa River: Stillwater and Dietrich (2002) provide water temperatures for several mainstem Napa River locations. Water temperatures are displayed with a central line representing the daily average, but the minimum and maximum daily temperatures reflected as well above and below the average line. Figure 6 shows the mainstem at St. Helena where water temperatures become adverse for salmonids beginning in May and rise above lethal limits in June and July. Downstream at Oak Knoll Avenue in Napa (Figure 7), the pattern of thermal impairment with regard to salmonids is similar with the mainstem Napa River fluctuating into stressful ranges (> 20 ^{o} C) in May, but maximum temperatures never exceeding 25 ^{o} C. This may indicate some cool water influence in the reach at Oak Knoll because the Napa River at Trancas Avenue further downstream in the town is once again warmer (Figure 8). Interestingly, the Napa River at the latter location exceeds 25 ^{o} C for a longer duration than the St. Helena location, with lethal temperatures extending into August and September.

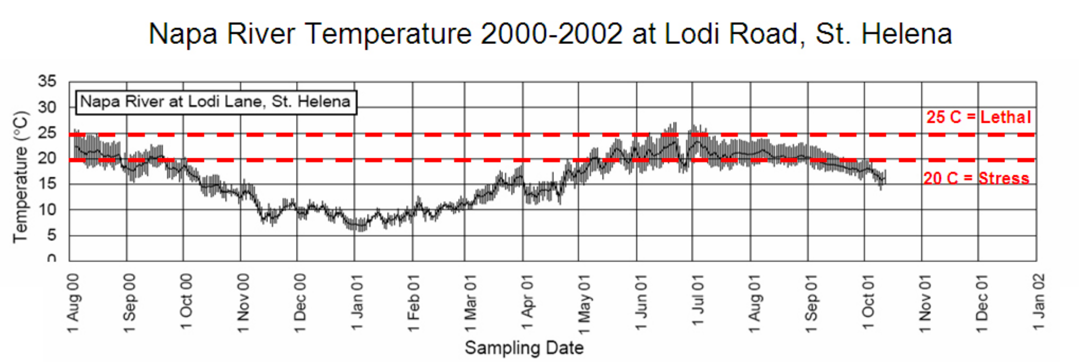


Figure 6. Napa River minimum, average and maximum daily water temperature indicates stressful to lethal conditions for salmonids from late May through mid-September at Lodi Road in St. Helena. Chart adapted from Stillwater and Dietrich (2002).

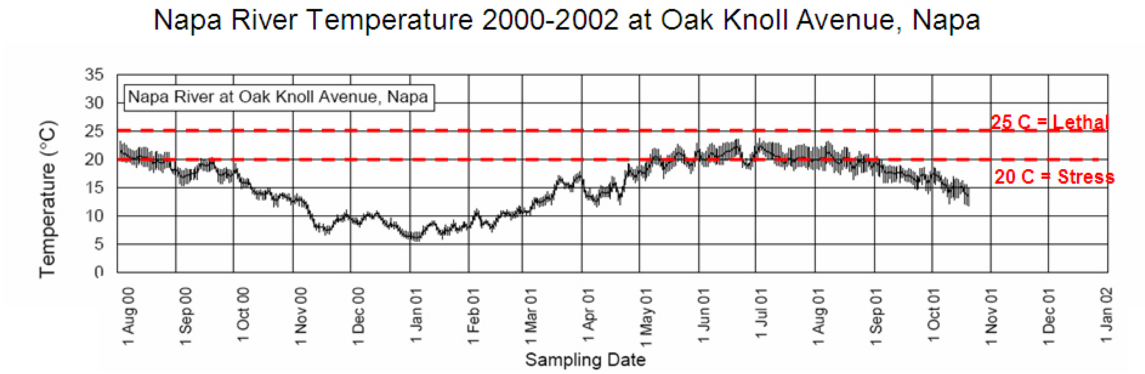


Figure 7. Napa River minimum, average and maximum daily water temperature indicates stressful conditions for salmonids from late May through mid-September 2001 at Oak Knoll Road in Napa. Chart adapted from Stillwater and Dietrich (2002).

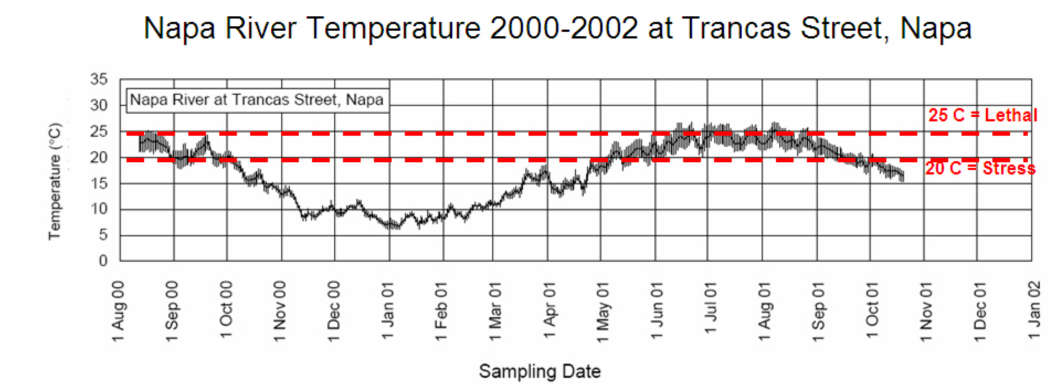


Figure 8. Napa River minimum, average and maximum daily water temperature indicates stressful or lethal conditions for salmonids from late May through mid-September 2001 at Trancas Street in Napa. Chart adapted from Stillwater and Dietrich (2002).

Tributary Impairment: Although Stillwater and Dietrich (2002) found some Napa River tributary reaches had water temperatures suitable for steelhead, they also found some impaired. In some cases, like Middle Carneros Creek, water temperatures appear suitable for steelhead but then stream segments are dewatered (Figure 9). Middle Conn Creek above Hennessey Reservoir shows a similar pattern, where temperatures are mostly suitable for steelhead with maximums only occasionally exceeding 20 ^{o} C, however, data then indicate that the reach was dry from early August to late September 2001 (Figure 10). Middle Sulphur Creek (Figure 11) shows an increase in water temperature to lethal levels (>25 ^{o} C) shortly before the reach went dry in July 2001. This is a typical pattern as flow volume diminishes, water temperature increases. Middle Chiles Creek above Lake Hennessey was also sampled for water temperature by Stillwater and Dietrich (Figure 12) and maximum daily water temperatures only exceeded 25 ^{o} C briefly in June and July 2001, but the range was stressful for salmonids from May through September. Upper Dry Creek water temperature data show very suitable conditions for steelhead juveniles, but then data suggest that the reach goes dry for days or weeks intermittently (Figure 13). Thus, Stillwater and Dietrich (2002) water temperature data demonstrate the need for impaired listing of the Napa River for both temperature and flow.

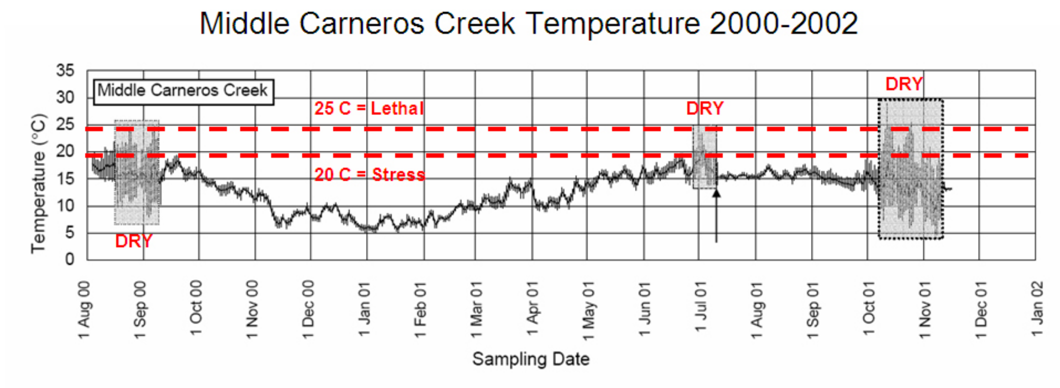


Figure 9. Middle Carneros Creek average, minimum and maximum daily water temperature indicates suitable conditions for salmonids but the reach also went dry intermittently. Chart adapted from Stillwater and Dietrich (2002).

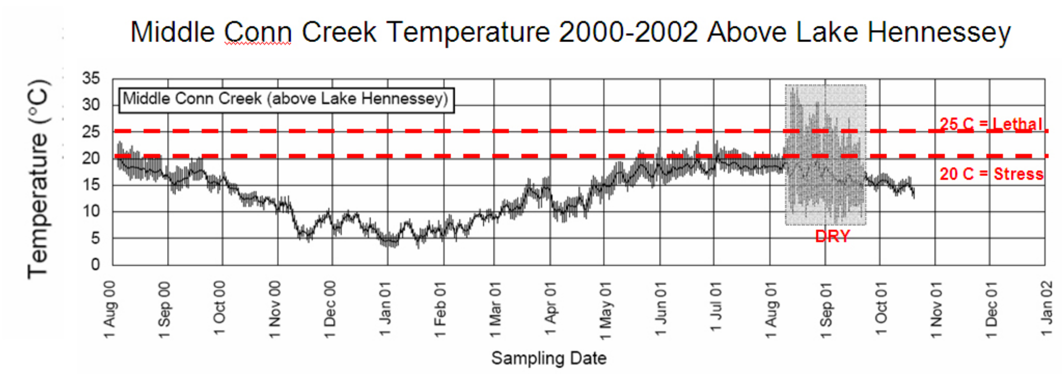


Figure 10. Middle Conn Creek average, minimum and maximum daily water temperature indicates suitable conditions for salmonids with the exception of brief exceedance of 20 C, but the reach also went dry from mid-August to late September 2001. Chart adapted from Stillwater and Dietrich (2002).

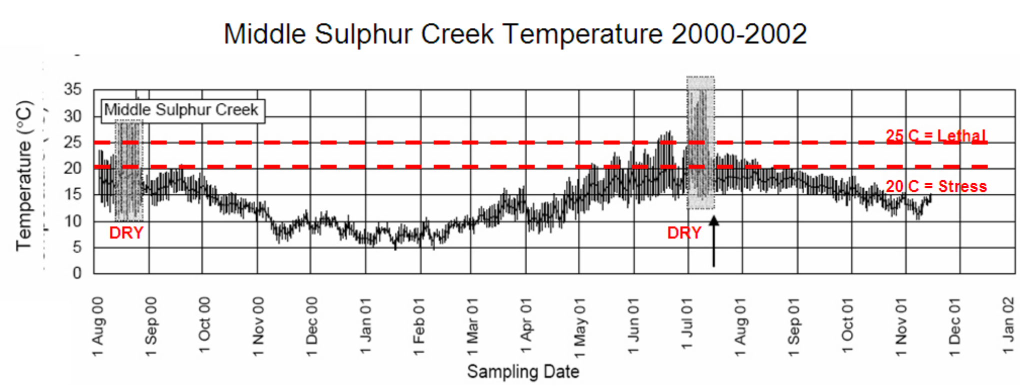


Figure 11. Middle Sulphur Creek average, minimum and maximum daily water temperature indicates periodically stressful conditions for steelhead and that the reach also went dry intermittently. Chart adapted from Stillwater and Dietrich (2002).

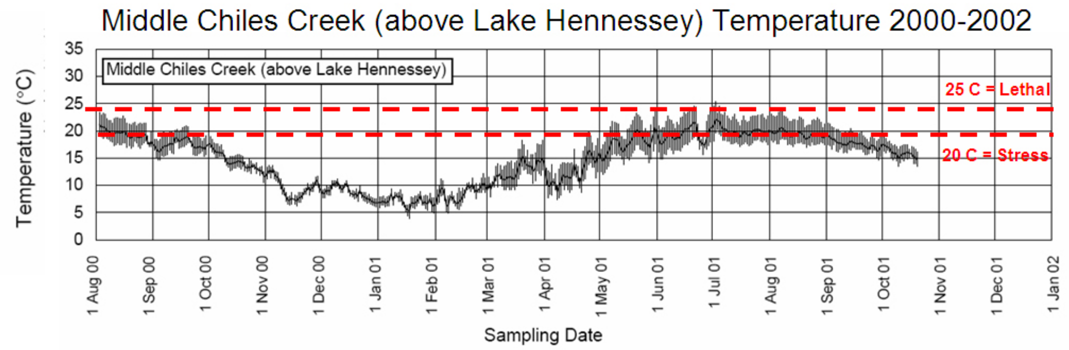


Figure 12. Middle Chiles Creek average, minimum and maximum daily water temperature indicates periodically stressful conditions for steelhead from May through September. Chart adapted from Stillwater and Dietrich (2002).

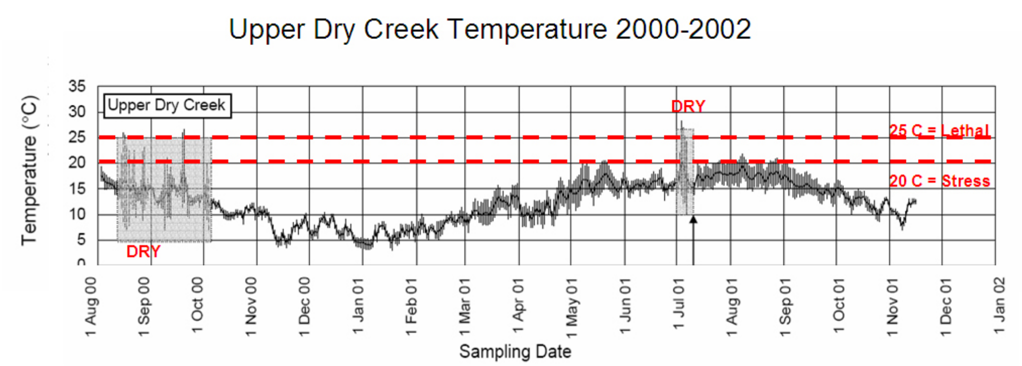


Figure 13. Upper Dry Creek average, minimum and maximum daily water temperature indicates suitable conditions for steelhead but extended periods when the stream went dry. Chart adapted from Stillwater and Dietrich (2002).

Causes of Flow Impairment

There is ample evidence of the cause of flow impairment in the Napa River and what follows is a brief discussion of causal mechanisms for reduced flows that demonstrate that listing causes should include flow alteration, pumping, hydromodification and diversion.

The North Coast Instream Flow Study (Stetson Engineers 2007) found hundreds of legal and illegal (286) diversions in the Napa River (Figure 14) and cumulatively they are dramatically impacting water available for steelhead. These are sources of impairment and suggest the need to list flow alteration and diversion as causes for impairment. Low level aerial images of the Napa River and Carneros Creek (Figures 15 and 16) show dozens of impoundments, but also highly confined stream reaches. Both are channelized, which disconnects both streams from their floodplains and cooling groundwater influence. This suggests that hydromodification needs to be considered as a cause of impairment as well.

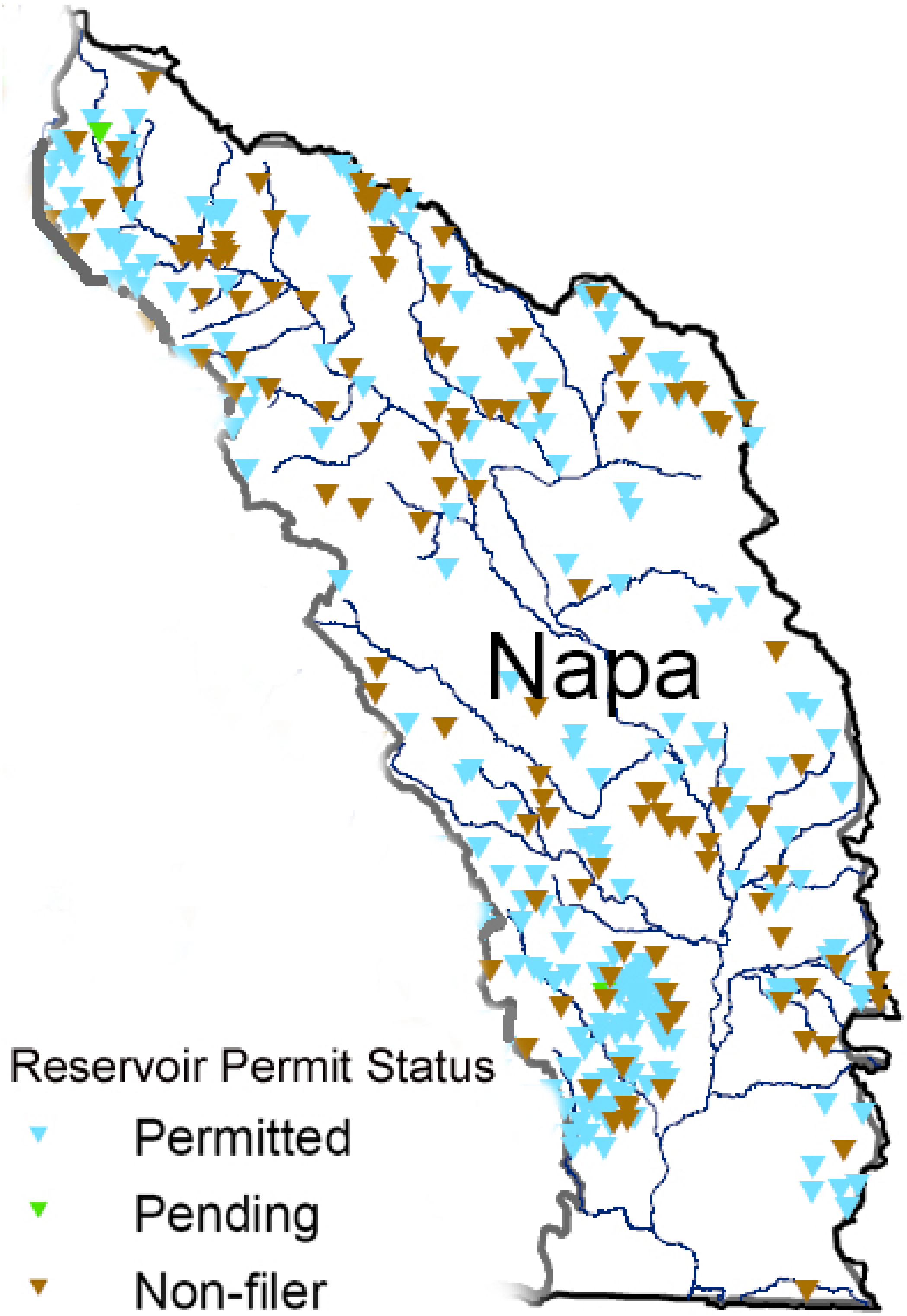


Figure 14. Napa River reservoirs as discerned using aerial photos by Stetson Engineers (2007) with assigned permit status, including a number of illegal diversions (non-filer).

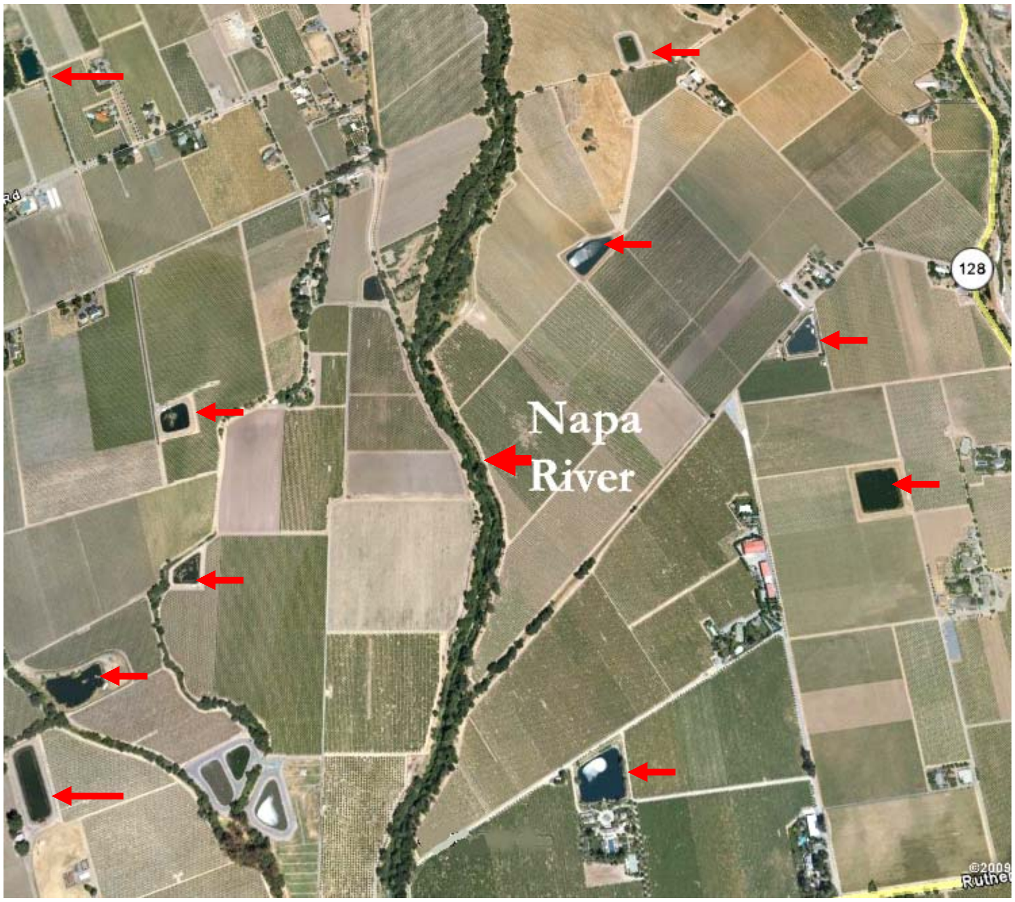


Figure 15. Napa River channelized and disconnected from its flood plain above Rutherford Rd. Note numerous impoundments (red arrows) and very narrow riparian zone. From Google Earth.

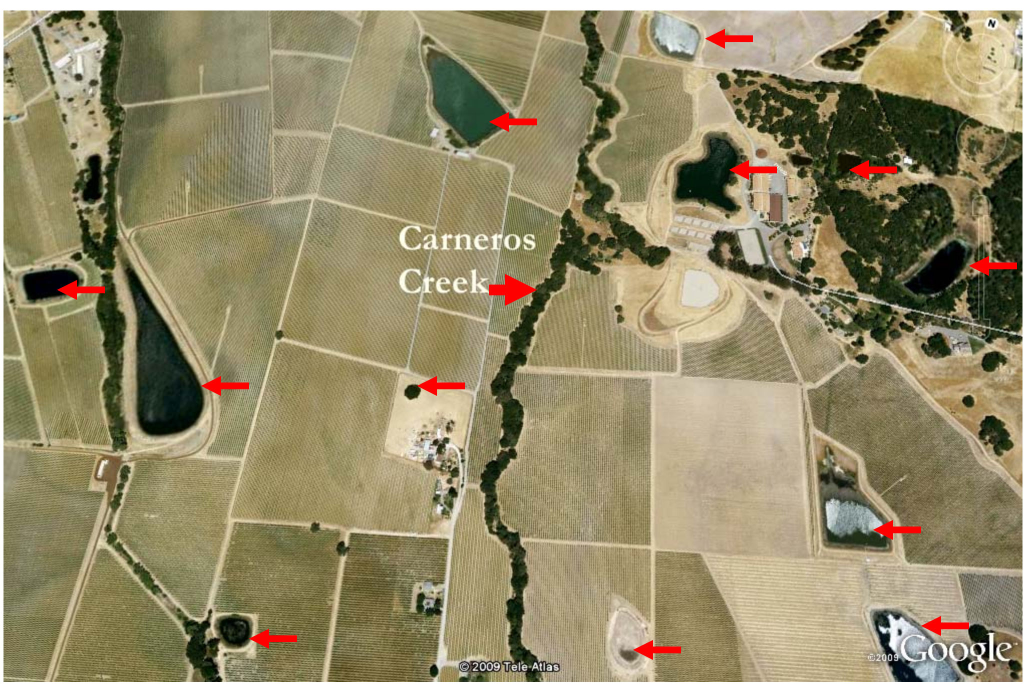


Figure 16. Carneros Creek with channel and riparian conditions similar to the mainstem Napa River. Note that a large number of impoundments (red arrows). From Google Earth.

The comments of hydrologist Dennis Jackson (2009) on the Napa TMDL have substantial bearing on groundwater and pumping issues and are included among the appendices attached. Jackson (2009) referenced groundwater papers by the U.S. Geologic Survey (USGS) (Faye 1973) to show that the Napa River lower mainstem was once a gaining stream. Cold water from tributaries and groundwater increased flows and at the same time moderated water temperatures. Faye (1973) simulated groundwater levels in the Napa Valley using a model and projected that when pumping exceeded 24,000 AF that there would be a reversal of flow from the river bed into the aquifer and that the Napa River would become a losing stream.

Jackson (2009) made the following case that what Faye (1973) projected has come to pass:

> "West Yost and Associates *Technical Memorandum 6* (2005) estimates that the groundwater extraction rate in 2005 was 24,856 acre-feet or 4.2 times the 1970 extraction rate. It is very likely that the current ground water extraction rate from the Napa Valley has increased since 2005. The Napa River was a gaining stream in 1972, meaning that groundwater flowed into the river from the water table. Faye's (1973) conclusions (1) and (2) and his simulation of pumping rates equal to four times the 1970 pumping rate show that groundwater extraction of more than 24,000 acre-feet has the potential to dry up portions of the Napa River during low rainfall years. The 2005 groundwater extraction rate of 24,856 acre-feet exceeded Faye's threshold of 24,000 acre-feet. Therefore, the current rate of groundwater extraction from the Napa Valley groundwater basin is likely contributing to dewatering portions of the mainstem of the Napa River in dry years. Steelhead trout, a federally listed species, are known to inhabit the mainstem of the Napa River so dewatering portions of the mainstem of the Napa River by groundwater pumping would be a very significant adverse impact."

Consequently, pumping should be listed as a cause of Napa River flow impairment on the California updated 2012 303d impaired waterbodies list.

Solution to Abatement of Temperature Problem Same as Shasta River

The National Academy of Science (NAS 2004) in a study of Klamath Basin endangered fishes determined that there was a direct connection between flow depletion and water temperature problems in the Shasta River and that flow augmentation was necessary to remediate the problem:

> "Low flows with long transit times typical of those now occurring in the summer on the Shasta River cause rapid equilibration of water with air temperatures, which produces water temperatures exceeding acute and chronic thresholds for salmonids well above the mouth of the river. Small increases in flow could reduce transit time substantially and thus increase the area of the river that maintains tolerable temperatures."

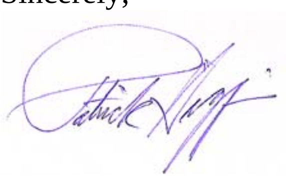
This is also an important part of the solution to temperature pollution abatement on the Napa River and its tributaries. If flows were sufficient to meet temperature tolerances of salmon and steelhead, then habitat would also expand and populations would rebound.

Conclusion

The SWRCB needs to recognize the Napa River as temperature and flow impaired on the California 2012 updated 303d list and should include all flow impairment categories for which there is precedent: flow alteration, hydromodification, pumping and diversion. The support for such action is clearly justified above and it is abundantly clear that Napa River water quality problems cannot be abated nor beneficial uses guaranteed under the Clean Water Act restored without increasing cold water flows.

Please fell free to call me, if you have questions.

Sincerely,



Patrick Higgins

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NAPA COUNTY FARM BUREAU
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January 14, 2014

Kevin Lunde
San Francisco Bay Regional Water Quality Control Board
1515 Clay St., Suite 1400
Oakland, CA 94612

RE: Support for proposal to delist portions of the Napa River & Sonoma Creek as impaired by nutrients

Dear Mr. Lunde,

Napa County Farm Bureau, a non-profit membership organization representing 878 farmers and ranchers in Napa County, offers support for the recommendation to delist the Napa River and Sonoma Creek as impaired by nutrients and appropriately revise the 303(d) list of impaired water bodies.

We have reviewed the staff report and research data and agree with the conclusion on page 4 of the staff report that states, "In sum, we conclude that water quality conditions in the Napa River and Sonoma Creek are meeting the narrative biostimulatory Water Quality Objectives with respect to nutrients and eutrophication. Staff's analysis has determined that these water bodies are supporting designated beneficial uses that could be affected by nutrients for which there are numeric evaluation guidelines. Therefore, we propose to delist the non-tidal portion of the Napa River main stem and Sonoma Creek main stem for impairment caused by nutrients."

We believe the Water Board was diligent and thorough in the research on the nutrient conditions which was conducted over a ten year process from 2002 to 2012. The staff report states that the review included 1) compiling all known existing data related to nutrients and algae growth in the watershed, 2) collection of additional data on benthic algae in a manner consistent with the State Water Board's nutrient numeric endpoint guidance (Tetra Tech 2006), 3) creation of eight lines of evidence to evaluate all relevant available data and 4) a proposal to refine the nature and scope of the beneficial use impairment in the Napa River based on the findings .

With our community's focus of responsible stewardship on our natural resources, we are heartened by the reduction in nuisance algae levels and we agree that this was most likely a cumulative effect of NPDES permit restrictions on wastewater discharges, changes in land use in the River's watershed over the past 30 years and improved agricultural best management practices (BMPs). As agriculturists, we remain committed to sustainable agriculture, operating our farms and ranches with a keen awareness of the critical importance impacts of our farming practices and an awareness of the critical importance of protecting water quality in the watersheds of our county.

Thank you for the opportunity to comment.

Sincerely,

Norma J. Tofanelli

Norma Tofanelli
President

Jim Lincoln
Natural Resources Committee Chairman

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Napa County Flood Control and Water Conservation District

PHILLIP M. MILLER, P.E.
DISTRICT ENGINEER

A Tradition of Stewardship
A Commitment to Service

CITY of NAPA

January 9, 2014

Kevin Lunde
San Francisco Bay Regional Water Quality Control Board
1600 Clay Street, Suite 1400
Oakland, CA 94612

Subject: Comment Letter – Proposed Revisions to the 303(d) list of Impaired Water Bodies in the San Francisco Bay Region, Napa River and Sonoma Creek Watersheds

Dear Mr. Lunde:

Thank you for the opportunity to comment on the proposal to remove freshwater portions of the Napa River and Sonoma Creek from the 303(d) list for nutrients.

We very much appreciate the work undertaken by staff of the Surface Water Ambient Monitoring Program (SWAMP) as well as staff of the San Francisco Estuary Institute over the last decade to collect and evaluate the copious amounts of data which led to the proposed de-listing.

We concur with the Waterboard's conclusion that the weight of evidence clearly demonstrates that Water Quality Objectives are being met and support the de-listing. More importantly, we are very pleased to know that all the beneficial uses which could be affected by nutrients are being supported within the Napa River and consider the de-

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www.napaflooddistrict.org

listing an important milestone that recognizes the success of our many water quality improvement efforts in Napa County.

Sincerely,

Phillip M. Miller, PE
District Engineer

Appendix D

Response To Comments

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Staff Response to Comment Letters on the Staff Report and the Proposed Delisting of the Napa River and Sonoma Creek for Nutrients

We received four comment letters during the December 16, 2013 to January 15, 2014, public comment period. The comments are summarized on the following pages, paraphrased for brevity, followed by staff's response. For the full content and context of each comment, refer to the comment letters.

Contents

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Comment Letter 1: Living Rivers Council and Chris Malan (Law Offices of Thomas N. Lippe)

Comment 1.1. Commenter states that the Water Board's consideration of a Resolution to modify the 303(d) list did not follow the environmental review procedures stated in California Environmental Quality Act (CEQA). Commenter states that the proposed revisions to the 303(d) list "…are discretionary decisions that will affect the physical environment, therefore, the Board must demonstrate compliance with CEQA before approving the proposed revisions."

Water Board staff has evaluated the delisting of portions of the Napa River and Sonoma Creek under CEQA. This delisting is not a "project" as defined in CEQA (Cal. Pub. Res. Code § 21065 and Cal. Code Regs., tit. 14, § 15378). Approval of the tentative resolution will not cause either a direct or reasonably foreseeable indirect physical change in the environment (Cal. Pub. Res. Code § 21065). "Where it can be seen with certainty that there is no possibility that the activity in question may have a significant effect on the environment, the activity is not subject to CEQA" (Cal. Code Regs., tit. 14, § 15061). In this case, the proposed delisting for nutrients will not alter any other listings in these water bodies, nor will it revoke any permits or other agreements requiring ameliorative actions or otherwise result in any physical changes to the environment. The Commenter did not identify any potential impacts to the environment. In response to this comment, we have revised the tentative resolution to insert the following finding 11:

The Water Board's approval of recommended modifications to California's Clean Water Act Section 303(d) List, and submittal to the State Water Resources Control Board for its consideration for approval, is not a "project" as defined in the California Environmental Quality Act (CEQA) (Pub. Res. Code § 21065) and the CEQA Guidelines (Cal. Code Regs., tit. 14, § 15378). The Water Board's approval of the recommended 303(d) list modifications is not an "activity which may cause either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment." (Pub. Res. Code § 21065.)

Comment Letter 2: Living Rivers Council and Chris Malan (Patrick Higgins)

Executive Summary

Comment 2.1. Data provided by Water Board staff and other data available on the Water Board's web site show signs of impairment consistent with nuisance algae blooms and nutrient pollution. Lack of high levels of phosphorus and nitrogen does not mean the Napa River and Sonoma Creek are not impaired.

We disagree that the Napa River (River) and Sonoma Creek (Creek) are impaired by nutrients. Please see the Staff Report and responses to Comments 2.2 through 2.32.

Comment 2.2. Phosphorus levels in the Napa River and Sonoma Creek are at levels that can cause nuisance algae blooms.

Impairment by eutrophication is caused by the interaction of a combination of environmental factors. Nuisance algae levels occur because of nutrient (nitrogen and phosphorus) concentrations interacting with environmental conditions such as sunlight, riparian shade, stream temperature, and stream velocity (Staff Report Section 2.1). Potential excessive nutrients or nutrient pollution is evaluated by assessing by both primary algal biomass indicators and secondary eutrophication indicators (e.g., pH and dissolved oxygen) while considering relevant environmental conditions. Not all algae growth or blooms will result in eutrophic conditions. Focusing on a single nutrient component, such as phosphorus, is not an effective way to determine impairment by eutrophication since a single nutrient does not result in eutrophic conditions. Therefore, the Staff Report focused primarily on algal biomass endpoints such as benthic chlorophyll *a* and percent macroalgae cover (comprised mostly of the filamentous algae *Cladophora*). Additionally, the Staff Report considered secondary indicators of eutrophic conditions such as pH and dissolved oxygen, which can be used to determine if current algal biomass is resulting in water quality conditions that are harmful to fish or wildlife.

We agree that phosphorus has been observed at some sampling locations at levels that could contribute to a nuisance algae bloom. However, the River and Creek are not nutrient impaired because they are limited by the availability of nitrogen. The delisting dataset for the River and Creek demonstrates that these water bodies are generally nitrogen-limited according to the Redfield Ratio, which is the proportion of nitrogen to phosphorous necessary for plant growth (Sterner and Elser 2002). The Redfield Ratio is the molar proportion of nitrogen to phosphorous, 16:1.When a water body is nitrogen-limited, additional phosphorus will not contribute to additional algae growth. A simplified example of this is making ham sandwiches and having someone supply extra ham (phosphorus), but only enough bread (nitrogen) for 10 sandwiches. Even though there is plenty of ham, no more than 10 complete sandwiches can be made.

Comment 2.3. The Staff Report states that chlorophyll *a* data suggest a lack of impairment. However, benthic chlorophyll *a* levels at some sites (N-09, N-55, S-06, S-13, and S-36) are indicative of nuisance algae blooms.

Staff disagrees that observed benthic chlorophyll *a* levels indicate the River and Creek are impaired by nutrients. The Water Board used a weight-of-evidence approach to assess eutrophication from nutrients for these listings and developed 8 lines of evidence based on primary and secondary indicators of eutrophication, including the algal biomass indicator benthic chlorophyll *a*. This approach was consistent with the State Water Board's Listing Policy's weight-of-evidence approach.

Additionally, the Listing Policy's approach is to assess water bodies as a unit. For example, data from all sample locations in the River's main stem and tributaries were considered when evaluating the number of exceedances for toxicants and weight-of-evidence for algal biomass indicators. The Staff Report also considered spatial and temporal variations to the data as mentioned in sections 3.3.3. and 3.3.4.

Of the 34 chlorophyll *a* samples collected across the River and Creek in 2011 and 2012, we observed only three exceedances were above the identified benchmark of 150 mg/m^2. The 150 mg/m^2 threshold is considered protective of the COLD beneficial use (Tetra Tech 2006). The observed chlorophyll *a* levels at site S-06 were 108 & 37 mg/m^2 , and those at S-13 were 110 & 71 mg/m^2, all levels below the threshold of 150 mg/m^2. While levels at three other sites had some observations above the threshold (i.e., 162 and 41 mg/m^2 at N-09, 161 mg/m^2 at N-55, and 259 and 27 mg/m^2 at S-36), we found these should not lead to a finding of impairment for the following reasons. No sites showed a consistent exceedance across both years for chlorophyll *a* and observed exceedances at N-09 and S-36 were close to the 150 mg/m2 guidance threshold. For N-09 in both 2011 and 2012, secondary indicators (e.g., dissolved oxygen and pH) showed that the COLD beneficial use was not affected by algae blooms (see responses to Comments 2.26 and 2.27). For N-55, observed percent macroalgae cover was low, and the chlorophyll *a* level appeared related to a combination of very low late summer flow and the temporary removal of shade by a river restoration project. For S-36, secondary indicators (e.g., pH, dissolved oxygen) did not show signs of eutrophic conditions (see responses to Comments 2.26 and 2.27).

Comment 2.4. The overall significance of chlorophyll *a* data was difficult to judge because the Staff Report did not include a description of shade conditions for each monitoring station that might suppress algal growth.

The Staff Report states that most portions of the River and Creek are well-shaded, so current levels of shade are important for preventing algae blooms (Sections 3.6 and 4.6). Further, shade conditions can be found in Tables 7 and 14 for sites with levels of chlorophyll *a* above 150 mg/m^2—that is, for those sites with potentially impairing levels of chlorophyll *a*. The average shade in the study was 71% on the River and 79% on the Creek, reported in Sections 3.5 and 4.5 of the Staff Report, respectively. In response to the Commenter's interest in the data, shade data for individual monitoring sites were added to the Revised Staff Report in Appendix A.

Comment 2.5. Continuous datasets show dissolved oxygen levels that do not support steelhead trout and COLD beneficial uses at several sites in the River and Creek (N-09, N-55, and S-36) and are not consistent with delisting.

Please refer to the responses to Comments 2.3 and 2.27.

Comment 2.6. Data show lethal or near-lethal levels for steelhead of dissolved ammonia at two locations (N-30 and N-25), which clearly is not supporting COLD nor is supportive of the proposed delisting.

Please refer to the response to Comment 2.20.

Comment 2.7. Commenter cites a study that found a number of Napa River tributaries lost flow seasonally and that a number of stream segments were becoming stagnant and incapable of supporting steelhead juveniles. Commenter states the Staff Report does not cite that study, and states the report identifies streams as intermittent when they were historically perennial.

The Commenter submitted data to the State Water Board on behalf of the Living Rivers Council as part of the 2012 listing cycle regarding potential flow impairment in the River. That data is currently in the review process for the next updated 303(d) listing of impaired water bodies. However, the Listing Policy is water body- and pollutant-specific. Thus, the proposed delisting for nutrient impairment is separate from the Commenter's request to consider listing the River for flow impairment. We will review the data submitted by the Commenter as part of the next listing cycle. See also our response to Comment 2.9 (below).

The Staff Report refers to streams that lack year round flow as non-perennial. The report does not speculate regarding whether the observed flow occurs because of natural conditions or because of water withdrawals.

Please refer to the response to Comments 2.11 and 2.28, which also refer to flows.

Comment 2.8. Commenter states that the Staff Report does not "fully disclose flow conditions in tributaries where monitoring occurs."

Water Board staff collected instantaneous flow data in 2011 and 2012 and stated the mean values and ranges of those data in the Staff Report (Sections 3.4 and 4.4). Because the Staff Report did not specifically analyze flow as a line of evidence, individual site data were not listed. In response to the Commenter's interest in the data, flow data for individual monitoring sites were added to the Revised Staff Report in Appendix A.

Comment 2.9. Substantial reaches of the Napa River and Sonoma Creek were not monitored.

Staff believes that the data appropriately characterize conditions in the River and Creek consistent with the Listing Policy. The study includes over 38 sample locations in the River and

23 in the Creek over a 10-year time frame. The study meets the Spatial (Section 6.1.5.2) and Temporal (Section 6.1.5.3) Representation Requirements in the Listing Policy as stated in Sections 3.3.3, 3.3.4, 4.3.3, and 4.3.4 of the Staff Report. There is no evidence that simply sampling more data points would result in observing a significantly higher proportion of exceedances for algae or nutrients. Our obligation under the Listing Policy is to evaluate conditions based on the readily available data (Listing Policy 6.1.1). The 2004 data collection undertaken by the San Francisco Estuary Institute (SFEI), which was part of the overall dataset reviewed, was also focused on hotspot areas most likely to be problematic, so this comprehensive dataset even included sample locations where the Water Board was likely to find nutrient-related issues, if present. However, no exceedances for ammonia, nitrate, or nitrite were identified in the 2004 data.

Comment 2.10. Commenter disagrees that nutrient inputs are generally lower in the summer. Nutrients could have discharged to unmonitored reaches of the River and Creek via groundwater and could be causing nutrient impairment in those unmonitored reaches.

Staff disagrees. The data collected by SFEI across multiple seasons in 2002-2004 support the conclusion that nutrient inputs are higher during the wet season, and this is discussed specifically in SFEI 2005 (p.16). In that analysis, nitrate and nitrite were the highest in winter and decreased as flows decreased in spring and summer. See also our response to Comment 2.9.

Comment 2.11. The Staff Report states that there are no Napa River flow trends in recent decades, but the Commenter identified a decreasing trend for one type of flow analysis. Declining flows increase the potential for nutrient pollution.

Please refer to the broad discussion on flow in the response to Comment 2.28.

Declining flows, if actually occurring in this watershed, would have the potential to increase nutrient concentrations or alter environmental conditions that facilitate algae growth (e.g., stream temperature, stream velocity). However, algal biomass data collected in 2011 and 2012 reflect current flows, and the weight-of-evidence analysis of water quality data in the River and Creek showed a lack of algal biomass indicative of excessive nutrients (Comments 2.13-2.15).

For a discussion on assessing nutrient pollution, please see the response to Comment 2.2.

Review of Justification Data and Arguments

Comment 2.12. Not all lines of evidence [were] reviewed…because only some were inconsistent with delisting.

Staff disagrees that that any lines of evidence are inconsistent with delisting as discussed elsewhere in the Staff Report and this response to comments. The following sections 2.13 through 2.29 address each of the Commenter’s specific comments regarding specific data sets.

Chlorophyll Data

Comment 2.13. Commenter states that they only addressed benthic chlorophyll in their comments and not water column chlorophyll because water column chlorophyll *a* is more appropriate for measuring photosynthetic activity in lakes.

As the Commenter notes, water column chlorophyll *a* is an indicator of lake productivity, and, while we would not use this indicator as the sole line of evidence for wadeable streams, it is also used to evaluate stream productivity (Central Coast Water Board 2010). Because previous water quality assessments in streams examined this analyte, we evaluated the available data as a line of evidence of potential nutrient impairment. We found it did not indicate nutrient impairment in the River or Creek.

Comment 2.14. The Staff Report uses 150 mg/m^2 of benthic chlorophyll *a* as an indicator of impairment by nutrients. However, Horner et al. (1983) found that a level of 100 mg/m^2 could compromise beneficial uses of Pacific coastal streams.

Water Board staff arrived at the decision to use the 150 mg/m^2 benchmark after careful deliberation. Tetra Tech, supported by U.S. EPA, published a report summarizing multiple chlorophyll *a* benchmarks, including the paper by Horner et al. (1983). Tetra Tech summarized results from Horner et al. (1983) that 100-150 mg/m^2 could affect recreational and aesthetic beneficial uses. Benchmarks used by other researchers varied between 100 and 150 mg/m^2 (Tetra Tech 2006). Additionally, we considered the benthic chlorophyll *a* dataset collected by SWAMP from minimally-impacted reference streams in 2008-2010, which contained observations as high as 169 mg/m^2 under minimally-impacted reference conditions (Water Board 2012) as discussed in the Staff Report (pp. 12, 28, and 45). We decided an appropriate balance between Type I error (declaring streams as impaired when they are truly not) and Type II error (not finding a stream as impaired when it truly is) would be to use the evaluation guideline stated by Tetra Tech as the threshold between Beneficial Use Risk Category II/III boundary, which represents a threshold above which the risk of beneficial use impairment by nutrients is probable (Tetra Tech 2006).

Comment 2.15. "The fact that stations at key locations on the main branches of both water bodies [showed] nuisance levels of algae in both 2011 and 2012 is not consistent with delisting them for nutrient pollution."

Staff disagrees that the observed levels of algae demonstrate the River and Creek are impaired by nutrients. As noted in comments 2.3 and 2.18, for the few instances where the algal biomass guidance threshold was exceeded for one indicator (e.g., chlorophyll *a*), the second algal biomass indicator (percent macroalgae cover) did not show an exceedance nor did secondary indicators (e.g., pH and dissolved oxygen) show signs of eutrophication. This finding is consistent with the Listing Policy's weight-of-evidence approach.

Comment 2.16. "[D]issolved oxygen levels are consistent with nutrient pollution and impairment."

Please see response to Comment 2.27.

Comment 2.17. “No problems with algae blooms or high levels of chlorophyll *a* occur in shaded locations.” Since the Staff Report gives no indication of shade at specific monitoring sites, there is no way for the reader to discern whether the low chlorophyll *a* results are low simply because most monitoring sites were shaded. “Similar questions and analytical problems exist for Sonoma Creek chlorophyll *a* data.” Impairment at sites N-55 and N-09 suggests that sites between the two stations may have similar problems.

Please see the responses to Comments 2.3 and 2.4. In response to the Commenter’s interest in the data, shade data for individual monitoring sites were added to the Revised Staff Report in Appendix A.

Percent Substrate Cover by Algae

Comment 2.18. Sites that exceeded 100-150 mg/m^2 benthic chlorophyll *a* also had levels of benthic macroalgae cover near or above 30% macroalgae cover. Algae cover at N-09 indicates high dry season nutrient availability. Results at N-09, S-36, S-06, and N-32, as well as N-55 (due to DO levels) are consistent with nutrient impairment.

Staff disagrees that percent macroalgae cover results are consistent with nutrient impairment. The estimate of stream bottom cover is one primary indicator of impairment, which should be supported by additional primary and secondary eutrophication indicators. We concur that, with some significant exceptions, sites with higher observed benthic chlorophyll *a* also had higher levels of benthic macroalgae cover. The 100-200 mg/m^2 range of chlorophyll *a* guidance thresholds is expected to correlate roughly to an estimated 30% stream bottom cover by benthic algae (Tetra Tech 2006). However, sites N-32, S-36, and S-06 all had less than 30% macroalgae cover. This is below the level indicating impairment based on this indicator. While observed values were close to 30%, the exercise of evaluating exceedances is based on the actual indicators. Further, although percent macroalgae cover was correlated with chlorophyll *a* (r=0.45), an exceedance of the chlorophyll *a* indicator was only associated with a simultaneous exceedance of percent macroalgae cover in one of three samples in Napa and in no samples in Sonoma (Tables 7 and 14 in the Staff Report).

We agree with Commenter’s statement that results at N-55 showed strong disagreement between the chlorophyll *a* and percent macroalgae cover indicators. However, we disagree that dissolved oxygen data show impairment related to nutrients (please refer to responses to dissolved oxygen in Comment 2.27).

Nutrient Criteria

Comment 2.19. Commenter claims dissolved phosphorus is not likely limiting algae blooms and aquatic plant growth in either basin, but that phosphorus levels reported are higher than those needed to stimulate nuisance algae blooms at most stations in both basins. Referencing a value of 20 µg/L (Welch et al. 1998) for soluble reactive phosphorus (SRP), the Commenter states that 79% of the sites exceeded this level indicating phosphorus is not limiting algae blooms.

Staff concurs with the Commenter that the River and Creek are not phosphorus-limited. As stated in Comment 2.2, eutrophic conditions are not defined by the concentrations of a single nutrient, but are assessed by looking at multiple primary and secondary eutrophication indicators. Staff does not support the use of the 20 ug/L threshold for SRP (called orthophosphate in the Staff Report) put forward by the Commenter for two reasons. The Staff Report highlighted a potential nutrient-based benchmark proposed by U.S. EPA for total phosphorus at 0.518 mg/L (Section 2.4, p.10) but rejected its applicability as a line of evidence because of the high proportion of exceedances found within the regional SWAMP reference data, indicating that unimpaired streams in the San Francisco Bay Region could exhibit levels of phosphorus higher than the proposed U.S. EPA benchmarks (Water Board 2012). The SWAMP reference stream dataset developed from monitoring 6 sites intensively over 3 years has 47 orthophosphate values, of which 38 (81%) were greater than the 20 µg/l (0.02 mg/L) threshold the Commenter draws from Welch et al. (1983). This indicates that data from streams in the Pacific Northwest may not be appropriate to apply to streams in this Region. Rather, local reference data from within this Region are more appropriate to evaluate nutrient benchmarks than data from Pacific Northwest streams (i.e., northern California, Oregon, and Washington) found in Welch et al. (1998). For these reasons, the Staff Report did not use total phosphorus or orthophosphate as individual lines of evidence. Still, observed values for these analytes were reported in Tables 10 and 17 in the Staff Report, and supplied in the public dataset, because they can be used in multivariate models such as the algae predictor tool developed by Tetra Tech (2006).

Dissolved Ammonia

Comment 2.20. Three data points out of 206 are near or above a dissolved ammonia threshold of 0.025 mg/L. A 0.022 mg/L level of un-ionized ammonia is "nearly lethal" to fish. "…[I]t is likely that even higher concentrations occurred on un-sampled dates. Therefore, these [two] sites manifest highly stressful or lethal conditions for salmonids and data are not consistent with delisting."

Staff disagrees that un-ionized ammonia data show exceedances of the ammonia objective indicating impairment. The San Francisco Bay Basin Water Quality Control Plan (Basin Plan) water quality objective for un-ionized ammonia is 0.025 mg/L. The objective, however, is calculated as an annual median of all data collected within the water body (e.g., all samples in the River in 2003) and is not calculated for every individual sample, as noted in Tables 2, 6, and 13 in the Staff Report. Annualized median results for un-ionized ammonia ranged from 0.000 to 0.002 mg/L for all years of the study in both watersheds, far below the 0.025 mg/L objective. Additionally, all 206 individual ammonia measurements, including the samples identified by the Commenter with high un-ionized ammonia levels, such as site N-30 (0.026, 0.024 mg/L) and N-25 (0.022 mg/L), were below the recently-published U.S. EPA criteria for both acute and chronic conditions (2013). These criteria are expressed as total ammonia thresholds based on pH and temperature associated with the total ammonia sample, which is the same information used to calculate un-ionized ammonia—the toxic form of ammonia. As specified in the Staff Report, total ammonia thresholds ranged from 0.1 to 2.8 mg/L (Tables 6 and 13). Therefore, the Commenter's proposed toxicity threshold of 0.022 mg/L un-ionized ammonia for salmonids does not correlate with the 2013 U.S. EPA ammonia criteria, which specifically considered that taxonomic group as well as other more-sensitive organisms. As noted in the Staff Report, there were no observed exceedances of the annual median un-ionized ammonia water quality objective, nor were there any exceedances of the U.S. EPA chronic or acute criteria for total ammonia.

pH

Comment 2.21. Commenter states that the continuous monitoring data from 2011 and 2012 "…show only modest indications of photosynthetic activity."

Staff agrees. In total, over 99.9% of these pH values were within the Basin Plan water quality objective of 6.5 - 8.5. Site N-32 (2012) showed 9 exceedances above 8.5 out of 1463 readings (<1%), and S-36 (2012) showed 2 exceedances above 8.5 out of 5688 readings (<0.1%). This number of exceedances is well below Listing Policy criteria in Table 4.1 that would indicate impairment due to pH.

Comment 2.22. Commenter states that "companion D.O. data for N-09, N-55, S-36, N-32 and S-05 show depressions indicating algal bloom activity and nocturnal respiration or high biological oxygen demand."

We disagree that dissolved oxygen data show eutrophication impairment related to excessive nutrients. Please refer to our response to Comment 2.27 regarding dissolved oxygen.

Comment 2.23. Commenter states that data collected in 2003 by the San Francisco Estuary Institute on the Napa River and Sonoma Creek showed elevated pH values consistent with eutrophic conditions that are stressful or lethal to salmonids.

The data reported by SFEI are unreliable and were noted as such in the dataset posted with the public notice. This information was also clarified in Sections 3.3.1 and 4.3.1 in the Staff Report. SFEI did not produce a pH Sampling and Analysis Plan or Quality Assurance Project Plan that could confirm the reliability of the equipment used, pH standards, number of points used for calibration, adequate frequencies for pre- and post-measurement calibrations, and established measurement quality objectives for drift. For these reasons, we determined these data to be unusable for the pH line of evidence analysis. Only pH data collected by this Region's SWAMP staff in 2011 and 2012 according to the SWAMP QAPrP (2008) were considered to be of suitable data quality and included in pH analysis. We note, further, that the recently-collected data, as noted in the Staff Report and our response to Comment 2.21, do not indicate impairment.

Comment 2.24. The Commenter states that the dataset contains "just one hand held 2011-2012 pH value except for the seven sites where continuous recorders were deployed in those years."

Staff disagrees. The dataset contained 27 handheld pH measurements from the River and another 27 from the Creek collected between 2011 and 2012, as noted in Tables 6 and 13 in the Staff Report. The handheld pH data have good spatial and temporal ranges, as outlined in our response to Comment 2.9. Of these 54 combined samples, none exceeded the Basin Plan water quality objectives. Additionally, continuous monitoring pH and dissolved oxygen data were collected from a total of seven locations, at sites we expected to have higher algal biomass than other sites. Continuous monitoring occurred at four locations in both 2011 and 2012. Three additional locations were monitored for one year, in either 2011 or 2012. This resulted in 11 continuous monitoring datasets. The datasets focused on the areas where high algae levels, if present, would have resulted in pH and dissolved oxygen patterns indicative of eutrophic conditions. However, such patterns were not observed. Please see responses to Comments 2.26 and 2.27 for a detailed discussion of the continuous monitoring data.

Comment 2.25. Commenter presents a case for pH values above 8.5 being harmful to salmonids.

This value is in agreement with the Basin Plan's maximum pH water quality objective of 8.5, which was not exceeded in the 2011-12 data in any of the 54 point measurements and was only exceeded a small <0.1% of the time at sites with continuous monitoring data.

Comment 2.26. "Seven locations on Sonoma Creek had pH greater than 9.5 according to SFEI data and only three sites were under 8.5. On the Napa River, only 17 readings of 60 in 2003 were under 8.5. Spot readings in 2011-2012 are not useful for judging diel swings of pH symptomatic of nuisance[.] Therefore, pH data are insufficient for understanding nutrient pollution and do not justify delisting."

Please see response to Comment 2.23.

The pH data contribute to an understanding of nutrient pollution. While we would not rely solely on pH data for assessing impairment, it is appropriate that they be used as part of the evidence in a weight-of-evidence approach to consider delisting. Spot readings, of which we collected 54 samples, are useful in identifying potentially high pH levels, particularly as they were collected during daylight hours, when pH maxima would be expected to be reached (Water Board 2012, raw data). For example, the short-term high of pH 8.0-8.6 range at site S-19 occurred in the early morning and late morning, which is when SWAMP staff collected most spot measurements from sites in 2011 and 2012. Also, 11 continuous monitoring deployments occurred in the River and Creek over 2011-12. In eutrophic waters, the data would be expected to show strong daily variation in pH with peaks potentially exceeding the Basin Plan maximum objective of 8.5. However, the data do not exceed that threshold, as demonstrated in Commenter's Table 2, "[m]aximum and minimum annual pH data from probes deployed by SFBRWQC[B] in 2011 and 2012 in Sonoma Creek and the Napa River." The amount of grab and continuous monitoring data are enough to show that pH is meeting current water quality objectives under a weight-of-evidence approach.

Figure 1, below, shows the pH data from the site in the Creek with the highest chlorophyll *a* readings. The small amount of daily variation in pH (0.5 units) was within the daily range of variation observed in regional reference sites (Water Board 2012, raw data). According to Nimick et al. (2011), the amplitudes of diel pH cycles in streams are typically are less than 1 pH unit, whereas during summer low-flow conditions in eutrophic streams, daily fluctuations can be as high as 2 pH units.

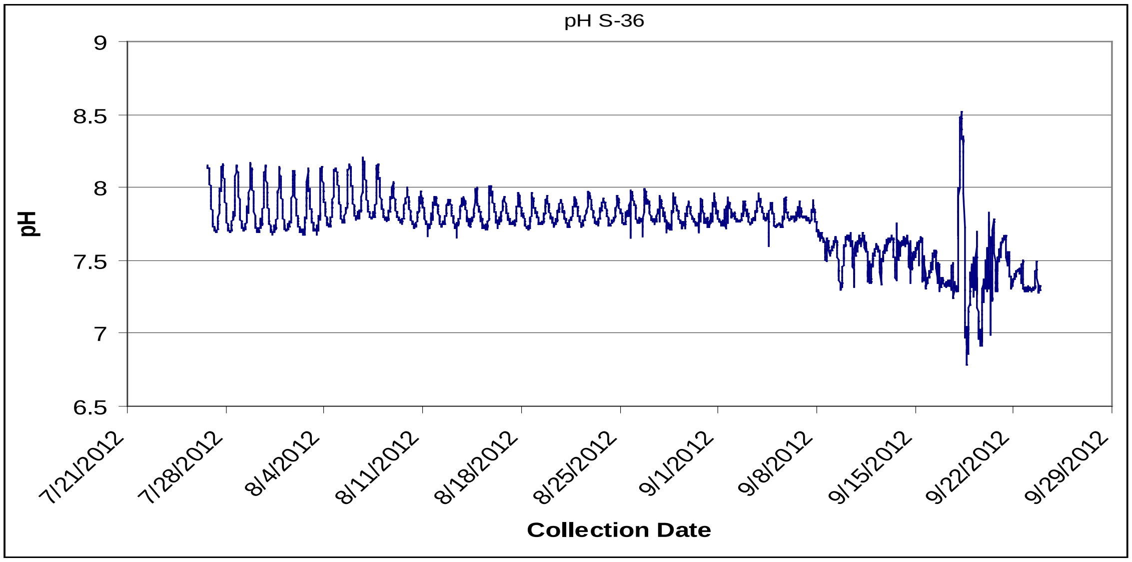

Figure 1. Site S-36 pH data, the only site in Sonoma Creek with chlorophyll *a* above 150 mg/m^2.

Dissolved Oxygen

Comment 2.27. Commenter states that many aquatic species in the River and Creek require high levels of dissolved oxygen, with stress occurring for juvenile steelhead trout at DO levels below 7 mg/L and death at DO levels below 3 mg/L. Commenter states that 2011 and 2012 data show "conditions limiting for salmonids" and "show that critically low DO levels were also accompanied by saturation levels that fell below 50% in some cases."

Staff concurs that continuous observations of dissolved oxygen included observations of dissolved oxygen below Basin Plan objectives. However, we disagree that dissolved oxygen data show signs of eutrophication (i.e., that dissolved oxygen data is likely a result of nutrient impairment). Severe eutrophication would be evidenced by large daily swings in dissolved oxygen levels. For example, observed dissolved oxygen levels in Arroyo Las Positas, a stream in the San Francisco Bay Region that was listed for nutrient-related eutrophication in 2010, ranged daily from 5 mg/l to 30 mg/L and up to 395% saturation (http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/00671.shtml#7578). Those conditions were not observed in the River or Creek.

Mild supersaturation of dissolved oxygen is expected in streams under natural conditions in the summer, when non-nuisance levels of algae produce oxygen in the day and respire at night (Nimick et al. 2011). However, the process of identifying nutrient impairment requires us to determine when these daily variations become too extreme. The Central Coast Regional Water Quality Control Board developed a benchmark for dissolved oxygen supersaturation of 13 mg/L (Water Board 2010). This concentration was never reached in any of the 11 samples of continuous monitoring data from both water bodies, as noted by the Commenter in Table 1, "Minimum and maximum values for DO from various Sonoma Creek and Napa River sites for 2011 and 2012 derived from data recorders."

The dissolved oxygen lows recorded at sites S-36, N-09, and N-55, as noted in Commenter's Table 1, were below the Basin Plan objective for dissolved oxygen. However, the daily pattern of changes in oxygen does not support eutrophication as the cause, as explained below. We note that 2012 was a very dry year, and flows in 2012 were correspondingly low, likely contributing to the observed low dissolved oxygen levels then, which were not observed at the same sites in 2011. In fact, two sections of the River's main stem that we intended to sample dried out in 2012.

At site S-36, the mean dissolved oxygen was 6.4 and generally ranged from 5 to 10 mg/L for 80% of the observation period (Figure 2). After September 9, 2012, nighttime oxygen levels started to dip below 5 mg/L.

At site N-55, the River was deep and wide (1-2 m depth by 9 m width) with very little flow (< 1 cubic feet per second), as described in the Staff Report. Dissolved oxygen levels were generally between 1 and 4.5 mg/L, with low readings often observed around midnight (Figure 3). The sonde at this site was tied to a root wad at the bottom of the stream.

At these two sites, available data are insufficient to determine the cause of low dissolved oxygen conditions. However, they are not indicative of eutrophic conditions because the amount of daily variation was within ranges observed in non-eutrophic reference streams monitored by the Water Board (Water Board 2012, raw data).

At site N-09 in 2012, dissolved oxygen data averaged 6.68 mg/L, and generally ranged from 5-10 mg/L, with some extreme low values observed around 7-10 PM. The daily fluctuations of about 4-5 mg/L are occurring because of daily cycles in photosynthesis and algae respiration (Nimick et al. 2011). This amount of daily variation was within ranges observed in non-eutrophic reference streams monitored by the Water Board (Water Board 2012, raw data). As noted above, they are not at levels exemplary of eutrophic conditions.

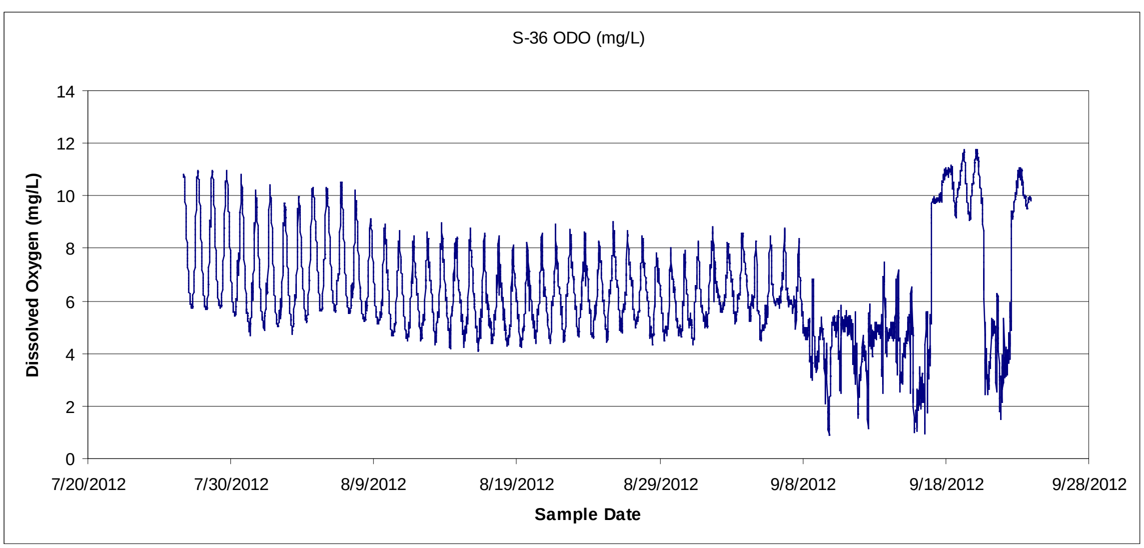

Figure 2. Dissolved oxygen data from site S-36, the only site in Sonoma with chlorophyll *a* above 150 mg/m^2.

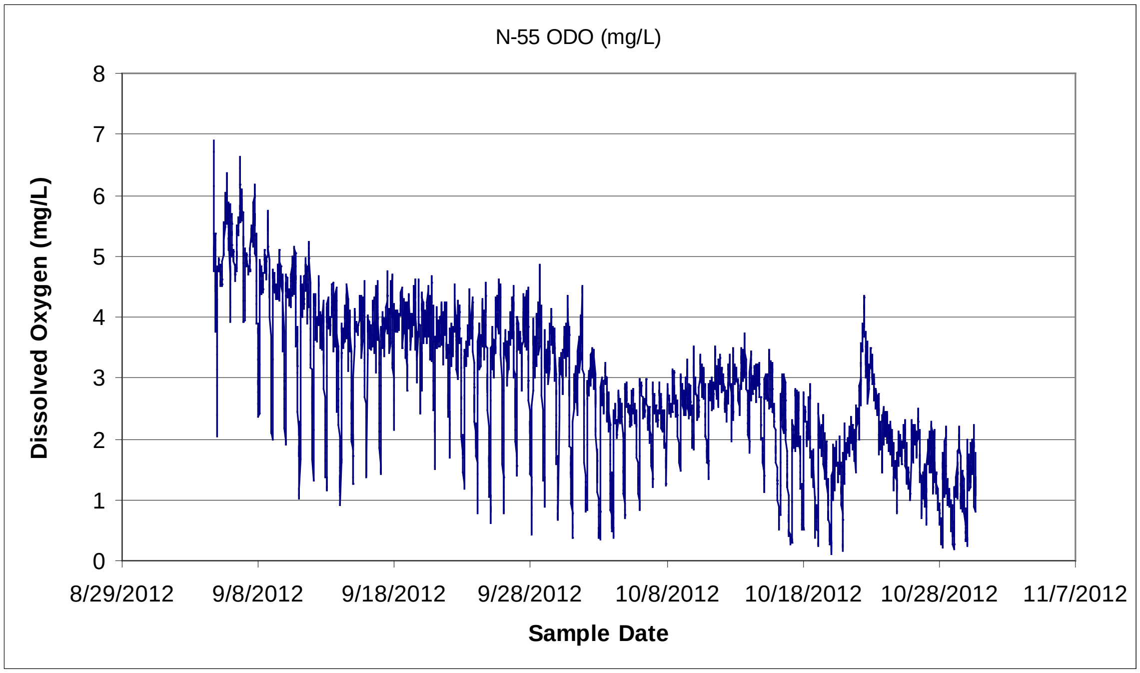

Figure 3. Dissolved oxygen data from site N-55, the one site in the Napa River with chlorophyll *a* greater than 150 mg/m^2 in 2012.

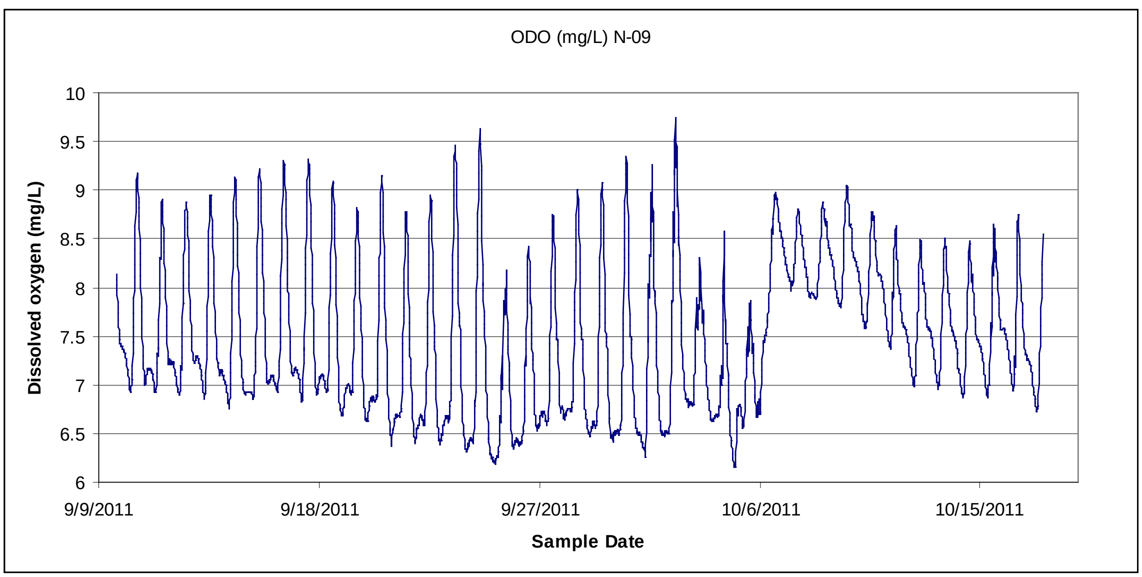

Figure 4. Dissolved oxygen data from site N-09 in 2011, the year high chlorophyll *a* (>150 mg/m^2) was recorded. The increase around October 7 closely follows a one inch rain event during October 4-5, 2011.

Flow Trends

Comment 2.28. Commenter includes approximately 5 pages of comments making an analysis of flow and assessing water withdrawals in this Region, stating, in part, that lack of flow and resulting conditions in the Napa River are causing conditions limiting juvenile steelhead production.

Comment noted. The proposed delisting is for the existing impairment listing for nutrients in the River and Creek. The Commenter separately submitted information to the State Water Board requesting that the River be listed as flow- and temperature-impaired on the 303(d) list of impaired water bodies. That information is, appropriately, under consideration as part of the 303(d) listing update process.

Listing Policy section 6.1.5.1 directs the Water Board to consider "readily available pertinent factors such as…flow" when assessing water quality standards attainment. Thus, it does not necessarily require a detailed flow analysis but does guide staff to take flow into consideration, as we did in the Staff Report in Sections 3.4 and 4.4.

The Staff Report includes a simple analysis of stream flow based on the three USGS gauging stations in the River and Creek. Flow is a variable that affects algae growth since it is correlated with stream temperature, stream depth, and light penetration to the stream bottom. The Staff Report analysis did not find a significant change in annual flows over a 40 year period and concluded that increases in flow were unlikely to have been a factor in why eutrophic conditions decreased since initial reports from the mid-1970s. If summer low flows have indeed decreased, as proposed by the Commenter, then water quality conditions appear to have improved independent of reductions in flow, even though flow reductions have a hypothetical potential to increase algae blooms if all other variables remain the same.

Visual Evidence

Comment 2.29. Commenter states that impairment of recreational beneficial uses can be visually assessed. Commenter includes an undated photo of an unidentified site on the Napa River near the Oakville Road Bridge, stating that it "…shows objectionable algae blooms and the channel choked with vegetation … conditions consistent with high nutrient availability even though the site is partially shaded."

We agree that impairment of recreational beneficial uses can be assessed visually but such a process needs to be systematic. This is why Water Board staff followed SWAMP protocols (Fetscher et al. 2009) in assessing percent macroalgae cover at 105 systematically-selected locations as a rapid visual indicator (results included in the Staff Report). Photographs of stream algae cannot be directly translated into a percent cover metric unless taken from an aerial view, which was not the case for the provided photograph. The Listing Policy was developed to ensure a reliable and consistent means for evaluating beneficial use impairment, including recreational beneficial uses. A single photograph, while helpful, does not meet the goals or requirements of the Listing Policy.

Another means of assessing recreational beneficial uses is to survey or observe stream users. We completed anecdotal observations during several visits to site N-09, which had the highest percent macroalgae cover observed in both watersheds. The site is publicly-accessible. We observed the site in 2012, when it had 45% macroalgae cover, to examine how it affected non-contact recreational use. There were no nuisance odors and the river bank was still a very aesthetically pleasing location for lunch and walking. River otters were seen by staff at this site on another visit. Many members of the public were also observed enjoying the site during the 2012 visit and other visits.

A challenge in assessing the amount of algae that affects non-contact recreation is that different people will perceive the same environmental conditions differently. Staff's qualitative anecdotal observations of site N-09 were that even though it had a quantitatively high level of macroalgae in 2012, the non-contact water recreation beneficial use did not appear to be impaired by it.

Conclusion

Comment 2.30. Commenter does not believe the data presented in the Staff Report provide appropriate justification to delist Napa River and Sonoma Creek.

Staff disagrees. The Water Board followed guidance in the Listing Policy to analyze available data to assess the historical listing for nutrients related to eutrophic conditions in these water bodies. Data meet the spatial, temporal, and quality assurance requirements in the Listing Policy. The weight-of-evidence approach, using eight lines of evidence and data collected throughout the two watersheds from 2002-2012, indicated that nutrients are no longer causing impairments to beneficial uses in the River and Creek.

Comment 2.31. Commenter urges the Water Board needs to take action to restore flow citing Supreme Court case *Jefferson County PUD and City of Tacoma v. Washington Dep't of Ecology* (1994) 511 U.S. 700.

Please refer to the response to Comment 2.28.

Comment 2.32. Commenter included as Appendix A a letter from Patrick Higgins to Jeffery Shu at the State Water Board containing data to be considered for the 2012 Integrated Report, requesting that the Napa River be listed as impaired for flow and temperature.

The Commenter's submittal does not include significant information on nutrients, which is the issue being considered in these proposed delistings. To the extent flow- impacted nutrient issues were raised, they are addressed elsewhere in this response (e.g., see responses to Comments 2.7, 2.11, and 2.28). The Commenter's submittal is currently in the review process for the next update of the 303(d) list of impaired waters, and we would expect to address it as a part of that process.

Comment Letter 3: Napa County Farm Bureau (Norma Tofanelli and Jim Lincoln)

Comment 3.1. Commenter supports the proposed delisting of the Napa River and Sonoma Creek main stems for nutrients.

Comment noted.

Comment Letter 4: Napa County Flood Control and Water Conservation District (Phillip M. Miller)

Comment 4.1. Commenter appreciates the work to collect data and concurs with the proposed delisting of the Napa River and Sonoma Creek main stems for nutrients.

Comment noted.

References

All references in this Response to Comment are identified in the Staff Report with the exception of the following:

Nimick, D.A., C.H. Gammons, and S.R. Parker. 2011. Diel biogeochemical processes and their effect on the aqueous chemistry of streams: A review. Chemical Geology, 283: 3-17.

Sterner, R.W., and J.J. Elser. 2002. Ecological Stoichiometry: The Biology of Elements from Molecules to the Biosphere. Princeton University Press, Princeton, N.J.