Appendix B
Nutrient Target Development

Contents

B.1 Introduction

The Water Quality Control Plan for the Central Coastal Basin (Basin Plan) contains a narrative water quality objective for biostimulatory substances, which states: "Waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growths cause nuisance or adversely affect beneficial uses." The Basin Plan does not however contain numeric water quality objectives for biostimulatory substances (e.g., nitrogen or phosphorus compounds) nor does the Basin Plan specify levels of aquatic growth that constitute a nuisance. This appendix describes the development of nutrient numeric criteria to prevent biostimulatory and nuisance conditions within Franklin Creek.

Central Coast Water Board staff (staff) are required to develop technically defensible numeric water quality targets that are protective of the Basin Plan's narrative objective for biostimulatory substances. Targets should be based on established methodologies or peer-reviewed numeric criteria. It is important to recognize that definitive and unequivocal scientific certainty is not necessary in the development of nutrient water quality targets for TMDLs that address biostimulation. Numeric targets should be scientifically defensible, but are not required to be definitive. Research on the topic of eutrophication is active and ongoing. If the water quality objectives and numeric targets for biostimulatory substances are changed in the future, then any TMDLs and allocations that are potentially adopted for biostimulatory substances pursuant to this project may sunset and be superseded by revised water quality objectives.

Recent biostimulation research of inland surface waters within an agricultural watershed in the California central coast region indicates that existing nutrient numeric water quality objectives found in the Basin Plan (i.e., the 10 mg/L nitrate-nitrogen MUN objective) is unlikely to reduce benthic algal growth below even the highest water quality benchmarks[1]. Therefore, the 10 mg/L nitrate-nitrogen objective does not sufficiently protect against biostimulatory impairments. Consequently, staff concludes that it is necessary to set nutrient numeric targets that are more stringent than existing nitrate numeric objectives contained in the Basin Plan (i.e., the 10 mg/L MUN objective).

As contained in *"Nutrient Criteria Technical Guidance Manual, River and Streams* [2]," USEPA has recommended the following three general approaches as guidance for establishing nutrient criteria for streams:

(1) Use of predictive relationships such as the California Nutrient Numeric Endpoints (California NNE) model, developed by Tetra Tech (2006)[3].

(2) Statistical analysis of data to estimate reference conditions: identification of reference reaches or percentile selections of data plotted as frequency distributions.

(3) Application and/or modification of established nutrient/algal thresholds (e.g., nutrient concentration thresholds or algal limits from published literature).

USEPA (2000) states that a weight of evidence approach combining any or all of the three approaches above will produce criteria of greater scientific validity. Table 1 summarizes the three approaches.

[1] University of California, Santa Cruz. 2010. Final Report: Long-term, high-resolution nutrient and sediment monitoring and characterizing in-stream primary production. Proposition 40 Agricultural Water Quality Grant Program. Dr. Marc Los Huertos, Ph.D., project director.

[2] U.S. Environmental Protection Agency. 2000. Nutrient Criteria Technical Guidance Manual, River and Streams. EPA-822-B-00-002.

[3] Tetra Tech. 2006. Technical approach to develop nutrient numeric endpoints for California. Prepared for USEPA Region IX (Contract No. 68-C-02-108 to 111).

Table 1. USEPA-recommended approaches for developing nutrient criteria.

USEPA-Recommended Approaches	Methodology	Notes
Use of **Predictive Relationships** (modeling)	California NNE Approach	Staff used the California NNE benthic biomass model tool to supplement and corroborate targets based on USEPA-recognized statistical approaches.
Statistical Analysis of Data to estimate reference conditions	USEPA-recommended statistical analysis: 25th percentile of nutrient data for stream population and an evaluation of reference stream (headwater) conditions	Staff used USEPA-recognized statistical approach in development of nutrient numeric criteria.
Use of established concentration **thresholds from published literature**	USEPA published nutrient criteria for Ecoregion III, Subecoregion 6	Staff evaluated USEPA ecoregional criteria. Staff concluded that subecoregion III-6 criteria are inappropriate because they are over-protective. The ecoregional criteria aggregate streams that represent significantly different characteristics: headwater streams, alluvial valley streams, coastal confluence streams, etc. USEPA itself recognizes ecoregional criteria may not sufficiently account for local variation.

Staff followed USEPA guidance in developing draft targets with the goal of being able to account for the unique physical and hydrologic conditions of the TMDL project area (USEPA 2000). The development of nutrient criteria should be specific to unique waterbody types and no single criterion should be broadly applied to all waterbodies at a regional scale.

Staff evaluated the three USEPA-recommended approaches outlined in Table 1 and concluded that the California NNE model combined with the statistical analysis approach that evaluate reference conditions are most appropriate for this project. The following sections of this appendix describe the development of nutrient numeric targets for Franklin Creek.

B.2 Nutrient Target Selection

In developing nutrient targets, it is important to recognize that:

1. Ambient nutrient concentrations in and of themselves, are not sufficient to predict the risk of biostimulation because algal productivity depends on several additional factors such as stream morphology, hydraulics, light availability, and other characteristics; and,
2. An important tenet of the California NNE approach (Tetra Tech 2006) is that targets should not be set lower than the value expected under natural conditions.

Staff developed nutrient targets by using a combination of recognized methods to bracket and calibrate Franklin Creek conditions with a goal that targets should not be over-protective nor under-protective. Additionally, staff identified a plausible range of ambient reach-scale stream conditions to account for local variation.

The aforementioned approaches have various strengths. The California NNE is a predictive modeling approach that helps establish concentrations at which nutrients can have detrimental effects on the biological health of a stream. The USEPA 25th percentile approach is a statistical approach, which can provide a plausible approximation of nutrient concentrations within reference streams or relatively undisturbed streams. As stated earlier, an important tenet of the California NNE approach (Tetra Tech 2006) is that targets should not be set lower than the value expected under background or relatively undisturbed conditions.

Further, staff applied the USEPA reference stream methodology (75th percentile approach) which ensures that biostimulation nutrient targets are no more stringent than nutrient concentrations found in natural or lightly-disturbed headwater and tributary reaches.

In summary, staff was able to evaluate a range of plausible nutrient targets for Franklin Creek using these various approaches. After establishing plausible ranges of potential nutrient targets using the aforementioned methodologies, the development and selection of final nutrient TMDL targets were determined using the following hierarchical approach, as illustrated in Figure 1 below.

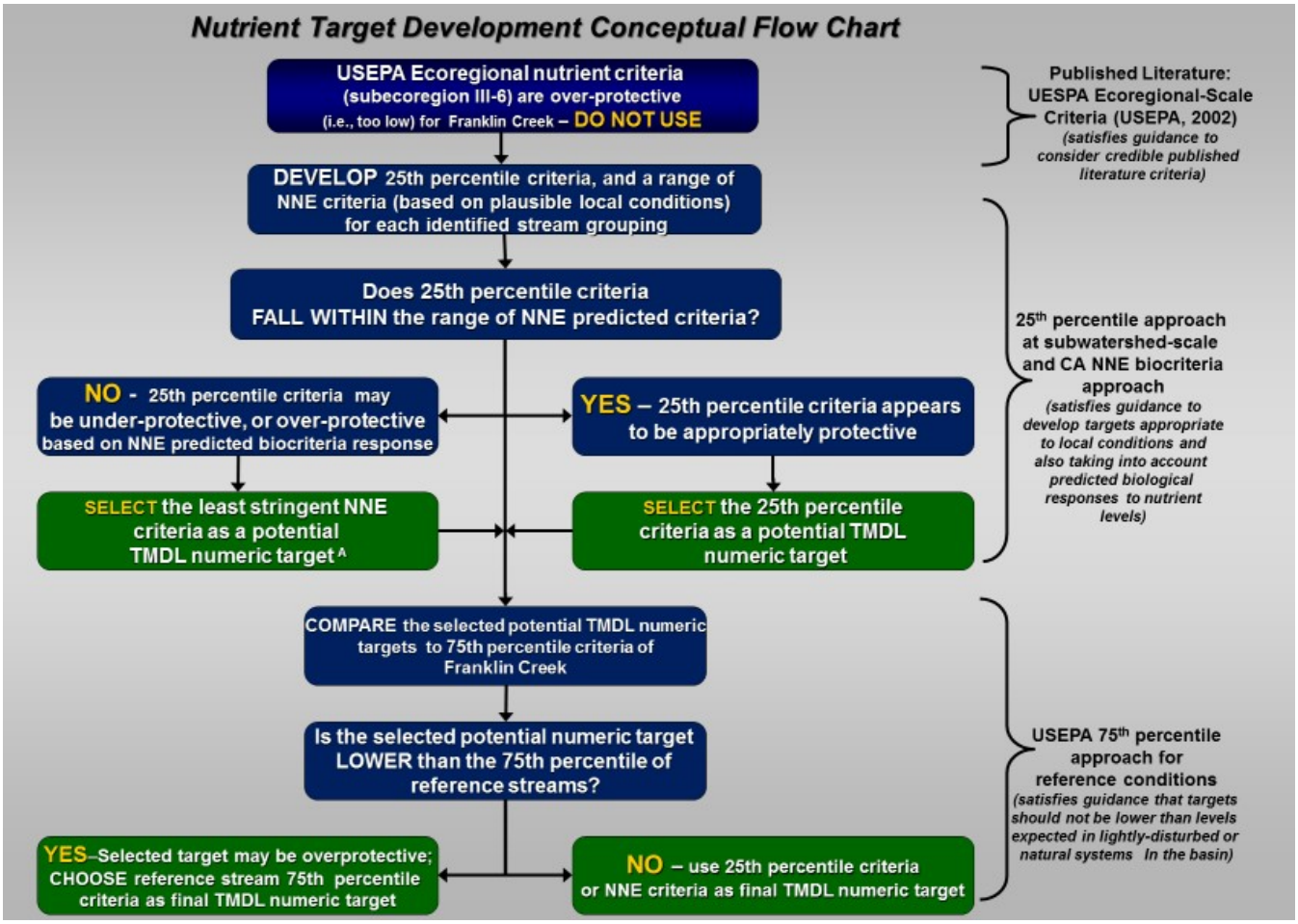


Figure 1. Conceptual flow chart of nutrient numeric target development

Notes:

[A] Where the 25th percentile numeric criteria is clearly under-protective, the marginally less stringent NNE numeric target is selected because central coast researchers have suggested that while it is reasonable to set lower nutrient numeric targets on stream reaches with limited anthropogenic sources, it may be prudent in areas with significant human disturbances to have less stringent targets until more information is available (source: Prop. 40 Nutrient Study–Pajaro River Watershed, 2011 – Project Lead: Dr. Marc Los Huertos). Where the 25th percentile numeric criteria is clearly over-protective, the next most stringent NNE numeric target was chosen, which is presumed to represent an intermediate end point between the most stringent and least stringent numeric criteria estimates developed for the stream category.

B.3 California Nutrient Numeric Endpoints Approach

The California NNE approach utilizes nutrient response indicators to develop potential nutrient water quality criteria. California NNE includes a set of relatively simple spreadsheet scoping tools for application in river systems to assist in evaluating the translation between response indicators (e.g., algal biomass) and nutrient concentrations. Accordingly, staff used the California NNE benthic biomass spreadsheet tool to develop potential water quality targets for the response indicator (e.g., benthic chlorophyll *a* density and corresponding estimated algal biomass density). These targets determine how much algae can be present without impairing designated beneficial uses. Numeric water quality models (e.g., QUAL2K) contained within California NNE are then used to convert the initial water quality targets for the response variables into numeric targets for nutrients.

The California NNE approach defines three beneficial use risk categories (BURCs) for indicators (measures of algal growth and oxygen deficit): 1) Presumably unimpaired; 2) Potentially impaired; and 3) Likely impaired. Additional details on the three risk categories is reproduced below:

> The California NNE approach recognizes that there is no clear scientific consensus on precise levels of nutrient concentrations or response variables that result in impairment of a designated use. To address this problem, waterbodies are classified in three categories, termed Beneficial Use Risk Categories (BURCs). BURC I waterbodies are not expected to exhibit impairment due to nutrients, while BURC III waterbodies have a high probability of impairment due to nutrients. BURC II waterbodies are in an intermediate range, where additional information and analysis may be needed to determine if a use is supported, threatened, or impaired. Tetra Tech (2006) lists consensus targets for response indicators defining the boundaries between BURC I/II and BURC II/III.

Table 2 synthesizes the consensus BURC boundaries for various secondary indicators developed by Tetra Tech for the California NNE approach. The BURC II/III boundary provides an initial scoping point to establish minimum requirements for a TMDL.

Table 2. Nutrient numeric endpoints for secondary indicators – beneficial use risk category boundaries: I & II and II & III

Beneficial Use Risk-Category I. Presumptive unimpaired (use is supported).
Beneficial Use Risk Category II. Potentially impaired (may require an impairment assessment)
Beneficial Use Risk Category III. Presumptive impaired (use is not supported or highly threatened)

RESPONSE VARIABLE	RISK – CATEGORY BOUNDARY	BENEFICIAL USE						
		COLD	WARM	REC-1	REC-2	MUN[1]	SPWN	MIGR
Benthic Algal Biomass in streams (mg chl-a/m^2)	I / II	100	150	C	C	100	100	B
Maximum	II / III	150	200	C	C	150	150	B
Planktonic Algal Biomass in Lakes and Reservoirs (as µg/L Chl-a)[2] – summer mean	I / II	5	10	10	10	5	A	B
	II / III	10	25	20	25	10	A	B
Clarity (Secchi depth, meters.)[3] – lakes summer mean	I / II	A	A	2	2	A	A	B
	II / III	A	A	1	1	A	A	B
Dissolved Oxygen (mg/l)	I / II	9.5	6.0	A	A	A	8.0	C
Streams – the mean of the 7 daily minimums	II / III	5.0	4.0	A	A	A	5.0	C
pH maximum – photosynthesis driven	I / II	9.0	9.0	A	A	A	C	C
	II / III	9.5	9.5	A	A	A	C	C
DOC (mg/l)	I / II	A	A	A	A	2	A	A
	II / III	A	A	A	A	5	A	A

A = No direct linkage
B = More research needed to quantify linkage
C = Addressed by Aquatic Life Criteria

[1] For application to zones within water bodies that include drinking water intakes.
[2] Reservoirs may be composed of zones or sections that will be assessed as individual water bodies
[3] Assumes that lake clarity is a function of algal concentrations, does not apply in waters of high non-algal turbidity

As described in this appendix, staff developed nitrogen and phosphorus nutrient targets using existing California NNE predictor run spreadsheet templates developed by staff of the Water Board's Central Coast Ambient Monitoring Program (available at http://www.ccamp.us/nne/nne_runs/). Staff adjusted turbidity and shade variables contained in the California NNE spreadsheet templates to reflect upper and lower light penetration conditions that influence the production of benthic biomass, thus providing a plausible range of stream conditions related to turbidity and shade.

It is important to recognize that the California NNE spreadsheet tool is highly sensitive to user inputs for tree canopy shading and turbidity, both of which determine the light extinction coefficient. Shading and turbidity have significant effects on light availability, and consequently photosynthesis and potential biostimulation. For shading, staff used aerial imagery to estimate shading conditions along stream segments within the Franklin Creek watershed. Based on aerial imagery, staff concluded that tree canopy and shading conditions are very poor, ranging from 0% to 10%. As such, staff used 0% and 10% tree canopy cover as high and low light penetration values in the California NNE model.

The default turbidity value in the NNE spreadsheet tool is 0.6 NTU. As shown in Figure 2, the USEPA (2000) ecoregional criteria (Ecoregion III-6) for reference turbidity conditions is 1.9 NTU. Both of these values (0.6 NTU and 1.9 NTU) represent ambient conditions in relatively undisturbed reference streams.

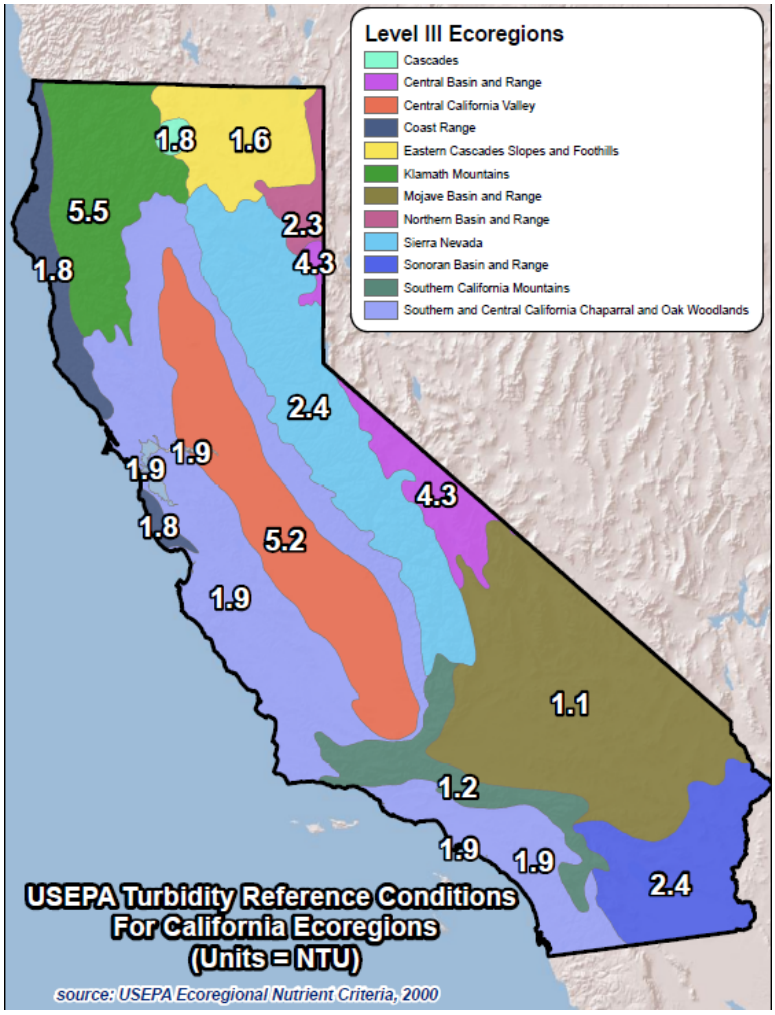


Figure 2. USEPA ecoregional criteria for turbidity.

Table 3 represents summary statistics for turbidity in Franklin Creek. Note that geomean values are less than the USEPA (2000) reference turbidity condition of 1.9 NTU, but greater than the California NNE default value of 0.6 NTU. Also, note that median turbidity values are slightly greater than USEPA (2000) reference turbidity condition of 1.9 NTU.

Table 3. Summary statistics for Franklin Creek turbidity measurements (NTU) sites 315FMV and 315FRC aggregated.

Period	Count	Median	25th	75th	90th	10th	Max	Min	Mean	Geomean
Wet-Season (Nov-Apr)	132	2.33	0.1	6.58	53.90	0.1	817.5	0.1	29.28	1.56
Dry-Season (May-Oct)	142	2.39	0.1	7.55	18	0.1	283.1	0.1	10.58	1.53
All	274	2.33	0.1	6.78	29.53	0.1	817.5	0.1	19.58	1.55

Site:	Franklin Creek
Analyst:	L. Harlan
Date:	8/21/2017

NNE Parameters:

- Beneficial Use Risk-Classification: (BURC): II / III
- Beneficial Use: **COLD**
- Response Variable: Benthic Algal biomass in streams
- Numeric Target: 150 mg chl-a/m^2
- Method: Revised QUAL2k, benthic chl a

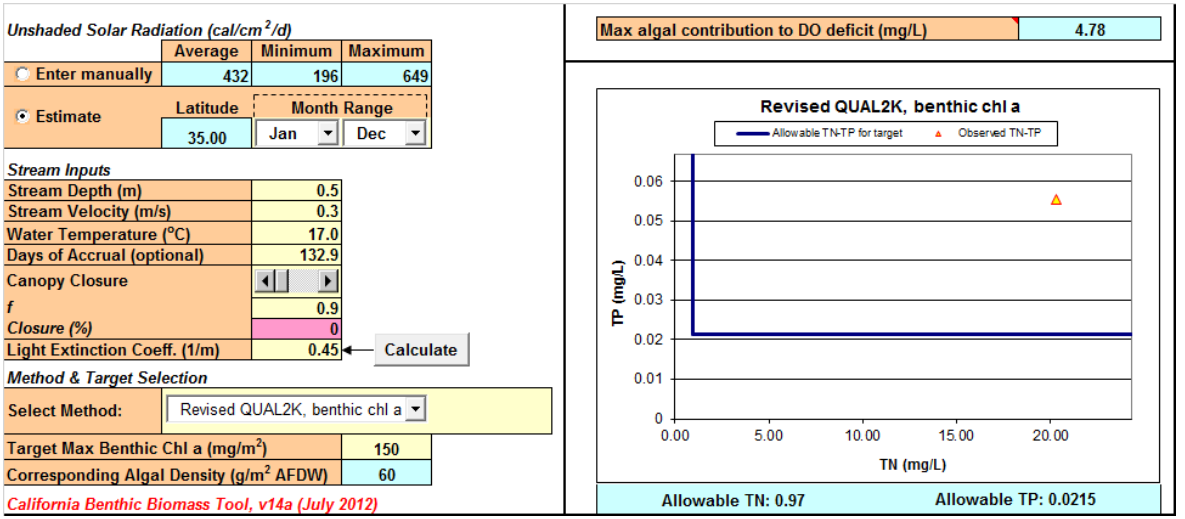
Stream Condition Input:

Higher Sunlight Availability Scenario

- 0% Tree Canopy Closure

- Ambient (low) Turbidity:

0.1 NTU turbidity = 25th percentile of May-Oct samples for Franklin Creek sites 315FMV and 315FRC.



Site:	Franklin Creek
Analyst:	L. Harlan
Date:	8/21/2017

NNE Parameters:

- Beneficial Use Risk-Classification: (BURC): II / III
- Beneficial Use: **COLD**
- Response Variable: Benthic Algal biomass in streams
- Numeric Target: 150 mg chl-a/m^2
- Method: Revised QUAL2k, benthic chl a

Stream Condition Input:

Lower Sunlight Availability Scenario

- 10% Tree Canopy Closure

- Dry-Season Mean Turbidity:

2.4 NTU turbidity = median turbidity of May-Oct samples for Franklin Creek sites 315FMV and 315FRC.

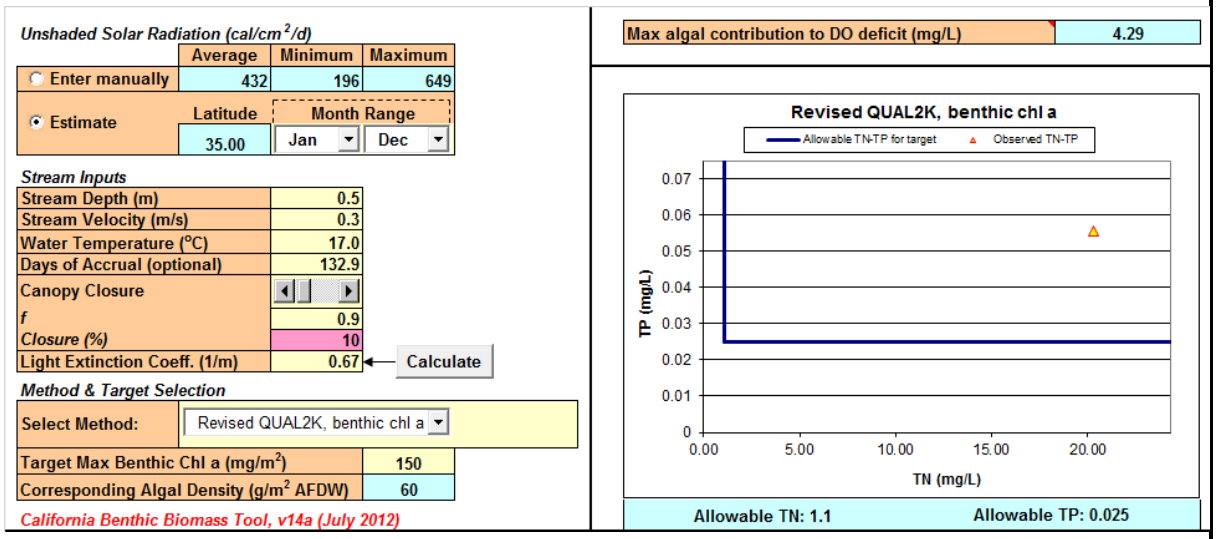


Figure 3. California NNE results for higher and lower sunlight availability scenarios.

Figure 3 shows the California NNE results for higher and lower sunlight availability scenarios based on a range of plausible turbidity and canopy conditions. Franklin Creek is specifically designated for cold freshwater aquatic habitat (COLD) in Table II-1 of the Basin Plan, therefore California NNE analysis was limited to the BURC II /III category for COLD beneficial use.

California NNE model results under the high sunlight availability scenario are numeric targets of 0.97 milligrams per liter (mg/l) total nitrogen and 0.0215 mg/L total phosphorus. For the lower sunlight availability scenario, numeric targets are 1.1 mg/L total nitrogen and 0.025 mg/L total phosphorus. Staff has compared these California NNE results to additional USEPA-recommended approaches in the following sections.

B.4 USEPA-Recommended Statistical Analysis of Data to Estimate Reference Conditions

USEPA's Technical Guidance Manual for Developing Nutrient Criteria for Rivers and Streams (USEPA, 2000 - refer back to footnote 2) describes two approaches that may be used to evaluate nutrient reference conditions, a 25th percentile of the entire population and a 75th percentile or headwater and lightly-disturbed reaches. This section provides information pertaining to both approaches, each of which may be used to estimate reference conditions and potential nutrient numeric targets for Franklin Creek.

B.4.1 USEPA 25th Percentile Approach

Staff evaluated USEPA's 25th percentile approach for developing nutrient targets. The USEPA has characterized the 25th percentile values as criteria recommendations to protect waters against nutrient over-enrichment (USEPA, 2000). This is because the 25th percentile of the entire population has been shown by USEPA to represent a surrogate for an actual reference population. Figure 4 shows the Franklin Creek monitoring sites used to calculate the 25th percentile statistics and Table 4 contains the summary statistics and 25th percentile values.

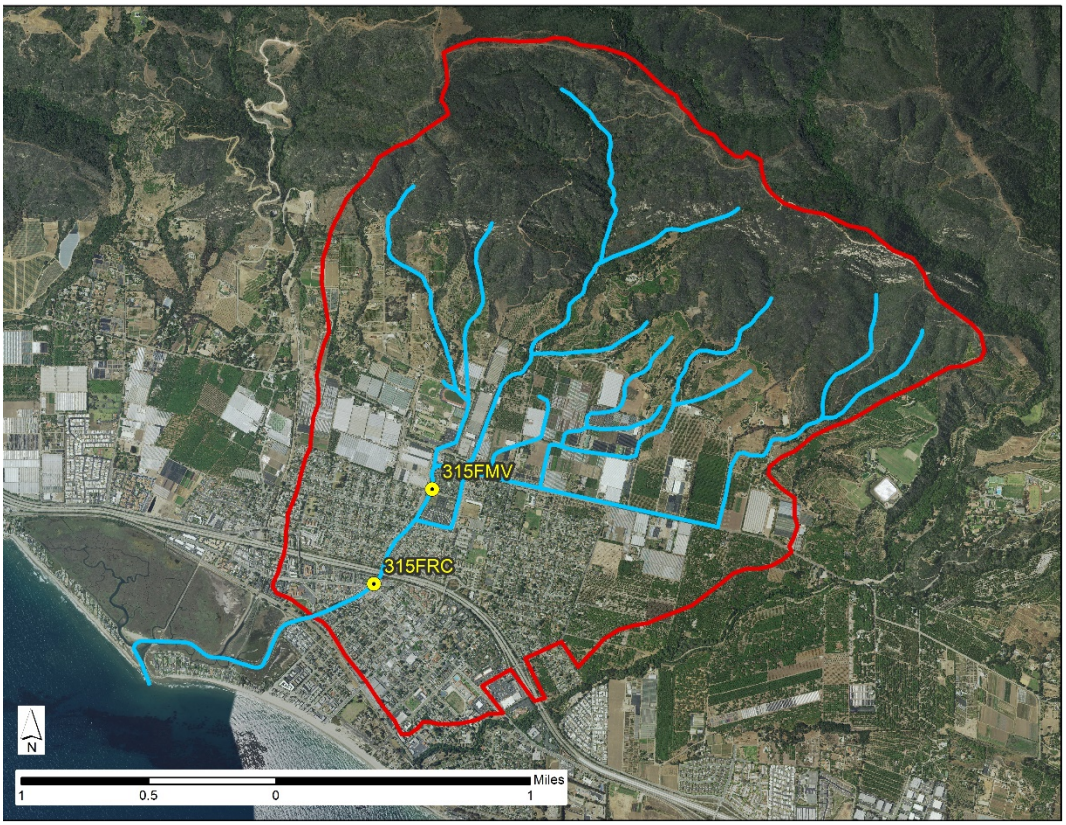


Figure 4. Monitoring sites used for 25th percentile water quality data

Table 4. Statistical summary and 25th percentile values for total nitrogen and total phosphorus.

Franklin Creek *Franklin Creek Monitoring Sites* *315FMV and 315FRC*	
Statistical Summary of Total Nitrogen	
Time Period	Jan. 2001 – March 2016
Mean	22.1
Median	22.7
Minimum	0.97
Maximum	50.2
Count	173
25th Percentile	20.4
Statistical Summary of Total Phosphorus	
Time Period	Oct. 2001 – March 2016
Mean	0.26
Median	0.13
Minimum	0.025
Maximum	2.6
Count	156
25th Percentile	0.075

B.4.2 USEPA 75th Percentile of headwater and lightly-disturbed reaches

This USEPA-recommended approach evaluates the upper 75th percentile of a reference population of streams, such as streams within headwater and lightly-disturbed reaches. According to USEPA, the 75th percentile likely represents minimally impacted conditions that are protective of designated beneficial uses. USEPA defines a reference stream "as a least impacted waterbody within an ecoregion that can be monitored to establish a baseline to which other waters can be compared. Reference streams are not necessarily pristine or undisturbed by humans."

Figure 5 and Figure 6 illustrate the statistics and 75th percentile values for nitrate (as N) and orthophosphate (as P) concentrations in headwater reaches and lightly-disturbed tributaries of the Santa Maria River watershed. Nitrate typically comprises over 95% of total water column total nitrogen concentrations while orthophosphate is estimated to generally (but not always) be the largest fraction of water column total phosphorus. Staff choose the Santa Maria River watershed because water quality data from a reference population of headwater and lightly-disturbed reaches within the south coast of Santa Barbara county is not available because monitoring stations are located primarily in moderately to highly disturbed portions of the coastal plain.

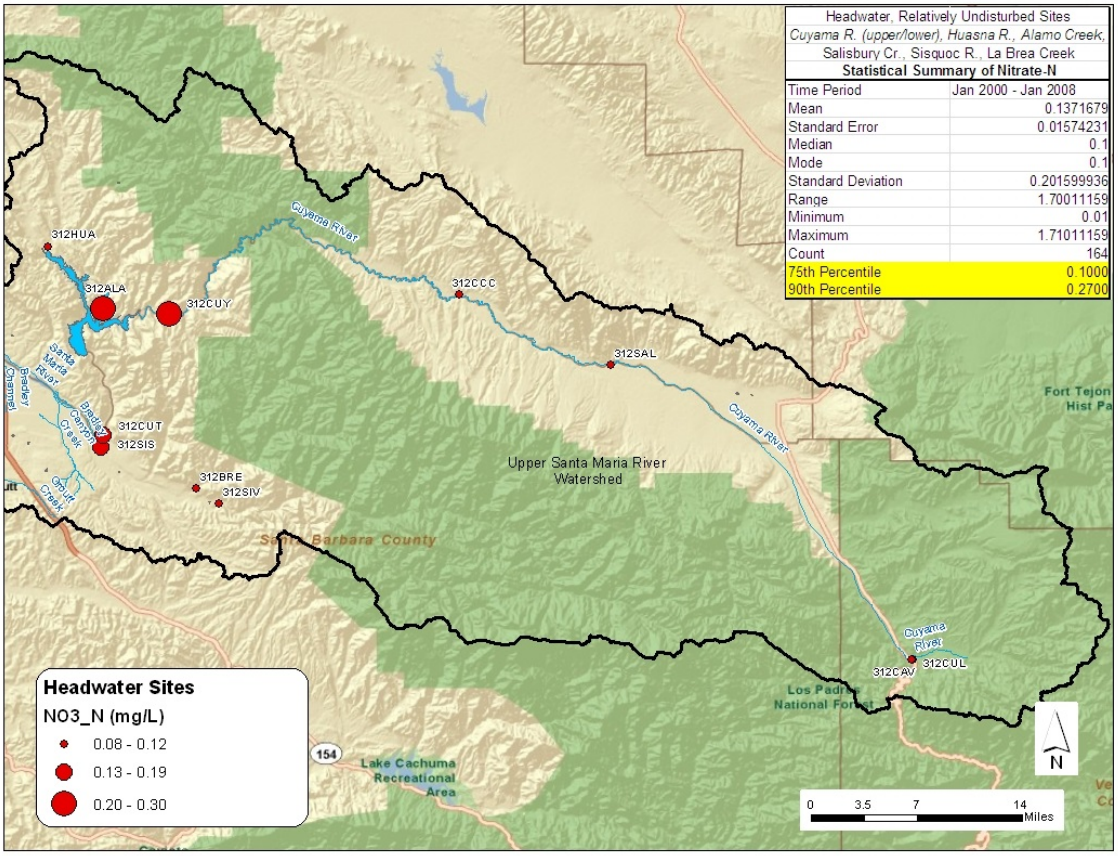


Figure 5. Nitrate as nitrogen (mg/L) statistics for headwater and undisturbed streams.

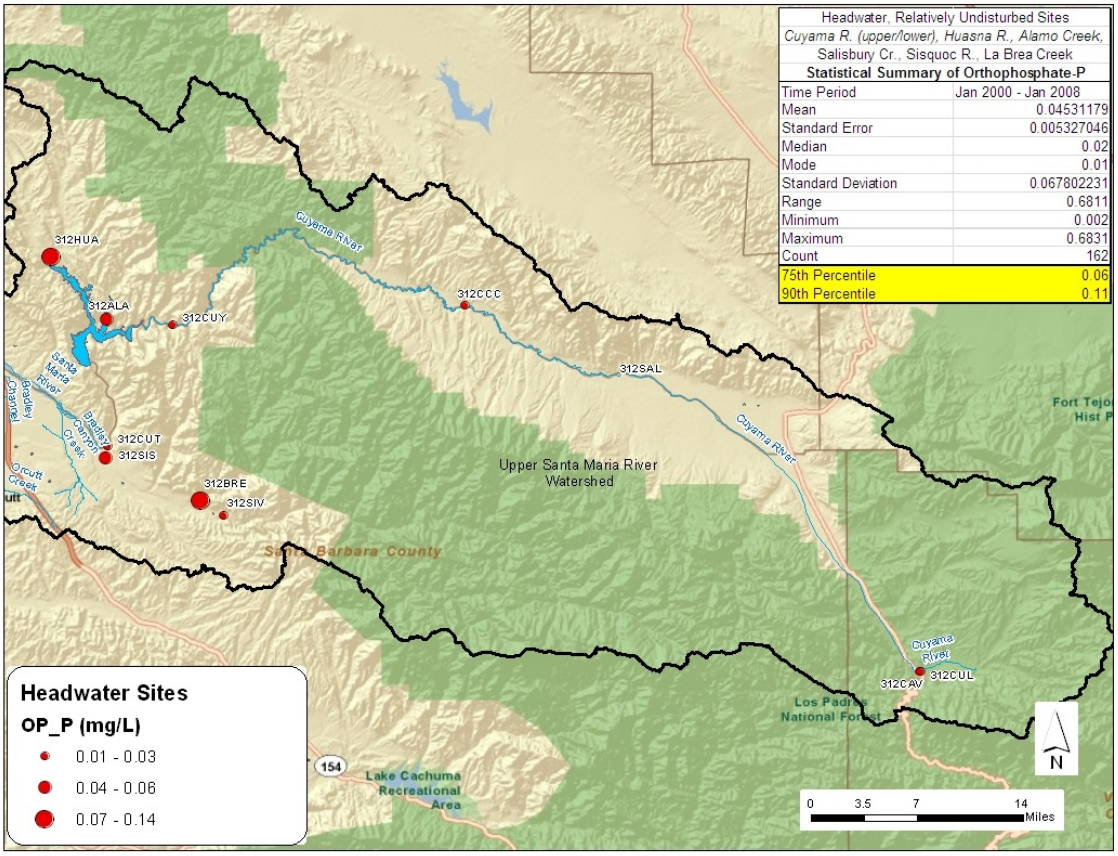


Figure 6. Orthophosphate as phosphorus (mg/L) statistics for headwater and undisturbed streams.

As shown in Figure 5 and Figure 6, the 75th percentiles for this population of stream data are 0.10 mg/L nitrate as nitrogen, and 0.06 mg/L orthophosphate as phosphorus. For comparative purposes, note that USEPA's reference condition for total phosphorus in subecoregion III-6 (Calif. Chaparral and Oak Woodlands) is 0.03 mg/L[4] (see Table 5). Note that the 90th percentile of nitrate as nitrogen in Santa Maria River watershed reference streams is 0.27 mg/L, which suggests that concentrations of nitrate as nitrogen in reference streams do not typically exceed 1 mg/L.

An important tenet of the California NNE approach (Tetra Tech, 2006 - refer back to footnote 3) is that potential numeric targets should not be set lower than concentrations expected under background or relatively undisturbed conditions. Further, guidance from researchers with expertise in central coast biostimulation issues indicates regulatory nutrient targets should not be more stringent (i.e., lower) than nutrient concentrations found in natural systems in the project area's basin (Dr. Marc Los Huertos[5], California State University, Monterey Bay, personal communication Oct. 14, 2011).

Therefore, staff assessed the USEPA reference stream methodology to ensure that biostimulation nutrient targets are no more stringent than nutrient concentrations that can be expected in natural or lightly-disturbed headwater and tributary reaches.

B.4.3 USEPA Published Nutrient Criteria for Ecoregion III, Subecoregion 6

For reference, USEPA's published (see footnote 4) 25th percentiles (representing unimpacted reference conditions) for the California Oak and Chaparral Subecoregion (nutrient subecoregion 6) are presented in Table 5.

Table 5. USEPA Reference conditions for Level III subecoregion 6 streams.

Parameter	**25th Percentiles based on all seasons data for the decade**
Total Nitrogen (TN) – mg/L	0.52
Total Phosphorus (TP) – mg/L	0.03
Chlorophyll *a* – µg/L	2.4
Turbidity - NTU	1.9

B.5 Comparison of USEPA 25th Percentile Approach and California NNE

Figure 7 shows the USEPA 25th percentile targets, described earlier in Section B.4.1, relative to the California NNE Higher Sunlight and Lower Sunlight Availability scenarios described in Section B.2. The USEPA 25th percentile value for nitrogen is twice the drinking water quality objective for drinking water (10 mg/L nitrate as nitrogen) and therefore not protective. The California NNE Lower Sunlight Availability scenario falls in between the 25th percentile and the NNE Higher Sunlight Availability scenario. Consistent with the nutrient target development outlined in Section B.2, the NNE Lower Sunlight Availability scenario for total nitrogen **(1.1 mg/L)** is identified here as a potential numeric target. For phosphorus, both NNE scenarios are lower than background reference conditions (0.06 mg/L) for headwater reaches (see Figure 6) and would be overly conservative. Therefore, the USEPA 25th percentile condition for total phosphorus **(0.075 mg/L)** was selected by staff as a potential target.

[4] USEPA. 2000. Ambient Water Quality Criteria Recommendations. Information Supporting the Development of State and Tribal Nutrient Criteria for River and Streams in Nutrient Ecoregion III – Xeric West. EPA-822-B-00-016.

[5] Dr. Marc Los Huertos in an Assistant Professor of Science and Environmental Policy at California State University, Monterey Bay. Dr. Los Huertos has substantial research experience with agricultural water quality, aquatic ecology, and biostimulation in the California central coast region.

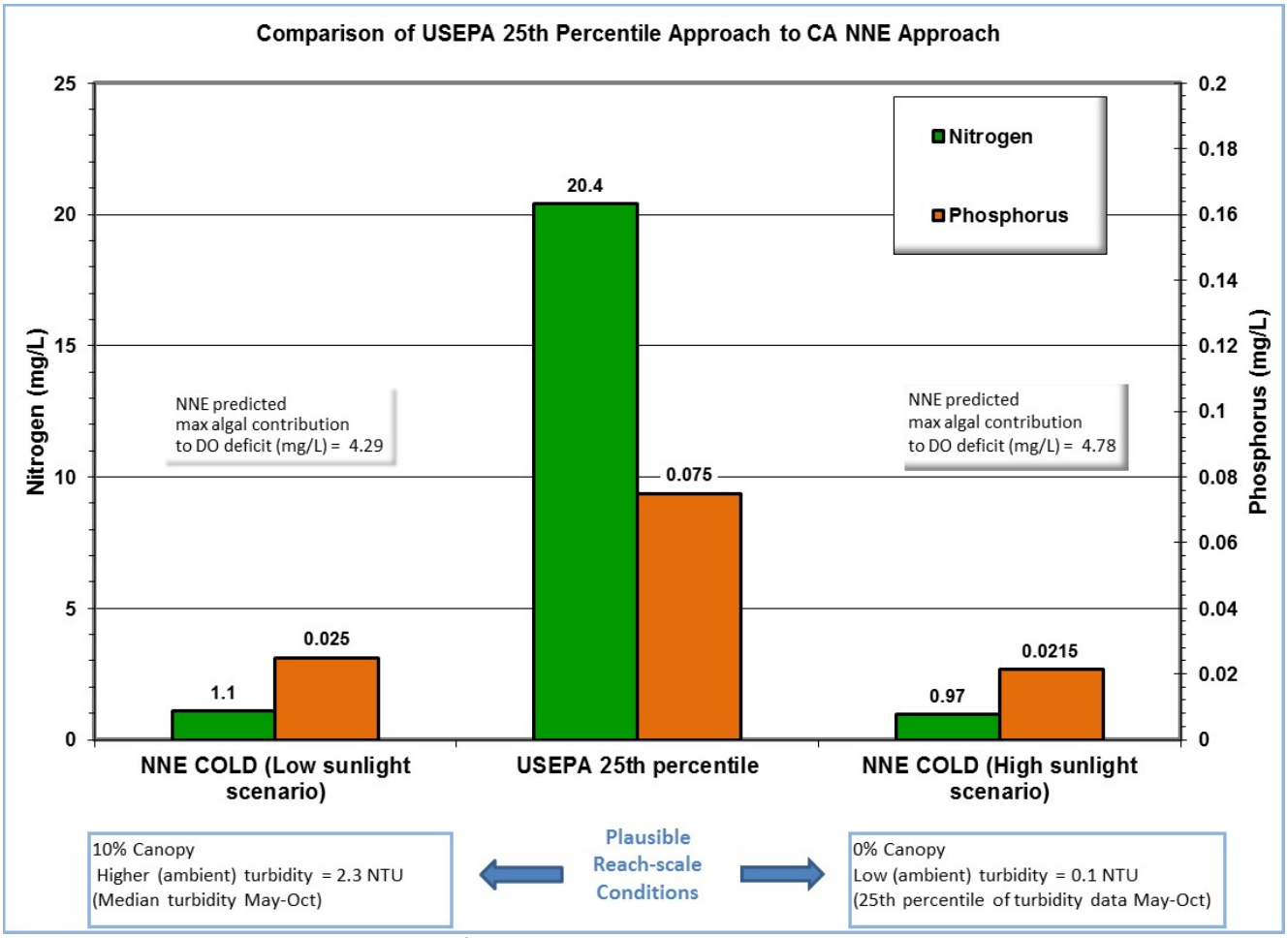


Figure 7. Comparison of USEPA 25th percentile approach and California NNE.

B.6 Comparison of Preliminary Numeric Criteria with 75th Percentile Numeric Criteria of Headwater Reaches

Figure 8 shows the preliminary and potential TMDL numeric criterion developed previously in this appendix with the 25th percentile approach and the California NNE approach, relative to the 75th percentile criterion for headwater and lightly-disturbed reaches. The proposed total nitrogen and total phosphorus criterion are not less than the 75th percentile reference stream criterion or the USEPA ecoregional values, and therefore conform to technical guidance that nutrient targets should not be lower than nutrient concentrations found in natural systems.

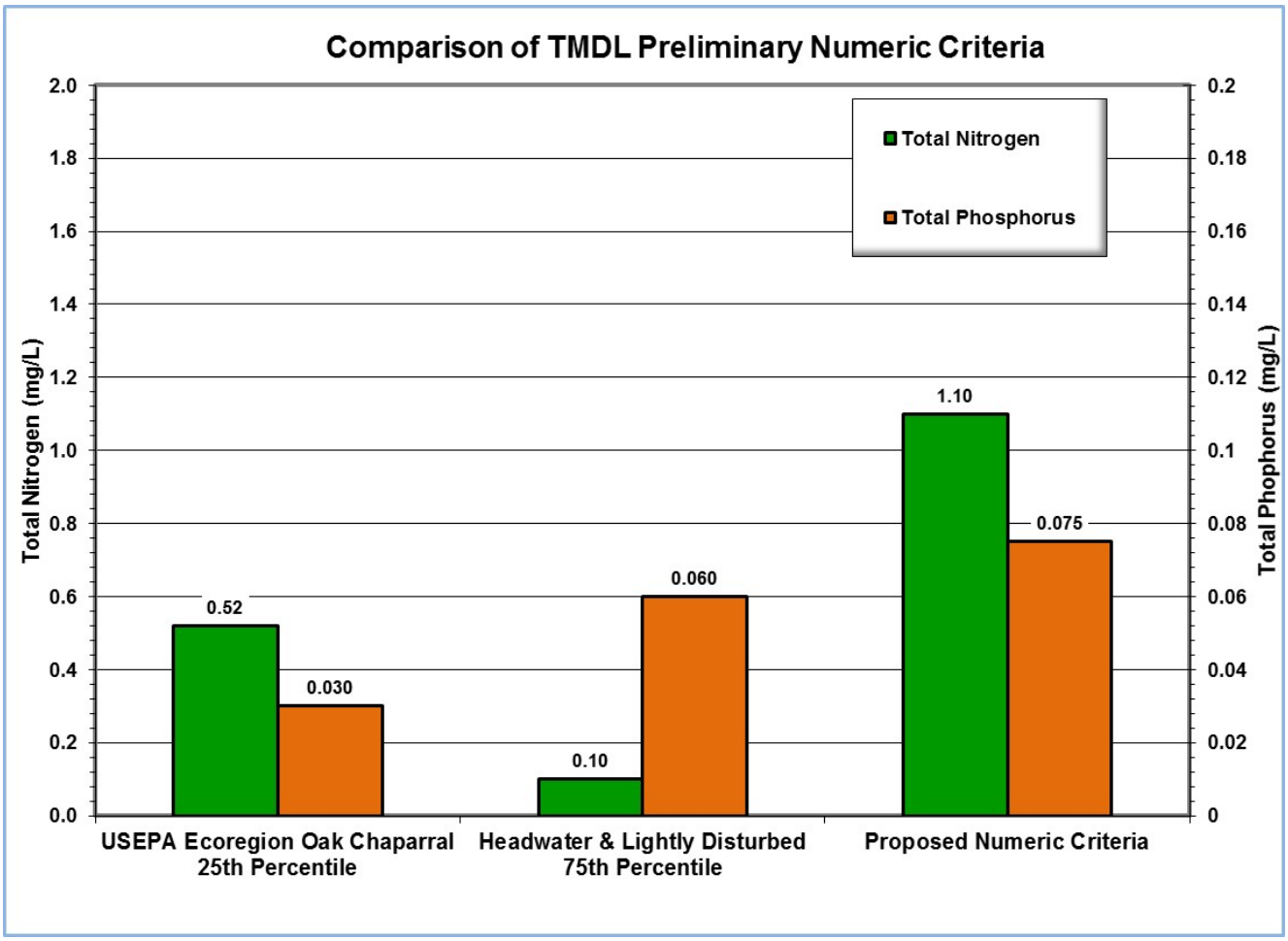


Figure 8. Comparison of Preliminary Numeric Criteria with 75th Percentile Numeric Criteria of Headwater Reaches

B.7 Seasonal Biostimulatory Numeric Targets

Photo documentation, field observations, and information provided by central coast researchers[6] with expertise in eutrophication issues indicate evidence of excessive algae problems and biostimulatory conditions in the summer months. As such, staff has concluded that biostimulatory conditions are primarily a summer-time water quality problem as shown in Figure 9.

[6] Personal communications: Ken Johnson, PhD. (Senior Scientist, Monterey Bay Aquarium Research Institute); Brent Hughes (Estuarine Ecologist, Elkhorn Slough National Estuarine Research Reserve); Mary Hamilton (Environmental Scientist, Central Coast Ambient Monitoring Program).

Dry-Season Summer	Wet-Season Winter
 September 2010	 February 2010
 October 2014	 January 2014

Figure 9. Photo documentation of the difference between summer months and winter months as related to biostimulation.

Staff concludes that it would be unwarranted at this time to apply the nutrient numeric targets developed in this appendix to implement the Basin Plan's biostimulatory objective on a year-round basis. Additionally, winter nutrient loads are often associated with higher velocity stream flows which are likely to scour filamentous algae and transport it out of the watershed. These higher flows also flush nutrient compounds through the watershed and ultimately into the ocean; in other words the residence time of nutrients in Franklin Creek is typically shorter than in lakes, reservoirs, or other static waterbodies. In short, evidence of algal impairment is less conclusive for winter-time than for summer conditions.

Therefore, staff proposes that the nutrient numeric criteria develop in preceding sections of this appendix should apply during the dry-season (May 1 to October 31) when excessive algal growth and biostimulation problems appear.

There is substantial scientific uncertainty about the extent to which winter-time nitrogen and phosphorus loads from upland areas contribute to summer-time biostimulation problems in downstream receiving waterbodies. Loading during the winter months may have little effect on summer algal

densities[7]. Alternatively, substantial internal loading of phosphorus and nitrogen in downstream and coastal confluence waterbodies may result over time from loads released from particulate matter, such as sediment or organic matter. The extent to which this sediment and organic matter-associated internal loading is consequential to summer-time biostimulation problems in the project area or in downstream receiving waterbodies is currently uncertain.

Therefore, to account for these uncertainties staff conclude that it is necessary to set numeric targets for winter months, but at this time these targets should be less stringent than dry-season nutrient targets in acknowledgement of these uncertainties. Previous California nutrient TMDLs have similarly incorporated seasonal targets for nutrients for the same reasons.

At this time, staff proposes a TMDL nitrogen target for the wet-season (Nov. 1 to April 30) that is less stringent than the dry-season targets developed previously in this appendix, but more stringent that the municipal drinking water (MUN) nitrate objective contained in the Basin Plan (10 mg/L nitrate as nitrogen). Staff proposes incorporating a 20% explicit margin of safety to the Basin Plan nitrate MUN numeric objective for the wet-season numeric target to help account for uncertainty concerning biostimulatory problems in the wet-season. As such, the proposed wet-season biostimulatory target for nitrogen is 8 mg/L. The basis for identifying the 8 mg/L wet-season total nitrogen target is as follows:

1) Photo documentation, field observations, water quality data, and input provided by researchers (refer back to footnote 6) with expertise in eutrophication issues in the central coast region indicate clear evidence of algae problems and biostimulation in the summer months, and that eutrophication is primarily manifested as a summer-time water quality problem in project area waterbodies. In the winter, higher flows, cooler temperatures, lower light availability, and scouring evidently limit algal production. There are substantial uncertainties regarding the extent to which winter-time algal biomass problems manifest themselves, and about the extent to which winter-time loads of nitrogen ultimately contribute to biostimulation problems in the summer.
2) The USEPA approved a nutrient TMDL for a stream in southern California which contained a winter-time nitrogen target of 8 mg/L, was based on the application of a 20% margin of safety to the Basin Plan's numeric objective of nitrate, and accounted for uncertainty regarding winter-time algae problems[8].
3) Recent research on biostimulation on inland surface waters from agricultural watersheds in the California central coast region indicates that existing nutrient numeric water quality objectives to protect drinking water standards found in the Basin Plan (i.e., the 10 mg/L nitrate as nitrogen) is unlikely to reduce benthic algal growth below even the highest water quality benchmarks. This is because aquatic organisms respond to nutrients at lower concentrations[9,10]. Therefore, the 10 mg/L nitrate as nitrogen objective is insufficiently protective against biostimulatory impairments. Consequently, staff concludes that it is necessary to set nutrient wet-season numeric targets more stringent than the existing numeric objectives found for nitrate in the Basin Plan (i.e., the 10 mg/L MUN objective).

Similarly, staff proposes to establish a wet-season total phosphorus target that is less stringent than the dry-season orthophosphate targets developed previously in this appendix. Staff is proposing a wet-season target to help account for uncertainty regarding biostimulatory problems associated with wet-season loads of phosphorus. Unfortunately, there are currently no established numeric water quality

[7] State of Connecticut Dept. of Environmental Protection. 2005. A Total Maximum Daily Load Analysis for Linsley Pond in North Branford and Branford, Connecticut

[8] USEPA. Total Maximum Daily Loads for Nutrients, Malibu Creek Watershed.

[9] University of California, Santa Cruz. 2010. Final Report: Long-term, high resolution nutrient and sediment monitoring and characterizing in-stream primary production. Proposition 40 Agricultural Water Quality Grant Program. Dr. Marc Los Huuertos, Ph.D., project director.

[10] Rollins, S., M. Los Huertos, P. Krone-Davis, and C. Ritz. 2012. Algae Biomonitoring and Assessment for Streams and Rivers of California's Central Coast. Final Report for Proposition 50 Grant Agreement No. 06-349-553-2

objectives for phosphorus in the Basin Plan on which to base a less stringent wet-season target. However, phosphorus targets for streams have been adopted in some other states. For example, the State of Nevada has a total phosphate criteria of 0.3 mg/L [11]. The State of Nevada total phosphate criteria of 0.3 mg/L has been adopted as a wet-season numeric target for three nutrient TMDLs in the central coast region[12]. As such, the proposed wet-season biostimulatory target for total phosphate is 0.3 mg/L. The basis for identifying the 0.3 mg/L wet-season phosphorus target is as follows:

1) Photo documentation, field observations, water quality data, and input provided by researchers (refer back to footnote 6) with expertise in eutrophication issues in the central coast region indicate evidence of algae problems and biostimulation in the summer months, and that eutrophication is primarily manifested as a summer-time water quality problem. In the winter, higher flows, cooler temperatures, lower light availability, and scouring evidently limit algal production. There are substantial uncertainties regarding the extent to which winter-time algal biomass problems manifest themselves, and about the extent to which winter-time loads of phosphorus ultimately contribute to biostimulation problems in the summer.
2) The State of Nevada has a total phosphate numeric criteria of 0.3 mg/L which has been used in three previously adopted nutrient TMDLs in the central coast region.
3) The proposed wet-season of 0.3 mg/L satisfies the conditions that a wet-season target at this time should be less stringent than a dry-season target, and the proposed target itself falls well within the range of high-end concentrations (sometimes greater than 0.3 mg/L) that can plausibly be expected under relatively undisturbed or reference conditions. In other words, 0.3 mg/L is consistent with high-end orthophosphate concentrations found in natural and lightly-disturbed stream systems, and consequently does not plausibly appear to be under-protective for use as a less stringent wet-season target.

However, it should be noted that research into eutrophication in inland surface streams and estuaries are an active and ongoing area of research. Should future research and studies indicate systematic biostimulatory impairments in the winter months, or contributions to summer-time biostimulation ultimately resulting from winter-time loading, Central Coast Water Board staff may consider extending the more stringent dry-season numeric targets into the wet-season.

Finally, nutrient TMDLs often embed a statistical threshold in targets developed for biostimulatory substances. This is because the application and use of the USEPA-recognized statistical approaches must consider that the published ecoregional approaches that underlies these statistical approaches inherently accounts for natural variability. Therefore, it would be inappropriate to expect Franklin Creek to not exhibit some natural variability, including concentrations that will ultimately be marginally higher than the proposed biostimulatory targets, as well as lower.

[11] USEPA, 1988. Phosphorus – Water Quality Standards Criteria Summaries: A Compilation of State/Federal Criteria. (Sept. 1988).
[12] Lower Salinas River Watershed Nutrient TMDL (Resolution R3-2013-0008), Santa Maria River Watershed Nutrient TMDL (Resolution R3-2013-0013), and the Pajaro River Nutrient TMDL (Resolution R3-2015-0004).

B.8 Final TMDL Numeric Targets for Biostimulatory Substances

Table 6 presents the final TMDL numeric targets for biostimulatory substances based on information contained in this appendix.

Table 6. Final TMDL numeric targets for biostimulatory substances.

Stream Reaches Assigned Total Nitrogen and Total Phosphorus Water Quality Targets				
Stream Reaches	**Allowable Total Nitrogen (mg/L)**	**Allowable Total Phosphorus (mg/L)**	**Methodology for Developing Numeric Target**	**Notes Pertaining to Development of Targets**
Franklin Creek (All reaches and tributaries)	**1.1** **Dry-Season Samples (May 1-Oct. 31)** **8.0** **Wet-Season Samples (Nov. 1-Apr. 30)**	**0.075** **Dry-Season Samples (May 1-Oct. 31)** **0.3** **Wet-Season Samples (Nov. 1-Apr. 30)**	Statistical Analysis (USEPA percentile-based approaches) Supplemented by Calif. NNE approach (NNE benthic biomass model tool) Wet-season targets based on Central Coastal Basin Plan nitrate objective and State of Nevada phosphate criteria for streams	Franklin Creek is specifically designated in the Central Coast Basin Plan (Table II-1) for cold freshwater aquatic habitat (COLD), and the assigned nutrient targets are protective of COLD habitat