Appendix D Nutrient Target Development

Contents

D.1 Introduction

The Central Coast Basin Plan has narrative criteria regarding 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." They do not however specify what levels of algal growth constitute a nuisance.

The Water Board is 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 a TMDL process with regard to development of nutrient water quality targets protective against biostimulation. Numeric targets should be scientifically defensible, but are not required to be definitive. Eutrophication is an ongoing and active area of research. 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and allocations that are potentially adopted for biostimulatory substances pursuant to this project may sunset and be superseded by revised water quality objectives.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 research on biostimuation on inland surface waters from 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 is insufficiently protective against biostimlatory impairments. Consequently, staff concludes that it is necessary to set nutrient numeric targets more stringent than the existing numeric objectives found for nitrate in the Basin Plan (i.e., the 10 mg/L MUN objective).

In USEPA (2000) nutrient criteria guidance for streams, three general approaches for criteria setting are recommended:

(1) Statistical analysis of data: identification of reference reaches for each stream class based on best professional judgment or percentile selections of data plotted as frequency distributions;

(2) use of predictive relationships (e.g., trophic state classifications, models, biocriteria); and

(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.

[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 Huuertos, Ph.D., project director.

USEPA-recommended approaches for developing nutrient criteria.

USEPA-Recommended Approaches	Approach Assessed in this TMDL project?	Methodology	Notes
Use of **Predictive Relationships** (modeling; biocriteria)	☑	California NNE Approach	Staff used NNE benthic biomass model tool to supplement and corroborate targets based on USEPA-recognized statistical approaches
Statistical Analysis of Data	☑	USEPA-recommended statistical analysis: 25th percentile of nutrient data for stream population	Staff used USEPA recognized[h] statisitcal 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 finds subecoregion III-6 criteria are inappropriate, and over-protective for the TMDL project area . The ecoregional-scale approach lumps together streams of with significantly different characteristics: headwater streams, alluvial valley streams, coastal confluence streams, etc. USEPA itself recognizes ecoregional criteria may not sufficiently address local variation.

Staff followed USEPA guidance in developing draft target with the goal being to account for physical and hydrologic variation within the TMDL project area (see *Nutrient Criteria Technical Guidance Manual, River and Streams* - USEPA July 2000). Nutrient criteria need to be developed to account for natural variation existing at the regional and basin level. Different waterbody processes and responses dictate that nutrient criteria be specific to waterbody type. No single criterion will be sufficient for each waterbody type. USEPA recommends classifying and group streams by type or comparable characteristics (e.g., fluvial morphology, hydraulics, physical, biological or water quality attributes). Classification will allow criteria to be identified on a broader scale rather than a site-specific scale. The aforementioned stream classification recommendation by USEPA is supported by recent research published for California's central coast region, as illustrated below:

> "*Sections of the Pajaro River watershed have been listed by the State of California as impaired for nutrient and sediment violations under the Clean Water Act ……**The best evidence linking elevated nutrient concentrations to algae growth was shown when the stream physiography, geomorphology, and water chemistry were incorporated into the survey and analysis."****
>
> ***emphasis added***
>
> *From: University of California, Santa Cruz. Final Report: Long-Term, High Resolution Nutrient and Sediment Monitoring and Characterizing In-stream Primary Production. Proposition 40 Agricultural Water Quality Grant Program.*

Staff used USEPA's 25th percentile approach for developing nutrient targets. 25th percentile values are characterized by USEPA as criteria recommendations that could be used to protect waters against nutrient over-enrichment (USEPA, 2000)[2]. This is because the 25th percentile of the entire population has been shown by USEPA to represent a surrogate for an actual reference population.

An additional line of evidence for establishing nutrient water quality targets in the TMDL project area was provided by an application of the California Nutrient Numeric Endpoint (California NNE) approach (Tetra Tech 2006). Use of the USEPA 25th percentile approach in conjunction with the NNE spreadsheet provide an additional line of evidence, and also may help corroborate the reasonableness USEPA 25th percentile approach nutrient targets.

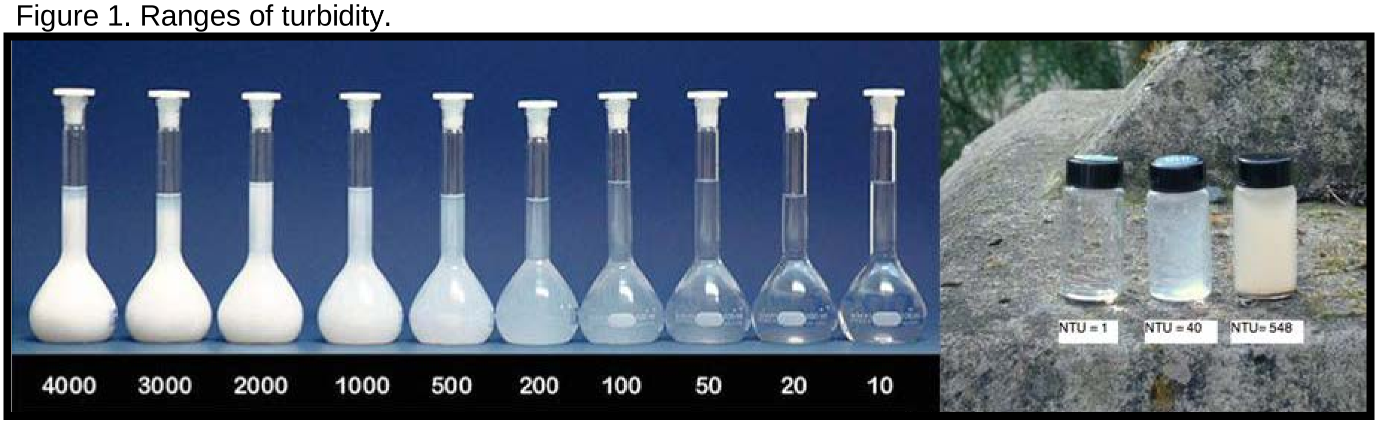
[2] U.S. Environmental Protection Agency. 2000. Nutrient Criteria Technical Guidance Manual, River and Streams. EPA-822-B-00-002.

It is important to recognize that the Calif. NNE spreadsheet tool is highly sensitive to user inputs for tree canopy shading and turbidity. Shading and turbidity have significant effects on light availability, and consequently photosynthesis and potential biostimulation. The light extinction coefficient is an important input parameter to the NNE spreadsheet tool. This coefficient is calculated in the spreadsheet as a function of turbidity. Higher levels of turbidity can preclude good sunlight penetration:

> *"...when nutrients are as high as they are in this system, talking about limiting nutrients probably isn't that relevant. In those cases,* ***light is probably what actually limits production*** *either* ***<u>because of turbidity</u>*** *which keeps overall biomass low or surface blooms which reduce light levels at depth."**
>
> **emphasis added*
>
> *— Dr. Jane Caffrey (University of West Florida), personal communication to Water Board staff, Sept. 12, 2011*

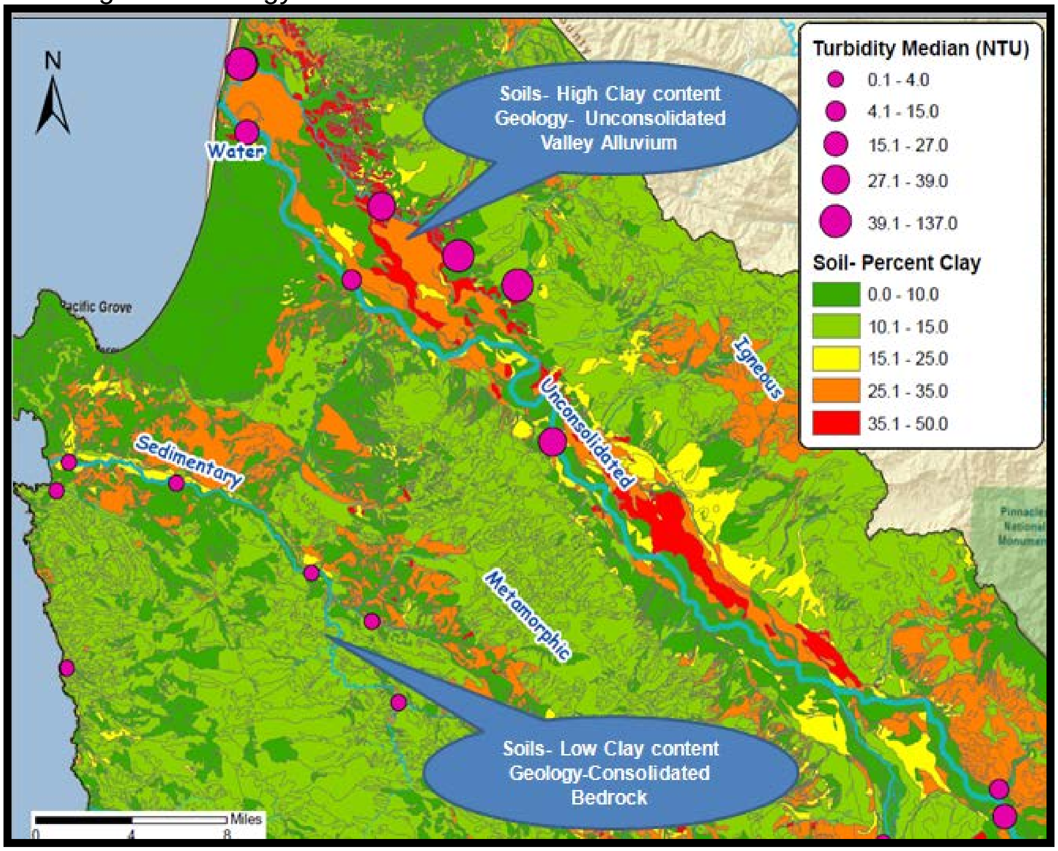
Nutrient target results provided by the NNE spreadsheet tool can vary substantially, based on even small changes in turbidity input. As such, it important it is to have plausible canopy and turbidity conditions that are reasonably representative of reach-scale conditions. The default value in the NNE spreadsheet tool is 0.6 NTU. The USEPA (2000) ecoregional criteria (Ecoregion III-6) for turbidity in reference conditions is 1.9 NTU. Both of these values (0.6 NTU and 1.9 NTU) represent ambient conditions in relatively undisturbed reference streams. It should be noted that relatively, undisturbed ambient turbidity conditions in some agricultural alluvial valley floor waterbodies may be closer to 20 or 30 NTU. For illustrative purposes, Figure 1 illustrates the appearance of water with various ranges of turbidity.

Figure 1. Ranges of turbidity.



Further, a cursory evaluation of water column turbidity, soil conditions, and regional geology illustrate the substantial variability in ambient conditions even at reach-scale or watershed-scale. Figure 2 illustrates that in northern Monterey County, turbidity conditions in an agricultural alluvial valley, with clay-rich soils and substrates will likely have substantially different ambient or relatively undisturbed turbidity conditions relative to stream reaches in upland areas, or areas underlain by consolidated bedrock and sandy soil and substrate conditions. A difference in five or ten NTU turbidity input into the NNE spreadsheet tool will provide significantly different results. It is noteworthy that in areas with clay-rich soil conditions and substrates, ambient turbidity is likely to be much higher (see figure below). Unlike sand, silt, or gravel, which are typically transported as bedload, clay is often transported in colloidal suspension in the water column even at very low stream velocities, thereby contributing to ambient turbidity.

Figure 2. Northern Monterey County, Water Column Turbidity (Median NTU), Soil Texture (% Clay), and Regional Geology.



The basis for staff's previous comment about the expectation of higher ambient turbidity levels in agricultural drainages (up to 20 or 30 NTU) are summarized below:

1) Peer-reviewed literature: It is recognized in the peer-reviewed literature that the hydraulics and substrates of agricultural water conveyance structures, such as canals and ditches, are often substantially different than natural streams, and can result in higher levels of turbidity under relatively undisturbed conditions.

> ***"The turbidity of irrigation water increases as it travels through delivery ditches, which are bare earth and add suspended solids via erosion"***
>
> *From: Research Article - "Monitoring helps reduce water-quality impacts in flood-irrigation pasture". Ken Tate, Donald Lancaster, Julie Morrison, David Lile, Yukako Sado, and Betsy Huang, in California Agriculture 59(3):168-175.*

2) Agricultural drain monitoring data: A large body of monitoring data from agricultural drains in the Central Valley and Salinas Valley of California indicate that an average expected 25th percentile of turbidity data is 21 NTU (representing a relatively unimpacted condition) – see the figure below. This is consistent with staff's comment in the project report about the expectation of relatively higher levels and valley floor agricultural drainages.

Further, as shown in Figure 3 below, expected relatively undisturbed conditions in agricultural drainages could be around 20 NTU, which is far higher than natural streams. The USEPA ecoregional criteria for subecoregion 1.9 NTU (see Figure 4), which is unreasonably low for many agricultural valley floor drainages.

Figure 3. Turbidity data from agricultural dainages in California.

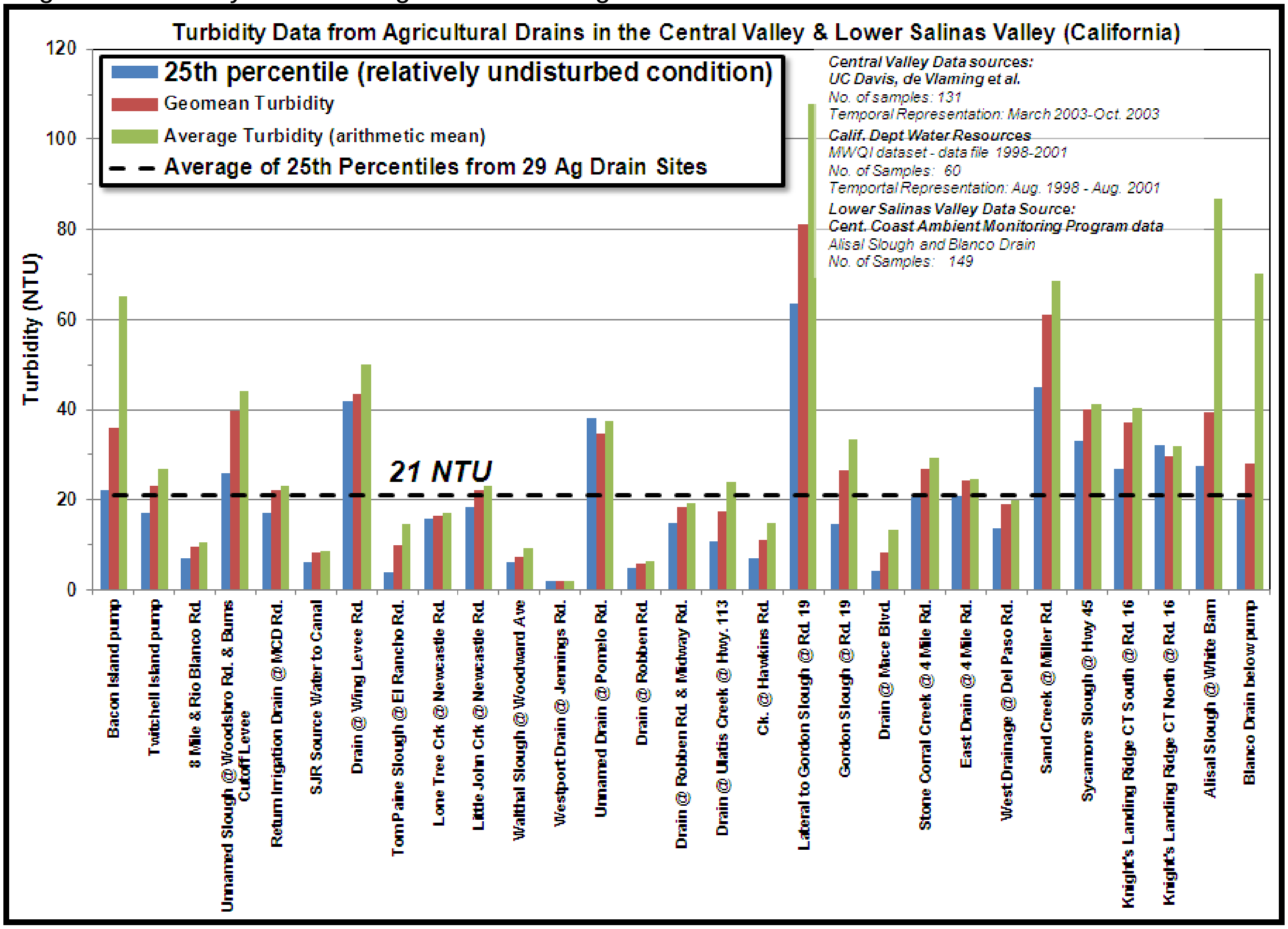
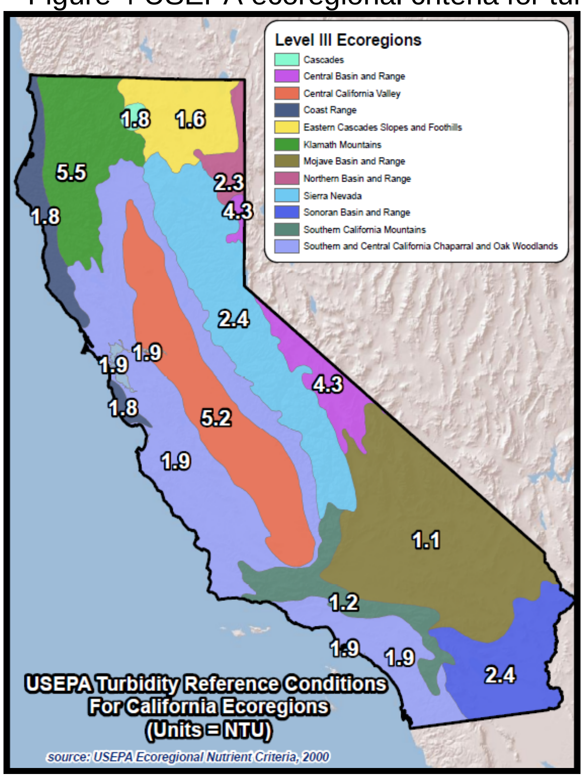


Figure 4 USEPA ecoregional criteria for turbidity.



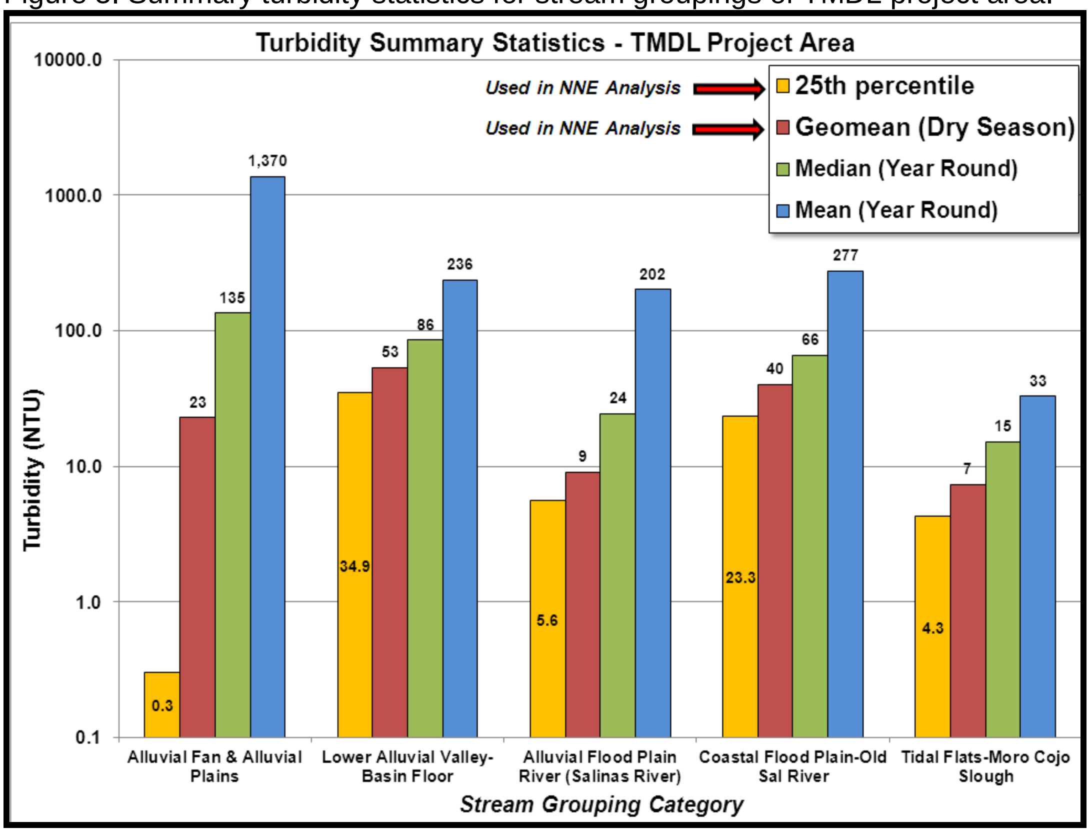
As turbidity is a senstitive input value into the Calif. NNE spreadsheet tool, staff concluded that plausible reach-scale turbidity inputs should represent a range from relatively undisturbed (ambient-25th percentile of data population) conditions to lightly-to-moderately disturbed conditions at the high end. Higher turbidity conditions that may reflect substantial anthropogenic activities and impacts were not included in the NNE spreadsheet inputs.

This approach conceptually is also consistent with the recommendations received from a scientific peer reviewer for this TMDL project:

> *"I would argue that the turbidity conditions that drive NNE modeling should be indicative of the **ambient** or **moderately** disturbed conditions*."*
>
> - Dr. Marc Beutel, Washington State University, peer reviewer for this TMDL project (see Appendix 5 to the Staff Report)
>
> ***** emphasis added by Water Board staff

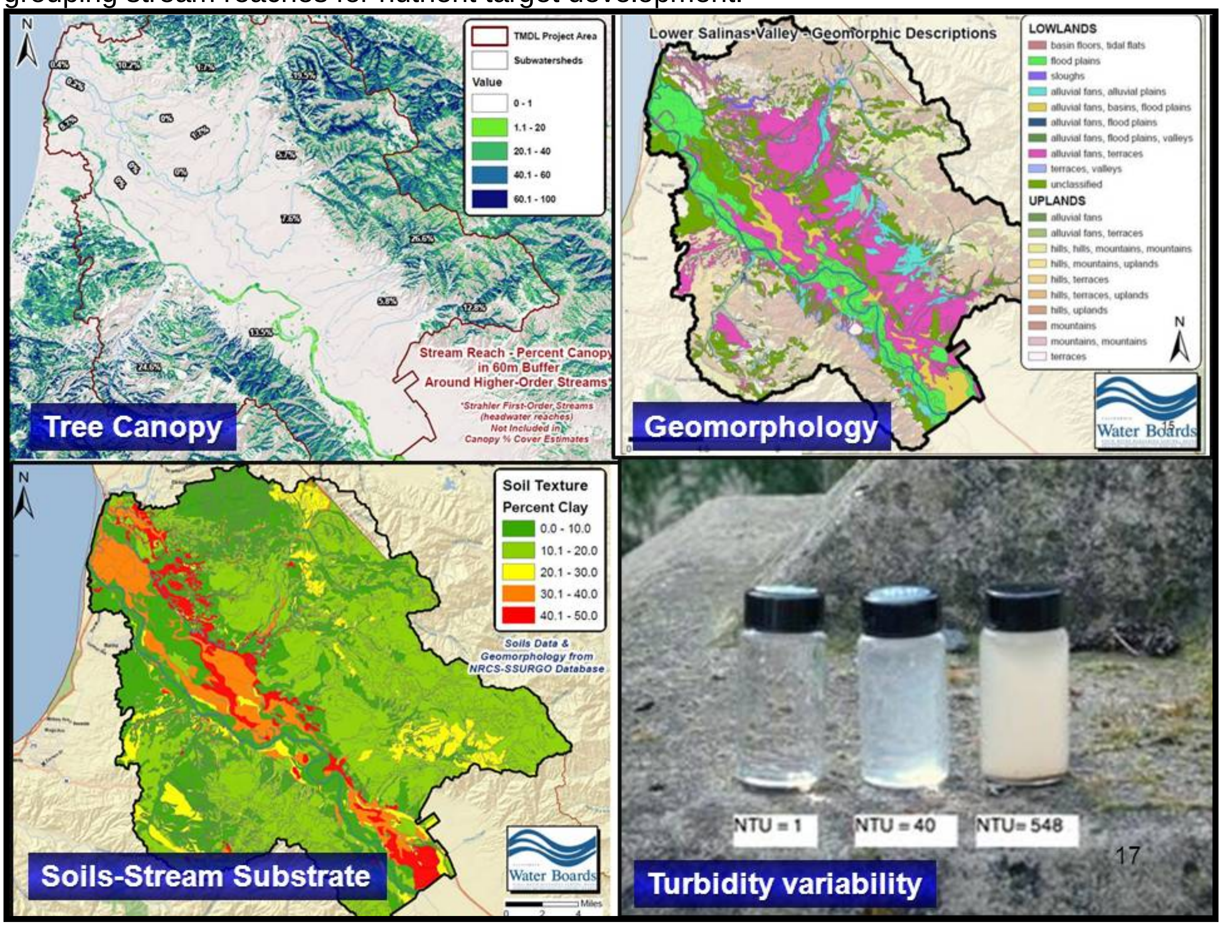
In fact, the upper, high-end NNE spreadsheet turbidity values staff used (dry season geomean – see sections D.4 through D.8) can plausibly be characterized as a lightly-to-moderately disturbed conditions. As our peer review referee Dr. Buetel, suggests above, it would be reasonable to use a range of ambient to *moderately disturbed turbidity* inputs in the NNE spreadsheet runs to represent reach conditions under which there are not substantial anthropogenic inputs. Figure 5 illustrates that for each stream grouping in the TMDL project area, the NNE turbidity dry-season geomean input values staff used are generally an order of magnitude lower than year-round averages (arithmetic mean) turbidity for each respective stream grouping. Further, the dry-season geomean turbidity input values also range 39% to 83% lower than the median turbidity value for each stream grouping (the median value represent the 50th percentile of the data population). Therefore, staff maintains that the dry-season geomean turbidity value of each stream grouping can fairly be characterized as a lightly-to-moderately disturbed condition; e.g. they are substantially lower than the average or median measures of turbidity in each respective stream grouping.

Figure 5. Summary turbidity statistics for stream groupings of TMDL project area.



Staff used field observations and digital datasets for tree canopy cover (source: National Land Cover Dataset, 2001) as presented in the Project Report, to estimate plausible canopy shading for stream categories. Additionally, as noted previously, stream geomorphology and stream physiography is important to consider with respect to establishing linkages between nutrient concentrations and algal growth (UC Santa Cruz, 2010)[3]. Consequently, staff used geomorphic classifications and soil properties data from the NRCS-SSURGO database (presented in the Project Report) to assist in classifying and grouping streams with comparable characteristics. Figure 6 conceptually illustrates some of the stream-reach and water column properties staff evaluated in grouping and classifying stream reaches with comparable characteristics, consistent with USEPA guidance.

Figure 6. Conceptual illustration of stream reach and water column characteristics used by staff in grouping stream reaches for nutrient target development.



D.2 California Nutrient Numeric Endpoints Approach

As noted previously, an additional line of evidence for establishing nutrient water quality targets in the TMDL project area was provided by an application of the California Nutrient Numeric Endpoint (California NNE) approach (Tetra Tech 2006). The California NNE approach is to use nutrient response indicators to develop potential nutrient water quality criteria. The California NNE approach also includes a set of relatively simple spreadsheet scoping tools for application in lake/reservoir or

[3] 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.

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 models (e.g., QUAL2K) 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 risk categories for indicators (measures of algal growth and oxygen deficit): 1) Presumably unimpaired; 2) Potentially impaired; 3) Likely impaired. Additional detail on the three risk categories is provided by TetraTech, 2007, as 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.

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

Nutrient Numeric Endpoints for Secondary Indicators – Risk Classification 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	I / II	5	10	10	10	5	A	B
(as µg/L Chl-a)[2] – summer mean	II / III	10	25	20	25	10	A	B
Clarity (Secchi depth, meters.)[3] – lakes summer	I / II	A	A	2	2	A	A	B
mean	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 –	I / II	9.0	9.0	A	A	A	C	C
photosynthesis driven	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

Staff developed nitrogen and phosphorus NNE nutrient targets in this appendix using existing NNE predictor run spreadsheet templates developed by the Water Board's Central Coast Ambient Monitoring Program staff available at http://www.ccamp.us/nne/nne_runs/

D.3 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, etc., 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 targets by using a combination of recognized methods to bracket and calibrate nutrient targets appropriate to local conditions, and that are credibly neither over-protective nor under-protective. The USEPA nutrient criteria technical guidance manual for rivers prescribes a combination of several approaches when developing water quality criteria for nutrients, including

1) the application of reference conditions;
2) predictive stressor-response relationships; and
3) values from existing literature.

Both USEPA and researchers (UC Santa Cruz, 2010-refer back to footnote 1) have recognized that combining these approaches help in the development of scientifically valid numeric objectives for nutrients. Staff used a range recognized nutrient target development methodologies, the USEPA recognized statistical-approaches, and the CA NNE approach. Additionally, staff identified a plausible range of ambient reach-scale stream conditions to account for local variation. This is consistent with USEPA guidance to group streams by type or comparable characteristics, thereby allowing nutrient criteria to be applied such that they account for spatial variations in stream characteristics.

The aforementioned approaches have different strengths. The CA 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 25th percentile approach is a statistical approach, which can provide a plausible approximation of nutrient concentrations one might expect during a relatively undisturbed state and given local conditions. An important tenet of the California NNE approach (Tetra Tech 2006)[4] is that targets should not be set lower than the value expected under background or relatively undisturbed conditions. Therefore, the 25th percentile USEPA approach can help satisfy the caveat those targets should not be set lower than expected under local background, or relatively undisturbed conditions.

Further, staff received guidance from a researcher with expertise in central coast biostimulation problems that nutrient targets should not be more stringent than nutrient concentrations found in natural systems in the Salinas River basin. Therefore, 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 the Salinas River basin.

In summary, staff was able to evaluate a range of plausible nutrient targets for identified stream reaches using the strengths of various approaches. After establishing plausible ranges of potential

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

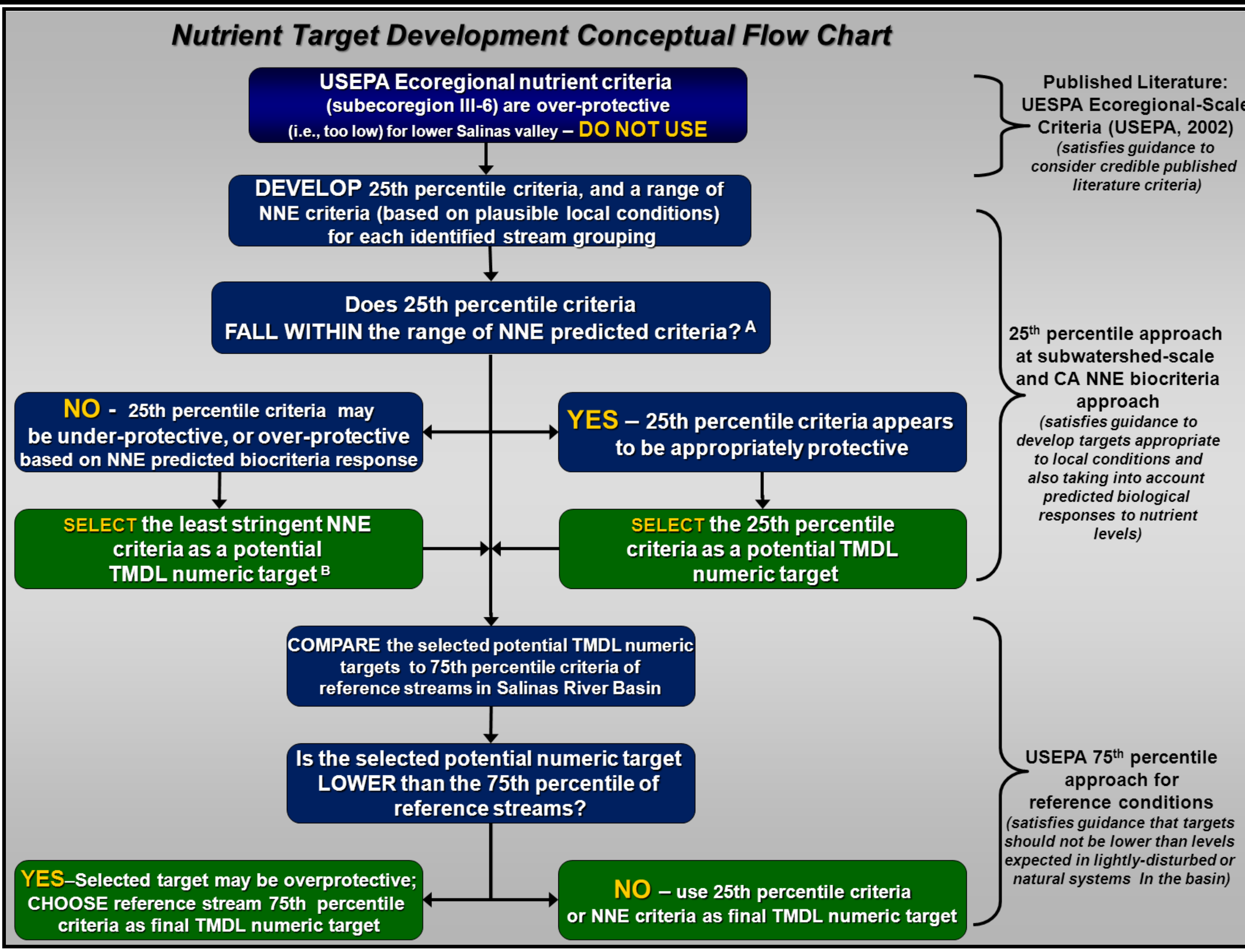
nutrient targets using the aforementioned methodologies, the development and selection of final nutrient TMDL targets were determined using the following hierarchical approach, as illustrated below:

Summary of published technical guidance used by staff in nutrient target development:

- ✓ Using a combination of recognized approaches (i.e., literature values, statistical approaches, predictive modeling approaches) result in criteria of greater scientific validity (source: USEPA, 2000. Nutrient Criteria Manual).
- ✓ Classify and group streams needing nutrient targets, based on similar characteristics (source: USEPA, 2000. Nutrient Criteria Manual).
- ✓ Targets should not be lower than expected concentrations found in background/natural conditions (source: Calif. NNE guidance – TetraTech, 2006).

See Figure 7 for a conceptual flow chart of the nutrient target development approach used in this TMDL project.

Figure 7. Nutrient target selection conceptual flow chart.

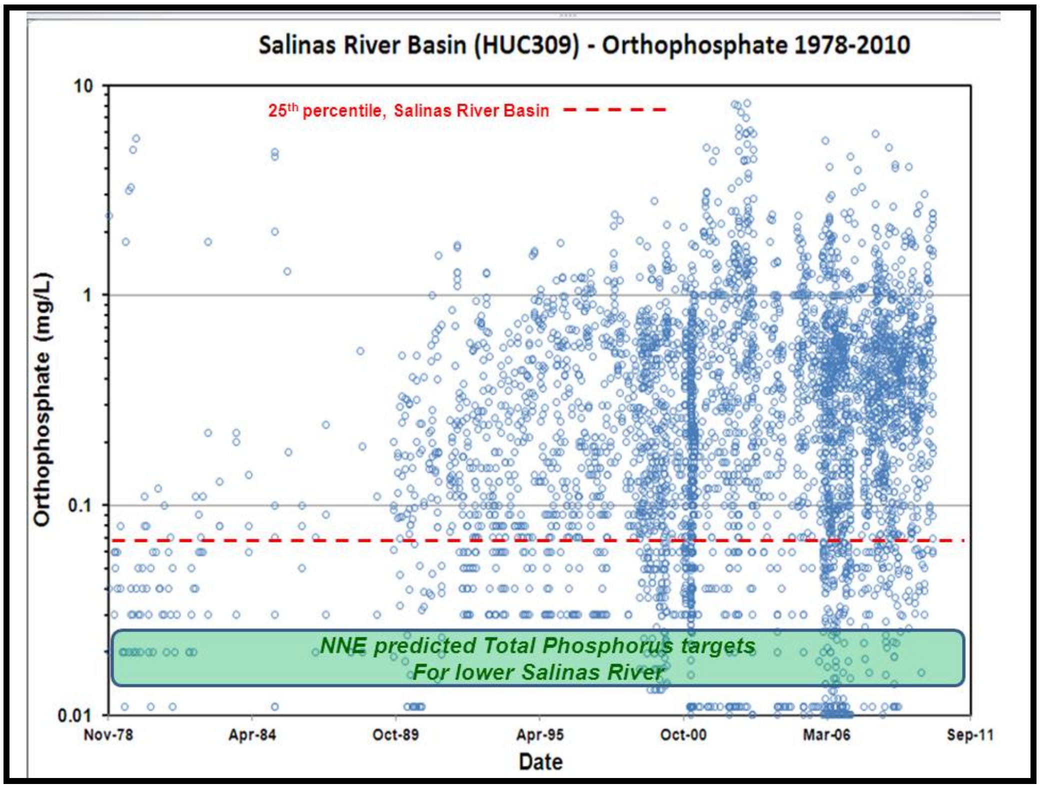


Notes:

[A] Orthophosphate targets developed with percentile-based approaches were not calibrated to NNE results. NNE only provides results for total phosphorus which may not be a good measure of orthophosphate. In contract, nitrate typically comprises over 95% of water column total Nitrogen (TN) in project area streams; therefore, nitrate is a plausible surrogate for total nitrogen and can be compared to NNE TN target predictions.

[B] 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.)

Note that orthophosphate numeric targets were based on USEPA 25th percentile methods. The CA NNE spreadsheet tool only calculates total phosphorus targets. In general, total phosphorus is not an adequate measurement of water column orthophosphate. Orthophosphate is only a fraction to total water column phosphorus. In addition, CA NNE calculations of total phosphorus generally appear to estimate targets that are lower than values expected under natural conditions in the Salinas River Basin. The total phosphorus targets predicted by NNE for project area waterbodies are even below USEPA's subecoregion III-6 total phosphorus criteria (0.03 mg/L). As such, these NNE values could be reasonably be considered over-protective. In addition, when NNE predicted targets for total phosphorus are plotted on a graph of orthophosphate data from throughout the Salinas River basin, the NNE predicted targets for phosphorus appear to be unreasonably low (see figure below). As such, staff followed guidance to develop targets that are not below (i.e., more stringent) than concentrations expected under natural conditions; therefore, staff used the 25th percentiles for orthophosphate as TMDL numeric targets.



The following sections of this Appendix present information pertaining to development of nutrient targets for project area waterbodies.

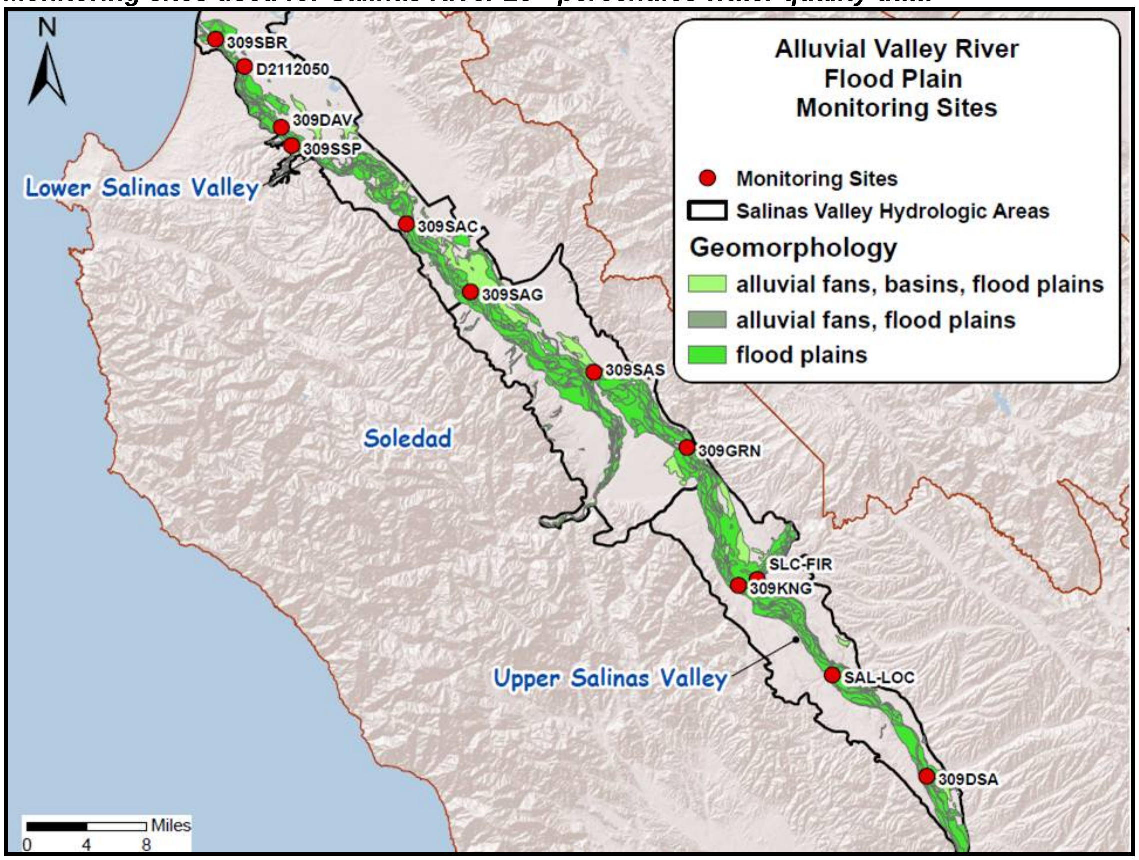
D.4 Lower Salinas River – Alluvial Valley Floodplain River

D.4.1 Lower Salinas River 25th Percentile Targets

Stream Conditions

- Geomorphic description: Alluvial valley river; alluvial floodplain (source: NRCS-SSURGO)
- Estimated average riparian tree canopy: 13.5% (source: NLCD, 2001 canopy raster, field observation)
- Substrate-soils: Dominantly sandy; <10% clay (source: NRCS-SSURGO)
- Turbidity conditions: 6 NTU (25th percentile-year round); 9 NTU (geomean-dry season, May-Oct.); 20.5 NTU (median-dry season, May-Oct)

Monitoring sites used for Salinas River 25th percentiles water quality data



Alluvial Valley River - flood plain: Statistical Summary

Salinas River - Soledad to Lagoon @ Monterey Bay *Stream geomorphic description: Alluvial valley - floodplain* **Statistical Summary of Nitrate-N**	
Temporal Representation	July 1965 to Dec. 2010
Mean	7.467873042
Standard Error	0.362364006
Median	2.938
Mode	2
Standard Deviation	10.71887185
Range	77.9976
Minimum	0.0024
Maximum	78
No. of samples	875
25th percentile	**1.0**

Salinas River - Soledad to Lagoon @ Monterey Bay *Stream geomorphic description: Alluvial valley - floodplain* **Statistical Summary of Orthophosphate-P**	
Temporal Representation	July 1965 to March 2010
Mean	1.237583006
Standard Error	0.178862758
Median	0.084
Mode	0.03
Standard Deviation	5.684347372
Range	60.996
Minimum	0.004
Maximum	61
No. of samples	1010
25th percentile	**0.04**

D.4.2 Lower Salinas River Nutrient Numeric Endpoint Analysis (Calif. NNE Approach)

The lower Salinas River is specifically designated for cold freshwater aquatic habitat (COLD) in Table II-1 of the Basin Plan; therefore NNE analysis was limited to the BURC II /III category for COLD beneficial use.

Site:	Salinas Riv - Alluvial Valley Flood Plain
Analyst:	PAO
Date:	10/4/2011 0:00

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

(based on plausible ranges of local conditions)

- 0% Tree Canopy Closure

- Ambient (low) Turbidity (6 NTU):

6 NTU turbidity = 25th percentile of Salinas River monitoring sites used in 25th percentile analysis

Unshaded Solar Radiation (cal/cm²/d)

	Average	Minimum	Maximum
Enter manually	424	184	649

	Latitude	Month Range	
Estimate (selected)	36.70	Jan	Dec

Stream Inputs

Stream Depth (m)	0.5
Stream Velocity (m/s)	0.3
Water Temperature (°C)	18.0
Days of Accrual (optional)	365
Canopy Closure	0% (selected) / 20% / 40% / 80%
Light Extinction Coeff. (1/m)	1.04

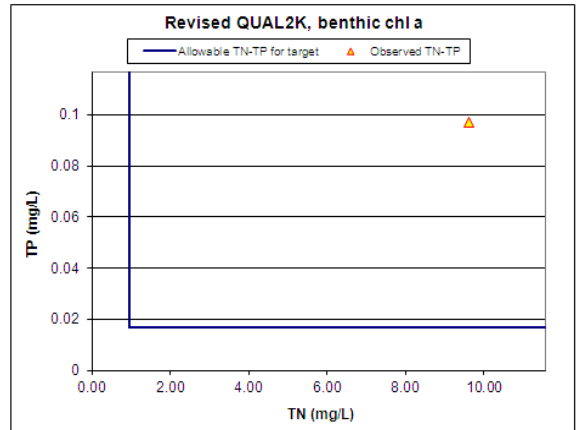
Calculate

Method & Target Selection

Select Method:	Revised QUAL2K, benthic chl a
Target Benthic Chl a (mg/m^2)	150
Corresponding Algal Density (g/m^2 AFDW)	60

California Benthic Biomass Tool, v13 (February 2007)

Max algal contribution to DO deficit (mg/L)	6.61



Allowable TN: 0.97 Allowable TP: 0.017

Site:	Salinas Riv - Alluvial Valley Flood Plain
Analyst:	PAO
Date:	10/4/2011 0:00

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

(based on plausible ranges of local conditions)

- 20% Tree Canopy Closure

- Geomean Dry Season Turbidity (9 NTU):

9 NTU turbidity = turbidity geomean of May-Oct sample of Salinas River monitoring sites used in 25th percentile analysis

Unshaded Solar Radiation (cal/cm²/d)

	Average	Minimum	Maximum
Enter manually	424	184	649

	Latitude	Month Range	
Estimate (selected)	36.70	Jan	Dec

Stream Inputs

Stream Depth (m)	0.5
Stream Velocity (m/s)	0.3
Water Temperature (°C)	18.0
Days of Accrual (optional)	365
Canopy Closure	0% / 20% (selected) / 40% / 80%
Light Extinction Coeff. (1/m)	1.34

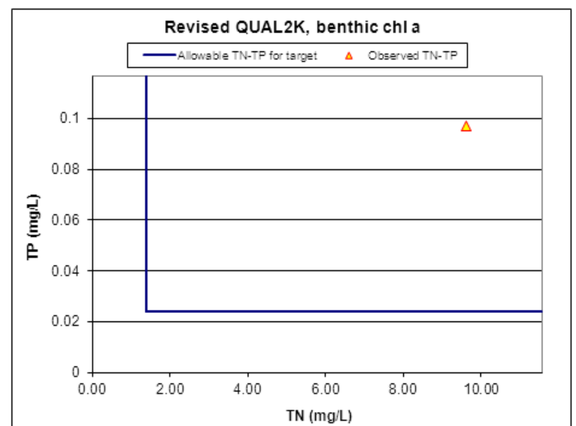
Calculate

Method & Target Selection

Select Method:	Revised QUAL2K, benthic chl a
Target Benthic Chl a (mg/m^2)	150
Corresponding Algal Density (g/m^2 AFDW)	60

California Benthic Biomass Tool, v13 (February 2007)

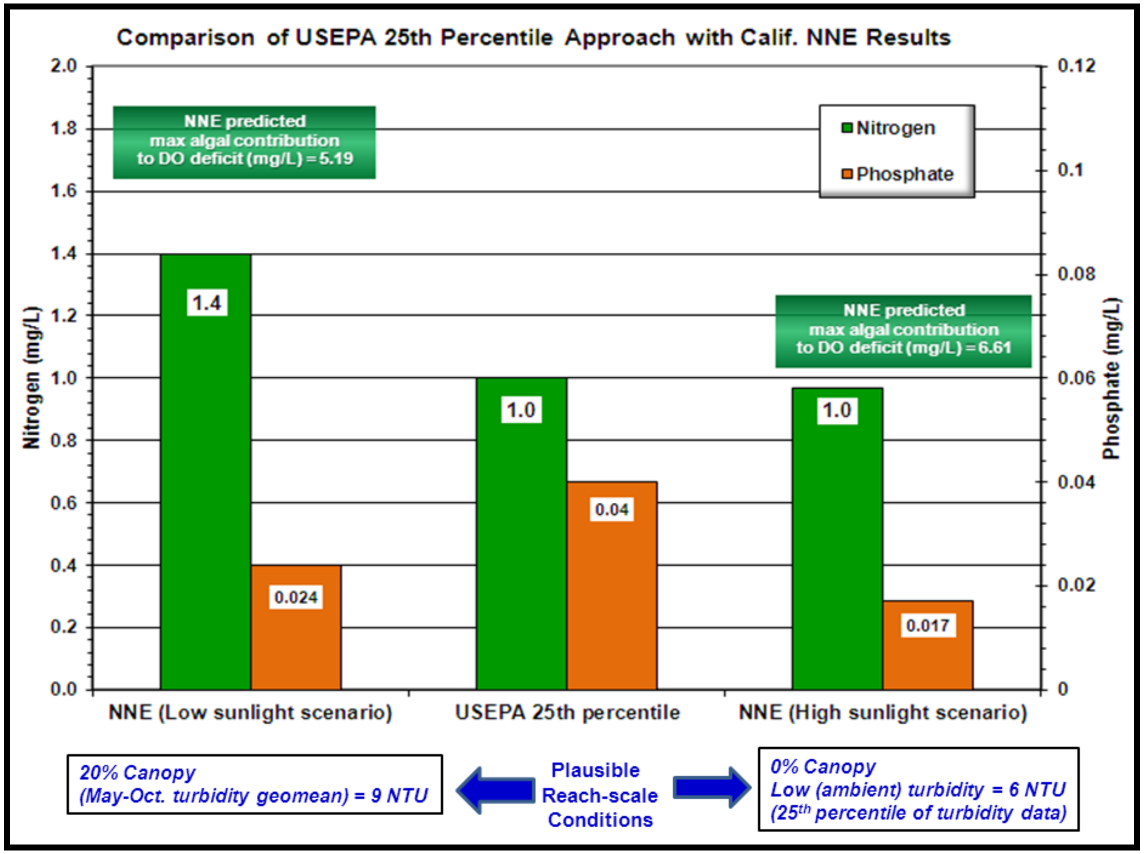
Max algal contribution to DO deficit (mg/L)	5.19



Allowable TN: 1.4 Allowable TP: 0.024

D.4.3 Comparison of USEPA 25th Percentile Approach and Calif. NNE Approach (Lower Salinas River)

The USEPA 25th percentile targets shown previously are show relative to the NNE Higher Sunlight Availability and NNE Lower Sunlight Availability scenarios, as shown in the figure below. This suggests the 25th percentile targets are in reasonably good agreement with NNE predicted nutrient targets that are based on plausible ranges of observed local conditions It is important to note that the 25th percentiles are calculated on nitrate-N and orthophosphate-P. These constituents are not directly comparable to the total N and total P results that the Calif. NNE spreadsheet tool provides, nevertheless nitrate is typically over 95% of total water column nitrogen in project area inland streams, Orthophosphate is estimated to generally (but not always) be the largest fraction of water column phosphorus in project area inland streams. For purposes of comparing the 25th percentile methodology and the NNE approach, nitrate and orthophosphate are plausible surrogates for total N and P in project area streams. The USEPA 25th percentile targets are shown relative to the NNE Higher Sunlight Availability and NNE Lower Sunlight Availability scenarios, as shown in the figure below. In this case, the 25th percentile criteria is exactly equal to the marginally more stringent NNE criteria (1.0 mg/L). Consistent with the nutrient target development approach outlined in Section D.3, the marginally less stringent NNE criteria is identified here as a potential numeric target. Therefore, marginally less stringent NNE criteria (1.4 mg/L) and the 25th percentile for orthophosphate (0.04 mg/L) are selected as potential numeric targets for this stream reach.



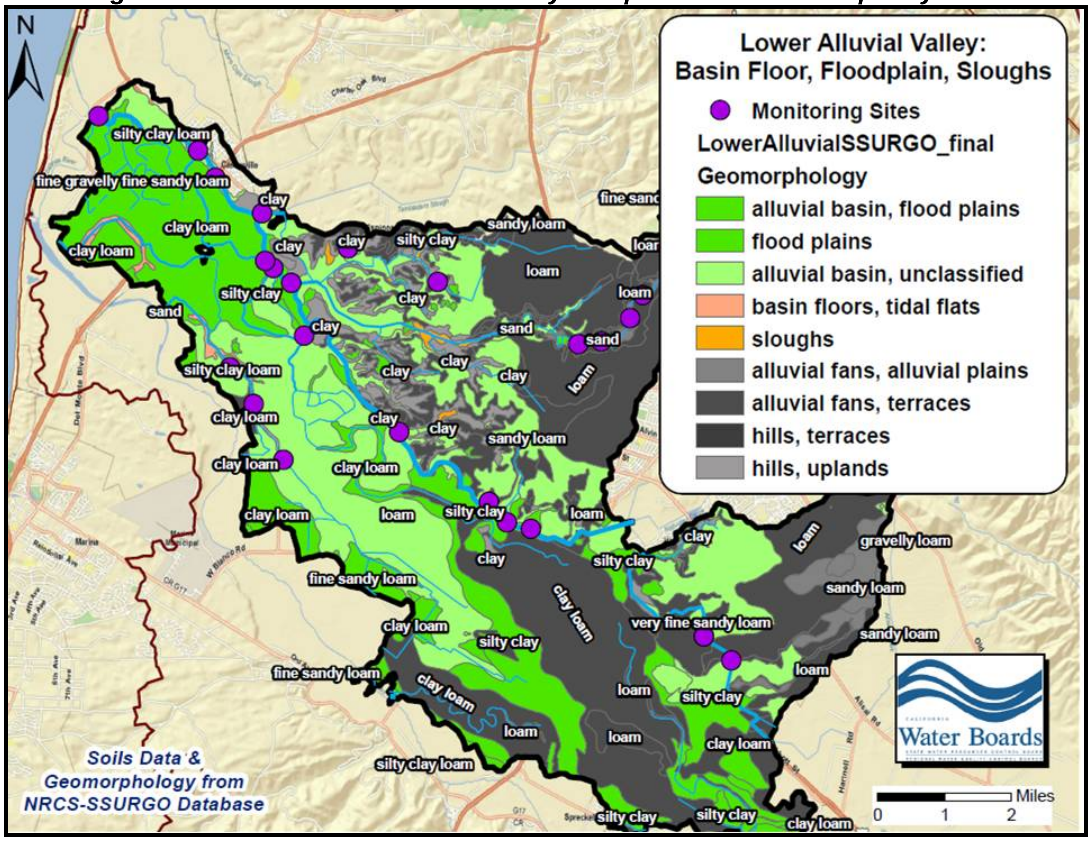
D.5 Lower Alluvial Valley - Basin Floor Stream Reaches

D.5.1 Lower Alluvial Valley Basin Floor Streams and Sloughs 25th Percentile Targets

Stream Conditions

- Geomorphic description: Alluvial basin floor; floodplain, sloughs. Low gradient, slopes less than 1 degree (source: NRCS-SSURGO)
- Waterbodies: Alisal Slough, Blanco Drain, Espinosa Slough, Merritt Ditch, Reclamation Canal, Santa Rita Creek, Tembladero Slough
- Estimated riparian tree canopy: close to 0% (source: NLCD, 2001 canopy raster, field observation)
- Substrate-soils: Dominantly fine-grained: clays, clay loams, silty clays (source: NRCS-SSURGO)
- Turbidity conditions: 35 NTU (25th percentile-year round); 53 NTU (geomean-dry season, May-Oct.); 56 NTU (median-dry season, May-Oct)

Monitoring sites used for lower alluvial valley 25th percentiles water quality data



Agricultural Alluvial Valley Inland Streams:
Basin floor, sloughs, and flood plain: Statistical Summary.

Reclamation Canal, Tembladero Slough, Alisal Slough, Santa Rita Creek, Blanco Drain
Stream Geomorphic Description: Agricultural Valley Inland Streams - Basin Floor, Slough, and Floodplains
Statistical Summary of Nitrate-N

Temporal Representation	**Nov. 1971 – Dec. 2009**
Mean	22.70226313
Standard Error	0.939154872
Median	15.417
Mode	0.036
Standard Deviation	26.62963663
Range	439.975
Minimum	0.025
Maximum	440
No. of Samples	804
25th percentile	6.4

Reclamation Canal, Tembladero Slough, Alisal Slough, Santa Rita Creek, Blanco Drain
Stream Geomorphic Description: Agricultural Valley Inland Streams - Basin Floor, Slough, and Floodplains
Statistical Summary of Orthophosphate-P

Temporal Representation	**Nov. 1971 – Mar. 2010**
Mean	0.593975919
Standard Error	0.031233157
Median	0.34625
Mode	0.0075
Standard Deviation	1.330986993
Range	29.7925
Minimum	0.0075
Maximum	29.8
No. of Samples	1816
25th percentile	0.125

D.5.2 Alluvial Basin Floor Streams and Sloughs Nutrient Numeric Endpoint Analysis (Calif. NNE Approach)

Site:	Lower Alluvial Valley - Basin Floor Sites
Analyst:	PAO
Date:	10/8/2011 16:32

NNE Parameters:

- Beneficial Use Risk-Classification: (BURC): II / III
- Beneficial Use: **WARM**
- Response Variable: Benthic Algal biomass in streams
- Numeric Target: 200 mg chl-a/m^2
- Method: Revised QUAL2k, benthic chl a

Stream Condition Input:

Higher Sunlight Availability Scenario

(based on plausible ranges of local conditions)

- 0% Tree Canopy Closure

- Ambient (low) Turbidity (35 NTU)

35 NTU turbidity = 25th percentile of lower alluvial valley monitoring sites used in 25th percentile analysis

Unshaded Solar Radiation (cal/cm^2/d)

	Average	Minimum	Maximum
○ Enter manually	424	184	649
	Latitude	Month Range	
◉ Estimate	36.70	Jan	Dec

Stream Inputs

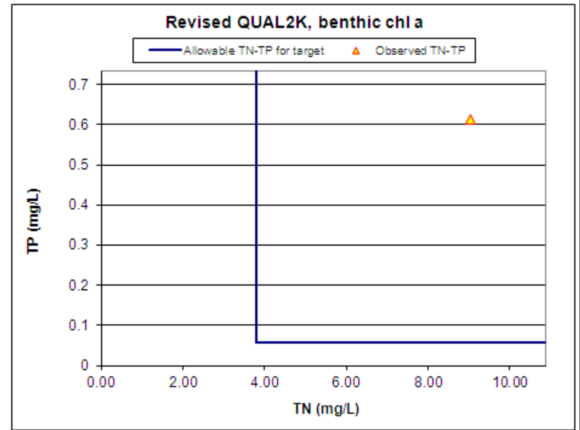
Stream Depth (m)	0.5
Stream Velocity (m/s)	0.3
Water Temperature (°C)	18.1
Days of Accrual (optional)	365
Canopy Closure	◉ 0% ○ 20% ○ 40% ○ 80%
Light Extinction Coeff. (1/m)	3.94 ← Calculate

Method & Target Selection

Select Method:	Revised QUAL2K, benthic chl a
Target Benthic Chl a (mg/m^2)	200
Corresponding Algal Density (g/m^2 AFDW)	80

California Benthic Biomass Tool, v13 (February 2007)

Max algal contribution to DO deficit (mg/L)	4.97



Allowable TN: 3.8 Allowable TP: 0.058

Site:	Lower Alluvial Valley - Basin Floor Sites
Analyst:	PAO
Date:	10/8/2011 16:32

NNE Parameters:

- Beneficial Use Risk-Classification: (BURC): II / III
- Beneficial Use: **WARM**
- Response Variable: Benthic Algal biomass in streams
- Numeric Target: 200 mg chl-a/m^{2}rclark@mlml.calstate.edu
- Method: Revised QUAL2k, benthic chl a

Stream Condition Input:

Lower Sunlight Availability Scenario

(based on plausible ranges of local conditions)

- 0% Tree Canopy Closure

- Geomean Dry Season Turbidity (53 NTU)

53 NTU turbidity = turbidity geomean of May-Oct. samples of lower alluvial valley monitoring sites used in 25th percentile analysis

Unshaded Solar Radiation (cal/cm^2/d)

	Average	Minimum	Maximum
○ Enter manually	424	184	649
	Latitude	Month Range	
◉ Estimate	36.70	Jan	Dec

Stream Inputs

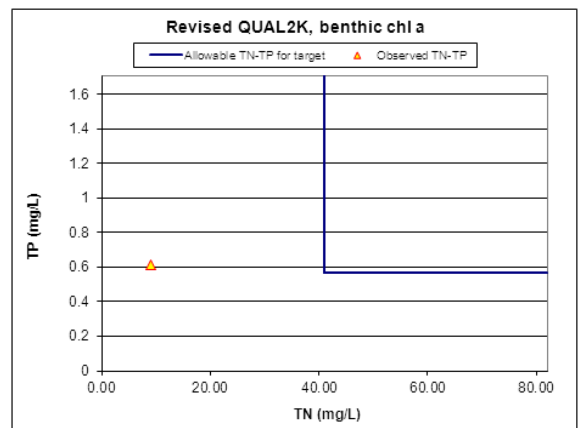
Stream Depth (m)	0.5
Stream Velocity (m/s)	0.3
Water Temperature (°C)	18.1
Days of Accrual (optional)	365
Canopy Closure	◉ 0% ○ 20% ○ 40% ○ 80%
Light Extinction Coeff. (1/m)	5.74 ← Calculate

Method & Target Selection

Select Method:	Revised QUAL2K, benthic chl a
Target Benthic Chl a (mg/m^2)	200
Corresponding Algal Density (g/m^2 AFDW)	80

California Benthic Biomass Tool, v13 (February 2007)

Max algal contribution to DO deficit (mg/L)	2.93



Allowable TN: 41 Allowable TP: 0.57

Site:	Lower Alluvial Valley - Basin Floor Sites
Analyst:	PAO
Date:	10/8/2011 16:32

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

(based on plausible ranges of local conditions)

- 0% Tree Canopy Closure

- Ambient (low) Turbidity (35 NTU)

35 NTU turbidity = 25^{th} percentile of lower alluvial valley monitoring sites used in 25^{th} percentile analysis

Unshaded Solar Radiation (cal/cm²/d)

	Average	Minimum	Maximum
Enter manually	424	184	649
Estimate	Latitude 36.70	Month Range: Jan	Dec

Stream Inputs

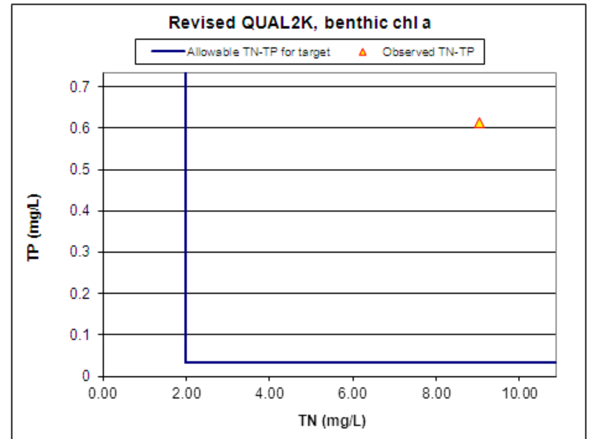
Stream Depth (m)	0.5
Stream Velocity (m/s)	0.3
Water Temperature (°C)	18.1
Days of Accrual (optional)	365
Canopy Closure	(•) 0% / 20% / 40% / 80%
Light Extinction Coeff. (1/m)	3.94 ← Calculate

Method & Target Selection

Select Method:	Revised QUAL2K, benthic chl a
Target Benthic Chl a (mg/m²)	150
Corresponding Algal Density (g/m² AFDW)	60

California Benthic Biomass Tool, v13 (February 2007)

Max algal contribution to DO deficit (mg/L)	4.97



Allowable TN: 2 Allowable TP: 0.033

Site:	Lower Alluvial Valley - Basin Floor Sites
Analyst:	PAO
Date:	10/8/2011 16:32

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

(based on plausible ranges of local conditions)

- 0% Tree Canopy Closure

- Geomean Dry Season Turbidity (53 NTU)

53 NTU turbidity = turbidity geomean of May-Oct. samples of lower alluvial valley monitoring sites used in 25^{th} percentile analysis

Unshaded Solar Radiation (cal/cm²/d)

	Average	Minimum	Maximum
Enter manually	424	184	649
Estimate	Latitude 36.70	Month Range: Jan	Dec

Stream Inputs

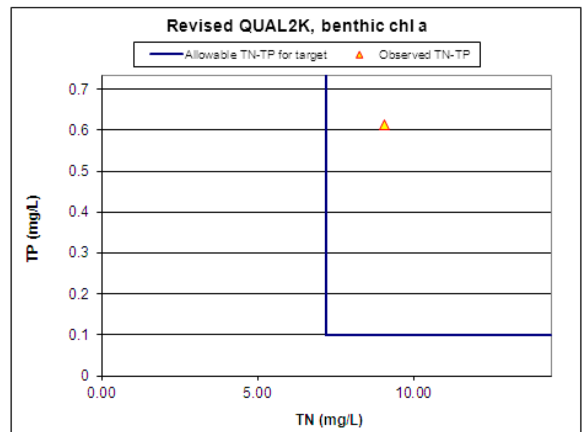
Stream Depth (m)	0.5
Stream Velocity (m/s)	0.3
Water Temperature (°C)	18.1
Days of Accrual (optional)	365
Canopy Closure	(•) 0% / 20% / 40% / 80%
Light Extinction Coeff. (1/m)	5.74 ← Calculate

Method & Target Selection

Select Method:	Revised QUAL2K, benthic chl a
Target Benthic Chl a (mg/m²)	150
Corresponding Algal Density (g/m² AFDW)	60

California Benthic Biomass Tool, v13 (February 2007)

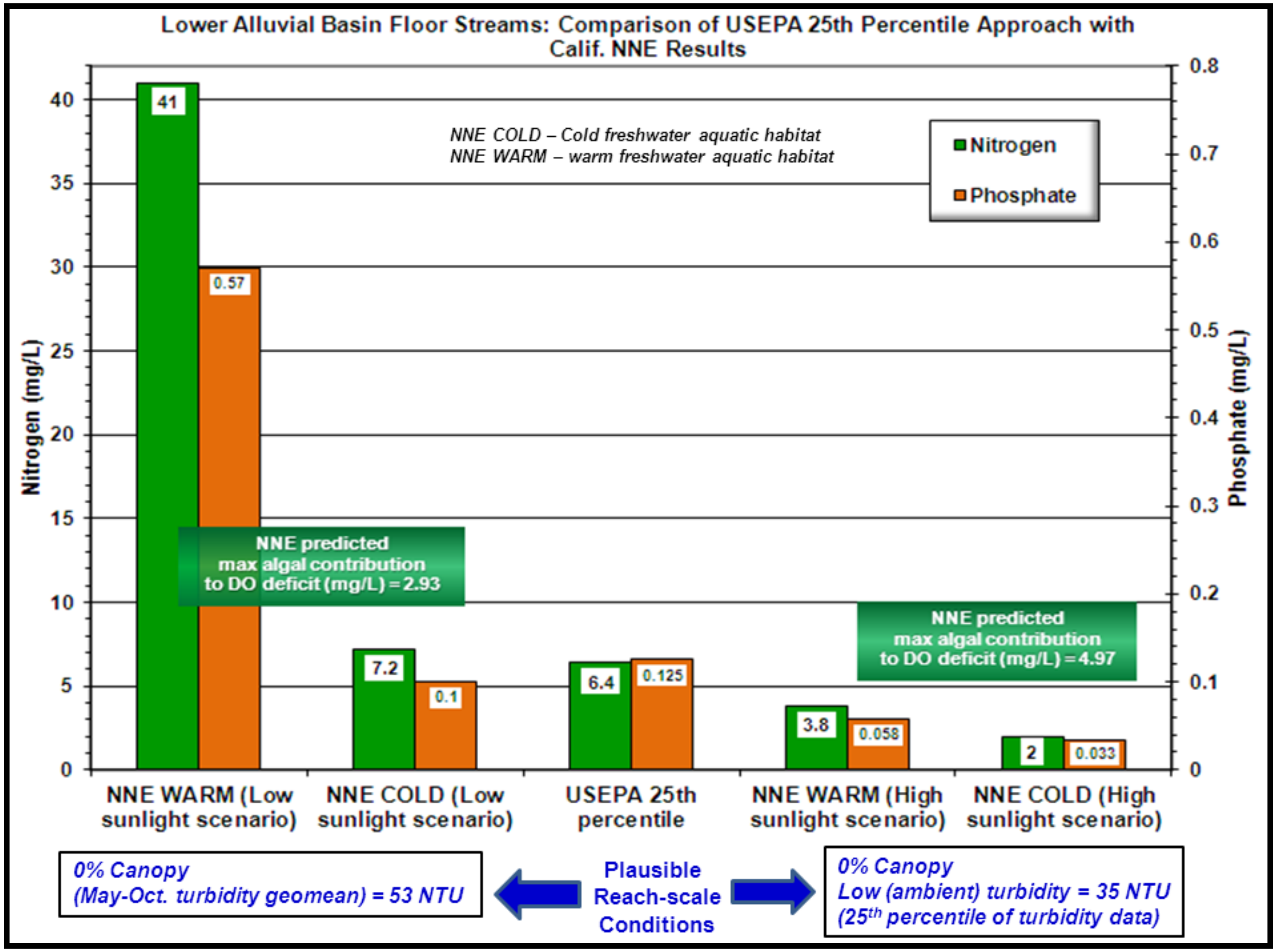
Max algal contribution to DO deficit (mg/L)	2.93



Allowable TN: 7.2 Allowable TP: 0.1

D.5.3 Comparison of USEPA 25th Percentile Approach and Calif. NNE Approach (Alluvial Basin Floor Streams and Sloughs)

The USEPA 25th percentile targets shown previously are shown relative to the NNE Higher Sunlight Availability and NNE low sunlight Availability scenarios, as shown in the figure below. This suggests the 25th percentile targets are in reasonably good agreement with NNE predicted nutrient targets that are based on plausible ranges of observed local conditions. Therefore, USEPA 25th percentile for nitrate (6.4 mg/L) and the 25th percentile for orthophosphate (0.125 mg/L) are selected as potential numeric targets for this stream reach



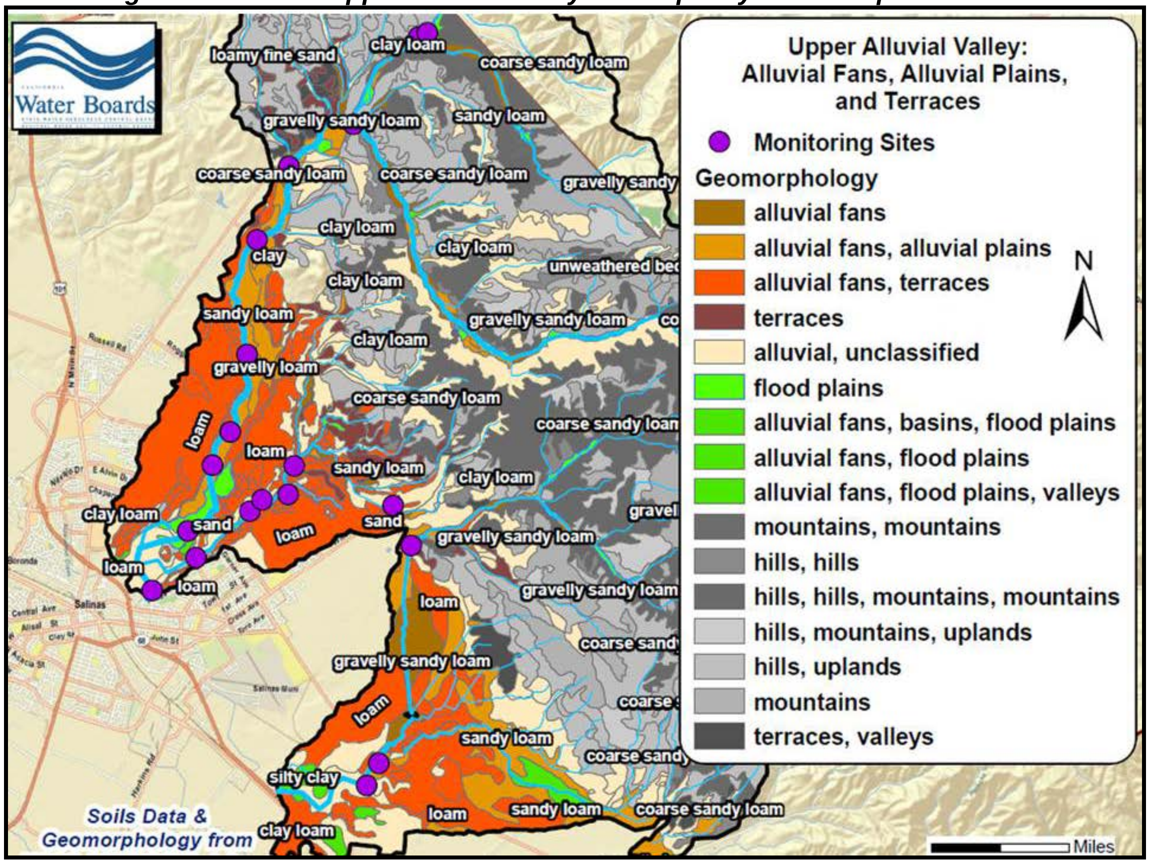
D.6 Upper Alluvial Valley - Alluvial Fan and Alluvial Plain Stream Reaches

D.6.1 Upper Alluvial Valley – Alluvial Fan and Plains 25th Percentile Targets

Stream Conditions

- Geomorphic description: Alluvial fans; alluvial plains, alluvial terraces, moderately-low gradient - slopes generally 1 to 3 degrees (source: NRCS-SSURGO)
- Waterbodies: Alisal Creek (upstream of Hartnell Rd), Gabilan Creek, Natividad Creek.
- Estimated riparian tree canopy: Varies, but generally 0% to 20% (source: NLCD, 2001 canopy raster, field observation)
- Substrate-soils: Sand-rich - generally loams, sandy loams, and gravelly loams (source: NRCS-SSURGO)
- Turbidity conditions: <1 NTU (25th percentile-year round); 23 NTU (geomean-dry season, May-Oct.); 67 NTU (median-dry season, May-Oct)

Monitoring sites used for upper alluvial valley water quality data 25th percentiles



Upper Alluvial Valley Streams: Alluvial Fans, Alluvial Plain and Terraces: Statistical Summary

Alisal Creek, Gabilan Creek, Natividad Creek
Stream Geomorphic Description: Upper alluvial valley, alluvial fan, plains and terraces
Statistical Summary of Nitrate-N

Temporal Representation	May 1974 - December 2008
Mean	13.2340784
Standard Error	1.534558199
Median	4
Mode	2
Standard Deviation	20.47355997
Sample Variance	419.166658
Kurtosis	8.448836613
Skewness	2.769385739
Range	110.986
Minimum	0.014
Maximum	111
No. of Samples	178
25th percentile	**2**

Alisal Creek, Gabilan Creek, Natividad Creek
Stream Geomorphic Description: Upper alluvial valley, alluvial fan, plains and terraces
Statistical Summary of Orthophosphate-P

Temporal Representation	June 1999 - March 2010
Mean	0.411987756
Standard Error	0.031945399
Median	0.27065
Mode	0.0075
Standard Deviation	0.486577822
Sample Variance	0.236757977
Kurtosis	13.49157755
Skewness	2.782657889
Range	3.9545
Minimum	0.0075
Maximum	3.962
No. of Samples	232
25th percentile	**0.05**

D.6.2 Upper Alluvial Valley – Alluvial Fan and Plains Nutrient Numeric Endpoint Analysis (Calif. NNE Approach)

Site:	Upper Alluvial Valley- Alluvial Fan&Plain
Analyst:	PAO
Date:	10/11/2011 0:00

NNE Parameters:

- Beneficial Use Risk-Classification: (BURC): II / III
- Beneficial Use: **WARM**
- Response Variable: Benthic Algal biomass in streams
- Numeric Target: 200 mg chl-a/m^2
- Method: Revised QUAL2k, benthic chl a

Stream Condition Input:

Higher Sunlight Availability Scenario

(based on plausible ranges of local conditions)

- 0% Tree Canopy Closure

- Ambient (low) Turbidity (1 NTU)

<1 NTU turbidity = 25th percentile of lower alluvial valley monitoring sites used in 25th percentile analysis

Unshaded Solar Radiation (cal/cm²/d)

	Average	Minimum	Maximum
○ Enter manually	424	184	649
⦿ Estimate	Latitude: 36.70	Month Range: Jan	Dec

Stream Inputs

Stream Depth (m)	0.5
Stream Velocity (m/s)	0.3
Water Temperature (°C)	16.5
Days of Accrual (optional)	365
Canopy Closure	⦿ 0% ○ 20% ○ 40% ○ 80%
Light Extinction Coeff. (1/m)	0.54

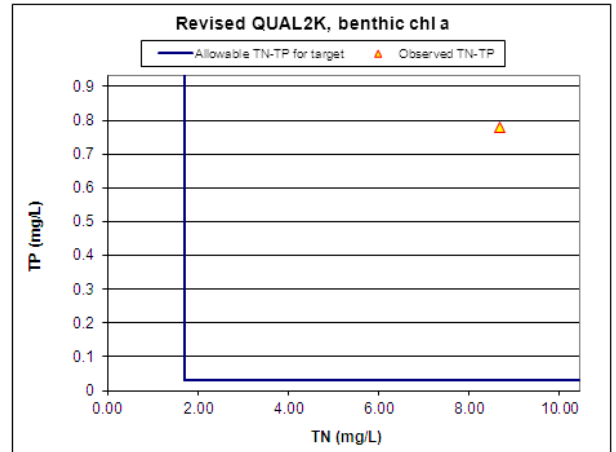
Calculate

Method & Target Selection

Select Method:	Revised QUAL2K, benthic chl a
Target Benthic Chl a (mg/m²)	200
Corresponding Algal Density (g/m² AFDW)	80

California Benthic Biomass Tool, v13 (February 2007)

Max algal contribution to DO deficit (mg/L)	6.95



Allowable TN: 1.7 Allowable TP: 0.029

Site:	Upper Alluvial Valley- Alluvial Fan&Plain
Analyst:	PAO
Date:	10/11/2011 0:00

NNE Parameters:

- Beneficial Use Risk-Classification: (BURC): II / III
- Beneficial Use: **WARM**
- Response Variable: Benthic Algal biomass in streams
- Numeric Target: 200 mg chl-a/m^2
- Method: Revised QUAL2k, benthic chl a

Stream Condition Input:

Lower Sunlight Availability Scenario

(based on plausible ranges of local conditions)

- 20% Tree Canopy Closure

- Geomean Dry Season Turbidity (23 NTU)

23 NTU turbidity = turbidity geomean of May-Oct. samples of lower alluvial valley monitoring sites used in 25th percentile analysis

Unshaded Solar Radiation (cal/cm²/d)

	Average	Minimum	Maximum
○ Enter manually	424	184	649
⦿ Estimate	Latitude: 36.70	Month Range: Jan	Dec

Stream Inputs

Stream Depth (m)	0.5
Stream Velocity (m/s)	0.3
Water Temperature (°C)	16.5
Days of Accrual (optional)	365
Canopy Closure	○ 0% ⦿ 20% ○ 40% ○ 80%
Light Extinction Coeff. (1/m)	2.74

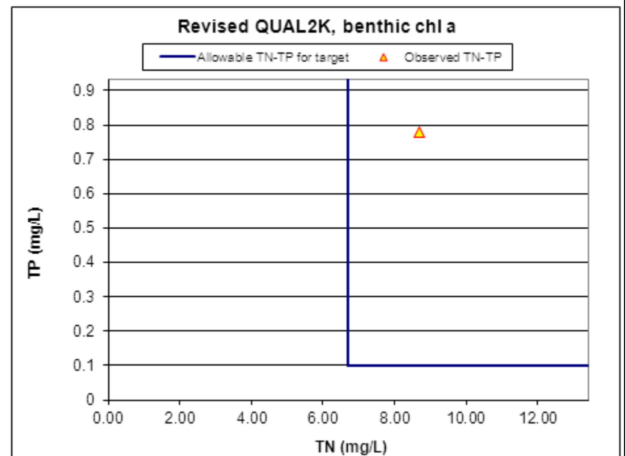
Calculate

Method & Target Selection

Select Method:	Revised QUAL2K, benthic chl a
Target Benthic Chl a (mg/m²)	200
Corresponding Algal Density (g/m² AFDW)	80

California Benthic Biomass Tool, v13 (February 2007)

Max algal contribution to DO deficit (mg/L)	3.85



Allowable TN: 6.7 Allowable TP: 0.098

Site:	Upper Alluvial Valley- Alluvial Fan&Plain
Analyst:	PAO
Date:	10/11/2011 0:00

NNE Input:

- 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

(based on plausible ranges of local conditions)

- 0% Tree Canopy Closure

- Ambient (low) Turbidity (1 NTU)

<1 NTU turbidity = 25th percentile of lower alluvial valley monitoring sites used in 25th percentile analysis

Unshaded Solar Radiation (cal/cm^2/d)

	Average	Minimum	Maximum
○ Enter manually	424	184	649
◉ Estimate	Latitude: 36.70	Month Range: Jan	Dec

Stream Inputs

Stream Depth (m)	0.5
Stream Velocity (m/s)	0.3
Water Temperature (°C)	16.5
Days of Accrual (optional)	365
Canopy Closure	◉ 0% ○ 20% ○ 40% ○ 80%
Light Extinction Coeff. (1/m)	0.54

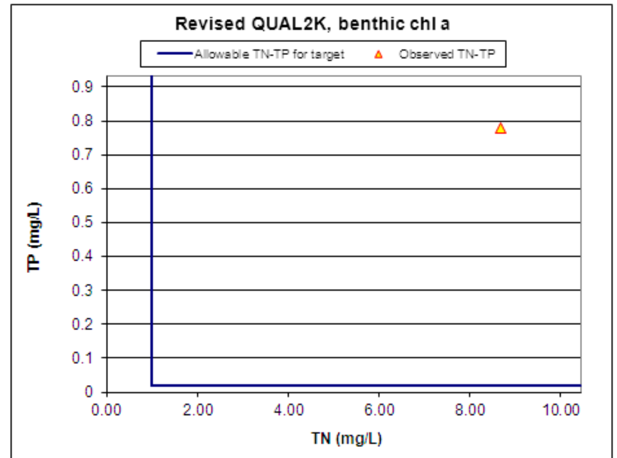
Calculate

Method & Target Selection

Select Method:	Revised QUAL2K, benthic chl a
Target Benthic Chl a (mg/m^2)	150
Corresponding Algal Density (g/m^2 AFDW)	60

California Benthic Biomass Tool, v13 (February 2007)

Max algal contribution to DO deficit (mg/L)	6.95



Allowable TN: 1 Allowable TP: 0.0185

Site:	Upper Alluvial Valley- Alluvial Fan&Plain
Analyst:	PAO
Date:	10/11/2011 0:00

NNE Input:

- 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

(based on plausible ranges of local conditions)

- 20% Tree Canopy Closure

- Geomean Dry Season Turbidity (23 NTU)

23 NTU turbidity = turbidity geomean of May-Oct. samples of lower alluvial valley monitoring sites used in 25th percentile analysis

Unshaded Solar Radiation (cal/cm^2/d)

	Average	Minimum	Maximum
○ Enter manually	424	184	649
◉ Estimate	Latitude: 36.70	Month Range: Jan	Dec

Stream Inputs

Stream Depth (m)	0.5
Stream Velocity (m/s)	0.3
Water Temperature (°C)	16.5
Days of Accrual (optional)	365
Canopy Closure	○ 0% ◉ 20% ○ 40% ○ 80%
Light Extinction Coeff. (1/m)	2.74

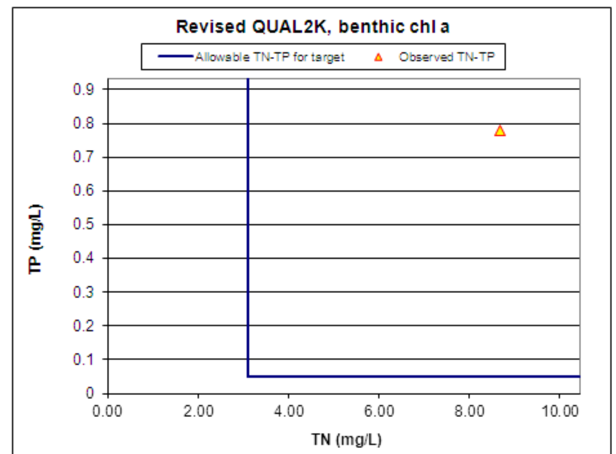
Calculate

Method & Target Selection

Select Method:	Revised QUAL2K, benthic chl a
Target Benthic Chl a (mg/m^2)	150
Corresponding Algal Density (g/m^2 AFDW)	60

California Benthic Biomass Tool, v13 (February 2007)

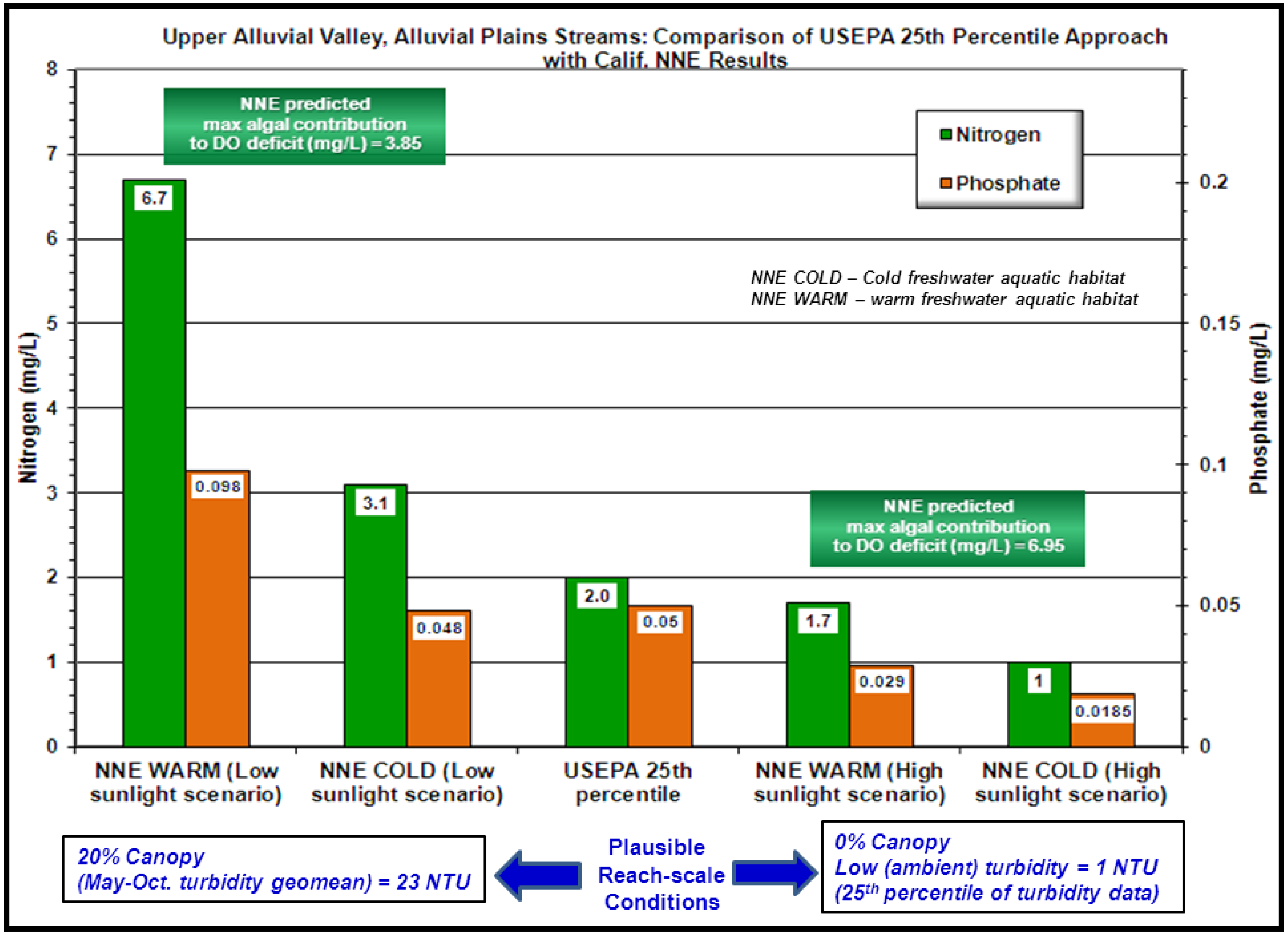
Max algal contribution to DO deficit (mg/L)	3.85



Allowable TN: 3.1 Allowable TP: 0.048

D.6.3 Comparison of USEPA 25th Percentile Approach and Calif. NNE Approach (Alluvial Fan and Plain Streams)

The USEPA 25th percentile targets shown previously are intermediate between the NNE Higher Sunlight Availability and NNE Lower Sunlight Availability scenarios, as shown in the figure below. This suggests the 25th percentile targets are in reasonably good agreement with NNE predicted nutrient targets that are based on plausible ranges of observed local conditions. Therefore, USEPA 25th percentile for nitrate (2.0 mg/L) and the 25th percentile for orthophosphate (0.05 mg/L) are selected as potential numeric targets for this stream reach



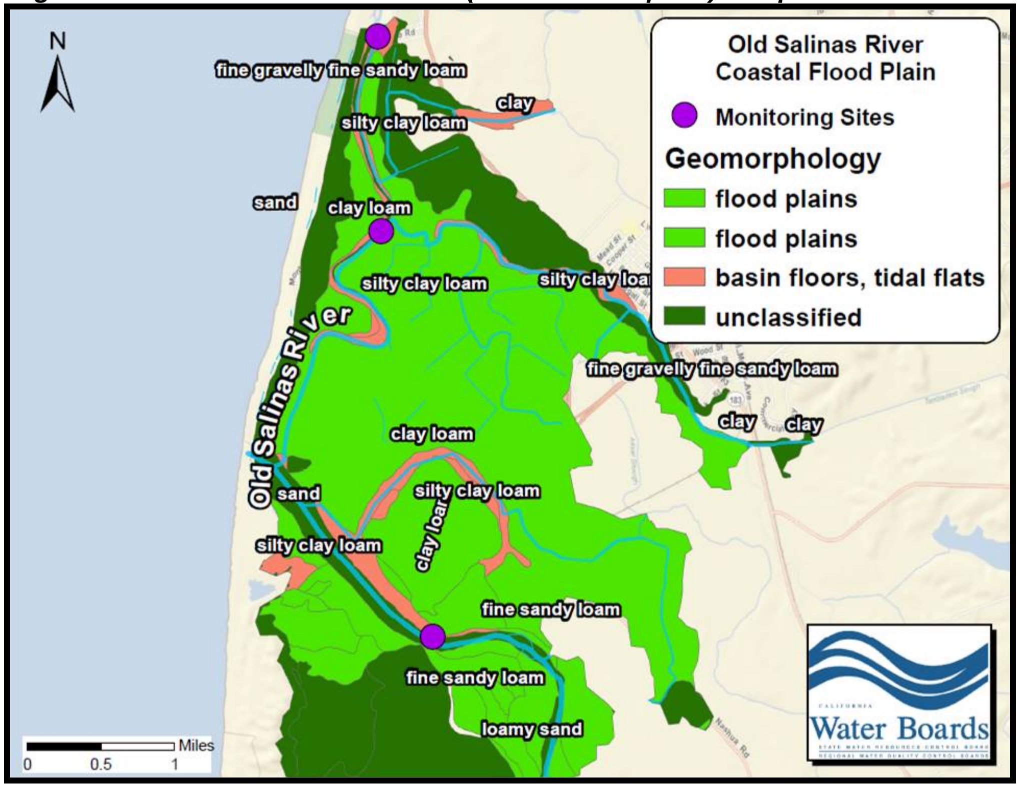
D.7 Old Salinas River – Coastal Flood Plain

Monitoring sites used to develop 25th percentile targets include 309SBR, OLS-MON, and OLS-POT. 309SBR is located at the Highway 1 and is the only reasonable approximation of nutrient concentrations in the Salinas River lagoon currently available. Note that the Old Salinas River receives it's inflow from the lagoon via a slide gate at Mulligan Hill; therefore 309SBR represents plausible nutrient concentrations in the uppermost reach of the Old Salinas River.

Stream Conditions

- Geomorphic description: Coastal flood plain, tidal flats. Low gradient - slopes generally less than 1 degree (source: NRCS-SSURGO)
- Waterbodies: Old Salinas River, from Salinas River lagoon slide gate to outlet to Old Salinas River estuary at Potrero Rd.
- Estimated average riparian tree canopy: 0% (source: NLCD, 2001 canopy raster, field observation)
- Substrate-soils: Dominantly fine-grained: clay loams, silty clay loams (source: NRCS-SSURGO)
- Turbidity conditions: 23 NTU (25th percentile-year round); 40 NTU (geomean-dry season, May-Oct.); 53 NTU (median-dry season, May-Oct)

Monitoring sites used for Old Salinas River (coastal flood plain) 25th percentiles



Old Salinas River – Statistical Summary

Old Salinas River - Outflow from Lagoon to Potrero Rd. *Stream geomorphic description: Coast flood plain and tidal flat* **Statistical Summary of Nitrate-N**	
Temporal Representation	Nov. 1971 to July 2009
Mean	13.8614247
Standard Error	0.359693207
Median	11.3
Mode	1.582
Standard Deviation	11.88621429
Range	66.98822992
Minimum	0.01177008
Maximum	67
No| of samples	1092
25th percentile	**4.3**

Old Salinas River - Outflow from Lagoon to Potrero Rd. *Stream geomorphic description: Coast flood plain and tidal flat* **Statistical Summary of Orthophosphate-P**	
Temporal Representation	Nov. 1971 to July 2009
Mean	0.508657174
Standard Error	0.026075332
Median	0.29
Mode	0.03
Standard Deviation	0.820026705
Range	6.396
Minimum	0.004
Maximum	6.4
No| of samples	989
25th percentile	**0.13**

D.7.1 Old Salinas River Nutrient Numeric Endpoint Analysis (Calif. NNE Approach)

The Old Salinas River estuary is specifically designated for cold freshwater aquatic habitat (COLD) in Table II-1 of the Basin Plan; therefore NNE analysis was limited to the BURC II /III category for COLD beneficial use.

Site:	Old Salinas River- Coastal Flood Plain
Analyst:	PAO
Date:	10/12/2011 0:00

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

(based on plausible ranges of local conditions)

- 0% Tree Canopy Closure

- Ambient (low) Turbidity (23 NTU):

23 NTU turbidity = 25th percentile of Old Salinas River monitoring sites used in 25th percentile analysis

Unshaded Solar Radiation (cal/cm²/d)

	Average	Minimum	Maximum
Enter manually	424	185	649
Estimate	Latitude: 36.80	Month Range: Jan	Dec

Stream Inputs

Stream Depth (m)	0.5
Stream Velocity (m/s)	0.3
Water Temperature (°C)	17.0
Days of Accrual (optional)	365
Canopy Closure	(•) 0% ( ) 20% ( ) 40% ( ) 80%
Light Extinction Coeff. (1/m)	2.74

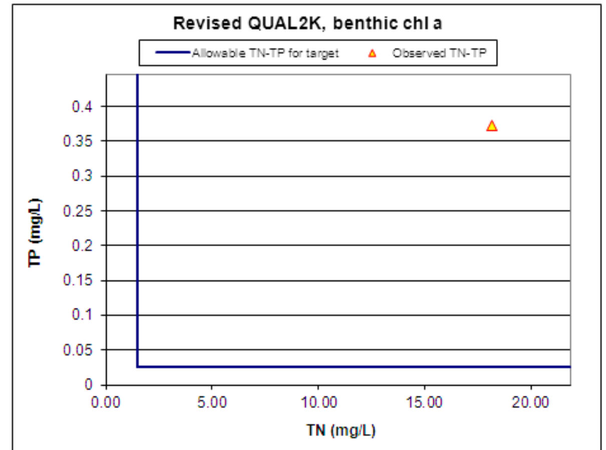
Calculate

Method & Target Selection

Select Method:	Revised QUAL2K, benthic chl a
Target Benthic Chl a (mg/m²)	150
Corresponding Algal Density (g/m² AFDW)	60

California Benthic Biomass Tool, v13 (February 2007)

Max algal contribution to DO deficit (mg/L)	6.33



Allowable TN: 1.5 Allowable TP: 0.0255

Site:	Old Salinas River- Coastal Flood Plain
Analyst:	PAO
Date:	10/12/2011 0:00

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

(based on plausible ranges of local conditions)

- 0% Tree Canopy Closure

- Geomean Dry Season Turbidity (40 NTU):

40 NTU turbidity = turbidity geomean of May-Oct sample of Old Salinas River monitoring sites used in 25th percentile analysis

Unshaded Solar Radiation (cal/cm²/d)

	Average	Minimum	Maximum
Enter manually	424	185	649
Estimate	Latitude: 36.80	Month Range: Jan	Dec

Stream Inputs

Stream Depth (m)	0.5
Stream Velocity (m/s)	0.3
Water Temperature (°C)	17.0
Days of Accrual (optional)	365
Canopy Closure	(•) 0% ( ) 20% ( ) 40% ( ) 80%
Light Extinction Coeff. (1/m)	4.44

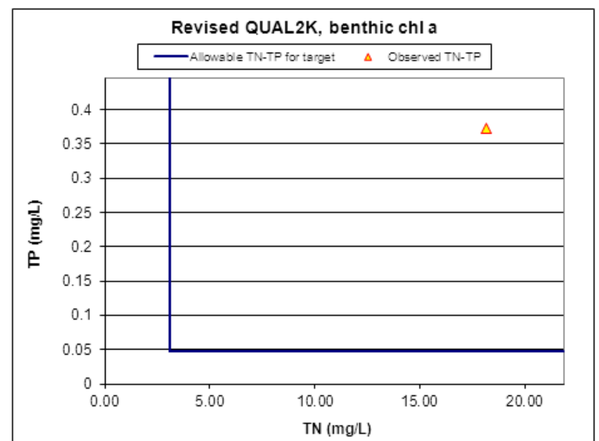
Calculate

Method & Target Selection

Select Method:	Revised QUAL2K, benthic chl a
Target Benthic Chl a (mg/m²)	150
Corresponding Algal Density (g/m² AFDW)	60

California Benthic Biomass Tool, v13 (February 2007)

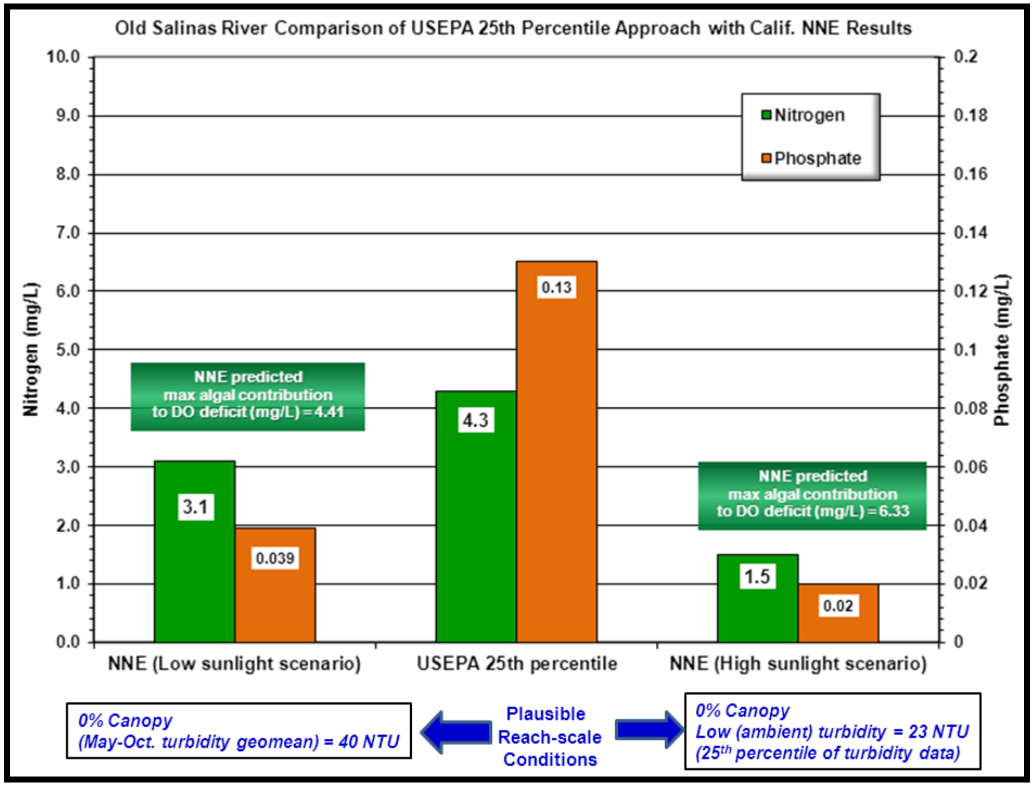
Max algal contribution to DO deficit (mg/L)	4.41



Allowable TN: 3.1 Allowable TP: 0.047

D.7.2 Comparison of USEPA 25th Percentile Approach and Calif. NNE Approach (Old Salinas River-Coastal Flood Plain)

The USEPA 25th percentile targets shown previously are show relative to the NNE Higher Sunlight Availability and NNE Lower Sunlight Availability scenarios, as shown in the figure below. For this stream reach, the USEPA 25th percentile for nitrogen is marginally higher than both the NNE scenarios; as such, in this case the USEPA 25th percentile appears to be marginally under-protective. As such, the 25th-percentile criteria for this stream appears to be underprotective. Consequently, the NNE nutrient targets under geomean dry season turbidity conditions (3.1 mg/L Nitrate-N) and 0.039 mg/L orthophosphate[5] are selected as potential numeric targets for this stream reach.



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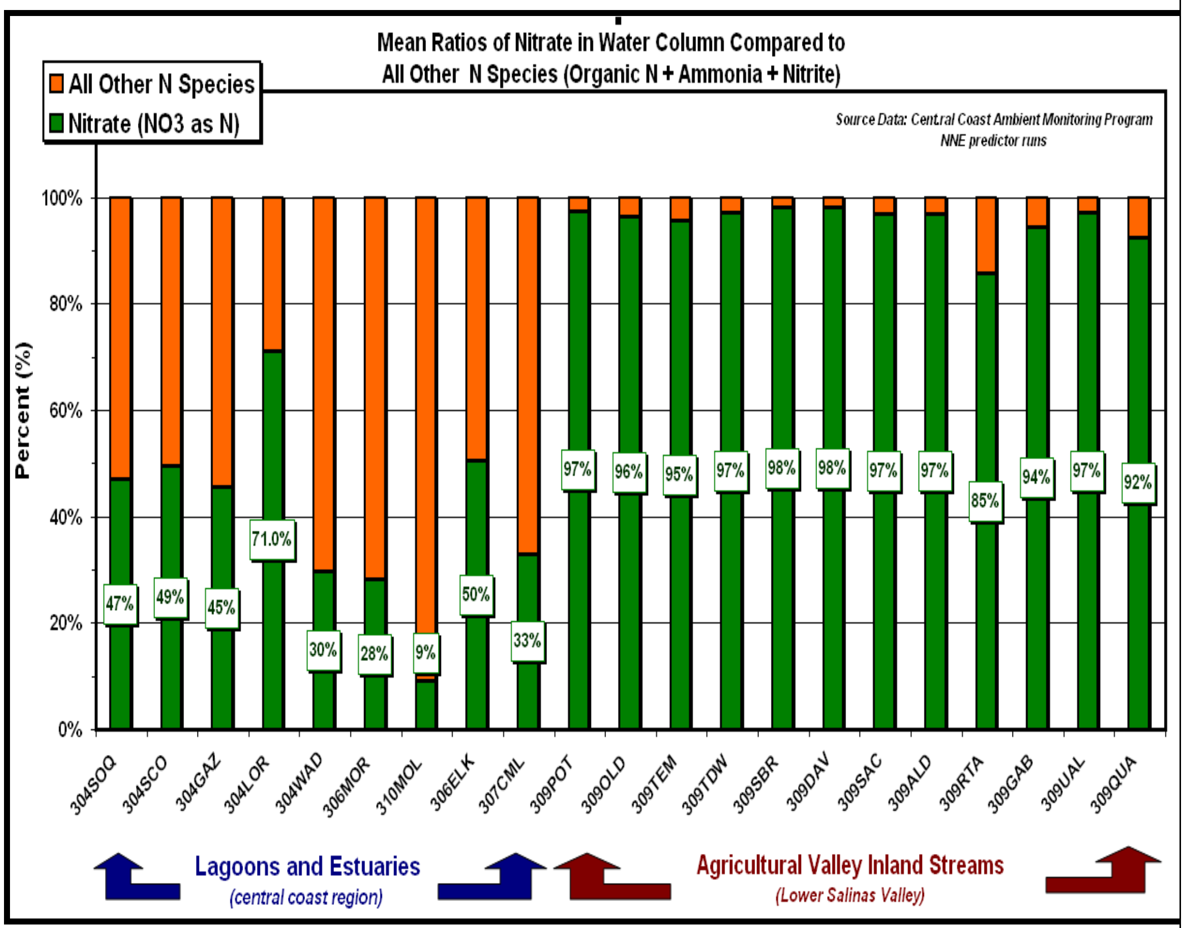
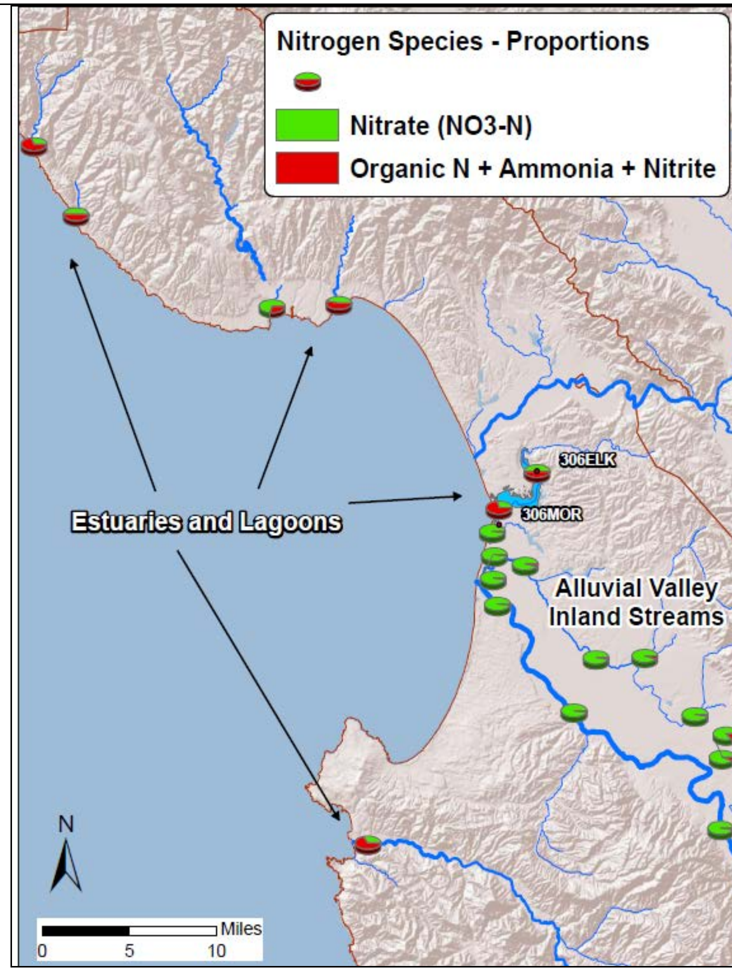
[5] A scientific peer review referee for this project noted that for the river ecotypes, the 25th percentile values for nitrate and orthophosphate covary; systems with > 4 mg-N/L nitrate have > 0.1 mg/L orthophosphate while systems with < 2 mg-N/L nitrate have < 0.05 mg/L orthophosphate. Consequently, the peer reviewer noted that it appears that the 25th percentile value for both nitrate and orthophosphate for the Old Salinas River are not representative of moderately disturbed conditions, as they are both higher than NNE model results under "low" and "typical" turbidity levels. As such, the orthophosphate targets should be down-scaled. The peer review referee recommended in the current scheme (refer back to Figure 7), it would more appropriate to lower the orthophosphate target to 0.039 mg/L (NEE low light scenario), then subsequently default to 0.07 mg/L (lightly disturbed orthophosphate 75th percentile level – see Section C.9.1 of this Appendix).

D.8 Moro Cojo Slough – Tidal Flats

Nitrate targets are not appropriate for Morro Cojo slough. Nitrate concentrations in Moro Cojo slough only measure a fraction of total nitrogen in the water column as shown in the figures below. In contrast, nitrate in the Salinas Valley agricultural valley inland streams constitute generally over 95% of total nitrogen in the water column, and thus nitrate is a plausible surrogate measuring total water column nitrogen in these waterbodies. Accordingly, a nitrate concentration from Moro Cojo slough may not be directly comparable to a nitrate concentration from, say, the Reclamation Canal. Presumably, nitrate comprises a lower ratio of total nitrogen in the water columns of coastal estuaries and lagoons in the central coast region because these are typically areas of high primary productivity, and nitrogen cycling and biological uptake are likely more pronounced relative to Salinas valley agricultural inland streams. As shown graphically below, nitrate-N is likely only a small fraction of total N in the water column at Moro Cojo Slough site 306MOR, likely due to elevated biological uptake of NO3 in tidal flat-estuarine environments and sequestration of N in organic phases. As such, total nitrogen targets (rather than nitrate targets) are more appropriate for Moro Cojo slough.

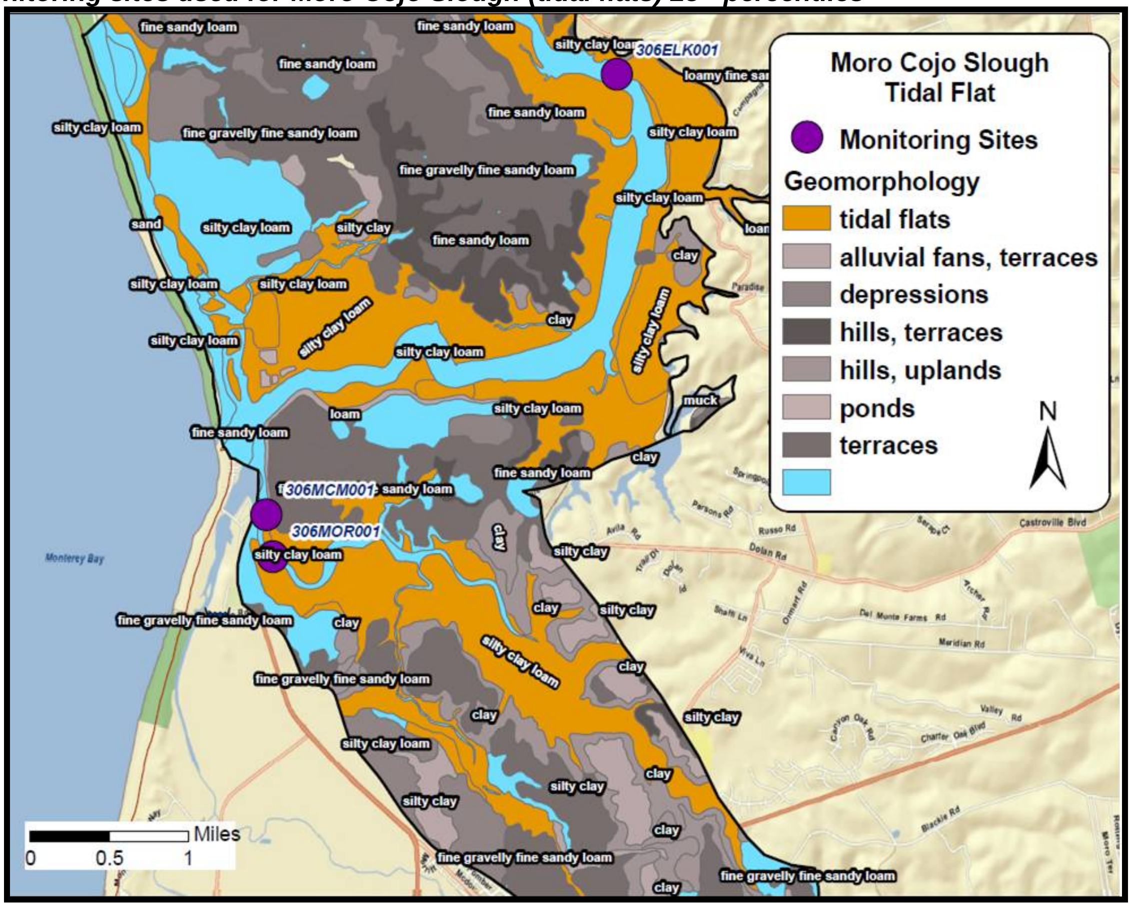




Stream Conditions

- Geomorphic description: Tidal flats. Low gradient - slopes generally less than 1 degree (source: NRCS-SSURGO)
- Waterbodies: Moro Cojo Slough
- Estimated average riparian tree canopy: 10% (source: NLCD, 2001 canopy raster, field observation)
- Substrate-soils: Mostly moderately fine-grained: silty clay loams, and clay (source: NRCS-SSURGO)
- Turbidity conditions: 4 NTU (25^{th} percentile-year round); 7 NTU (geomean-dry season, May-Oct.); 9 NTU (median-dry season, May-Oct)

Monitoring sites used for Moro Cojo Slough (tidal flats) 25^{th} percentiles



Tidal Flat: Statistical Summary.

Moro Cojo Slough *Stream geomorphic description: Tidal flats* **Statistical Summary of Total Nitrogen**	
Temporal Representation	Mar. 1999 - Feb. 2007
Mean	4.85
Standard Error	0.52
Median	5.00
Mode	5.00
Standard Deviation	3.28
Range	13.25
Minimum	1
Maximum	14.254826
No. of samples	40
25th percentile	**2.0**

Moro Cojo Slough *Stream geomorphic description: Tidal flats* **Statistical Summary of Total Nitrogen**	
Temporal Representation	Jan. 2006 - Feb. 2007
Mean	0.54
Standard Error	0.14
Median	0.23
Mode	0.15
Standard Deviation	0.77
Range	2.88
Minimum	0.02
Maximum	2.9
No. of samples	28
25th percentile	**0.13**

D.8.1 Moro Cojo Slough Nutrient Numeric Endpoint Analysis (Calif. NNE Approach)

The Old Salinas River estuary is specifically designated for cold freshwater aquatic habitat (COLD) in Table II-1 of the Basin Plan; therefore NNE analysis was limited to the BURC II /III category for COLD beneficial use.

Site:	Moro Cojo Slough-Tidal Flats
Analyst:	PAO
Date:	10/13/2011 0:00

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

(based on plausible ranges of local conditions)

- 0% Tree Canopy Closure

- Ambient (low) Turbidity (4 NTU):

4 NTU turbidity = 25th percentile of observed turbidity at site 306MOR.

Unshaded Solar Radiation (cal/cm^2/d)

	Average	Minimum	Maximum
○ Enter manually	424	185	649

◉ Estimate	Latitude	Month Range	
	36.80	Jan	Dec

Stream Inputs

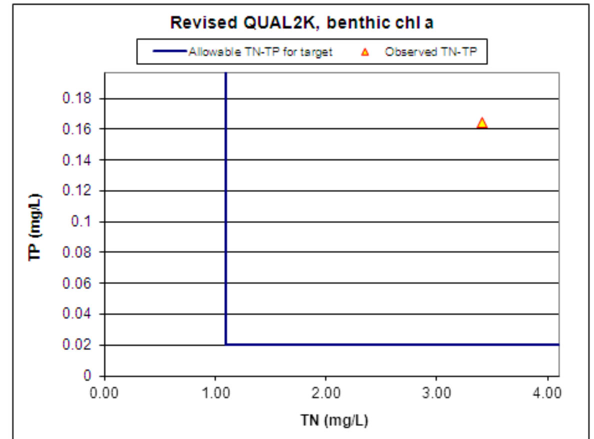
Stream Depth (m)	0.5
Stream Velocity (m/s)	0.3
Water Temperature (°C)	16.2
Days of Accrual (optional)	365
Canopy Closure	◉ 0% ○ 20% ○ 40% ○ 80%
Light Extinction Coeff. (1/m)	0.84 ← Calculate

Method & Target Selection

Select Method:	Revised QUAL2K, benthic chl a
Target Benthic Chl a (mg/m^2)	150
Corresponding Algal Density (g/m^2 AFDW)	60

California Benthic Biomass Tool, v13 (February 2007)

Max algal contribution to DO deficit (mg/L)	4.58



Allowable TN: 1.1 Allowable TP: 0.02

Site:	Moro Cojo Slough-Tidal Flats
Analyst:	PAO
Date:	10/13/2011 0:00

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

(based on plausible ranges of local conditions)

- 20% Tree Canopy Closure

- Geomean Dry Season Turbidity (7 NTU):

7NTU turbidity = turbidity geomean of May-Oct. samples from site 306MOR.

Unshaded Solar Radiation (cal/cm^2/d)

	Average	Minimum	Maximum
○ Enter manually	424	185	649

◉ Estimate	Latitude	Month Range	
	36.80	Jan	Dec

Stream Inputs

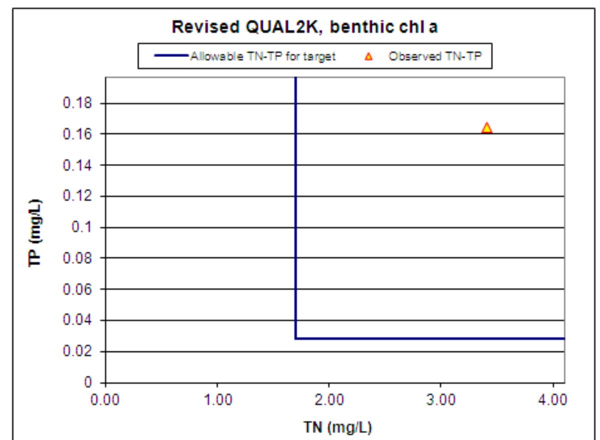
Stream Depth (m)	0.5
Stream Velocity (m/s)	0.3
Water Temperature (°C)	16.2
Days of Accrual (optional)	365
Canopy Closure	○ 0% ◉ 20% ○ 40% ○ 80%
Light Extinction Coeff. (1/m)	1.14 ← Calculate

Method & Target Selection

Select Method:	Revised QUAL2K, benthic chl a
Target Benthic Chl a (mg/m^2)	150
Corresponding Algal Density (g/m^2 AFDW)	60

California Benthic Biomass Tool, v13 (February 2007)

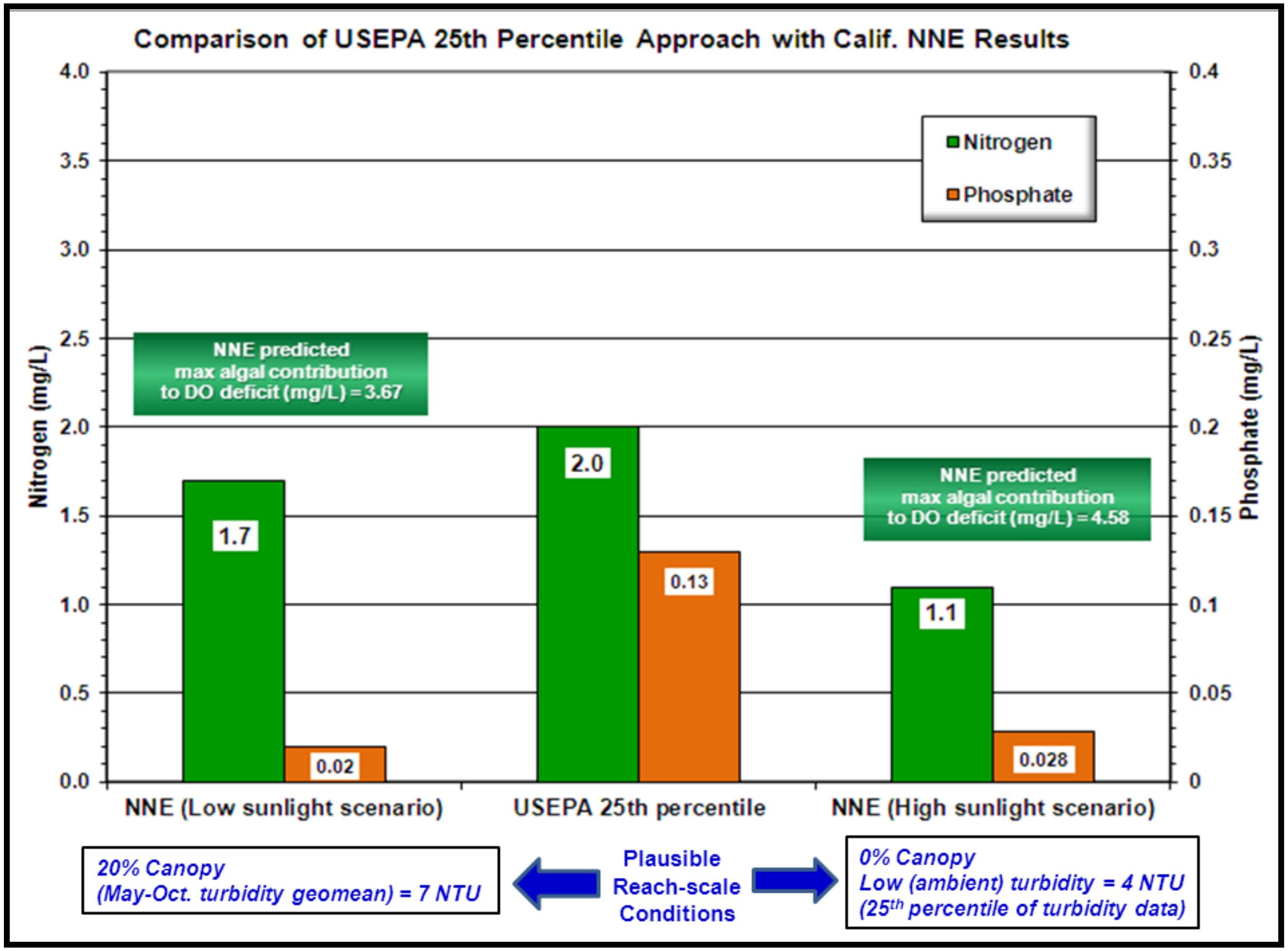
Max algal contribution to DO deficit (mg/L)	3.67



Allowable TN: 1.7 Allowable TP: 0.028

D.8.2 Comparison of USEPA 25th Percentile Approach and Calif. NNE Approach (Moro Cojo Slough – Tidal Flats)

The USEPA 25th percentile targets shown previously are show relative to the NNE Higher Sunlight Availability and NNE Lower Sunlight Availability scenarios, as shown in the figure below. For this stream reach, the USEPA 25th percentile for nitrogen is marginally higher than both the NNE scenarios; as such in this case the USEPA 25th percentile appears to be marginally under-protective. Therefore, the 25th percentile target for this stream reach will not be based on the USEPA 25th percentile target. The NNE nitrate target under "typical" dry season turbidity conditions (1.7 mg/L total nitrogen) and the 25th percentile for orthophosphate (0.13 mg/L) are selected as potential numeric targets for this stream reach.



D.9 Nutrient Concentrations in Headwater Reaches and Lightly-Disturbed Tributaries of the Salinas River Basin

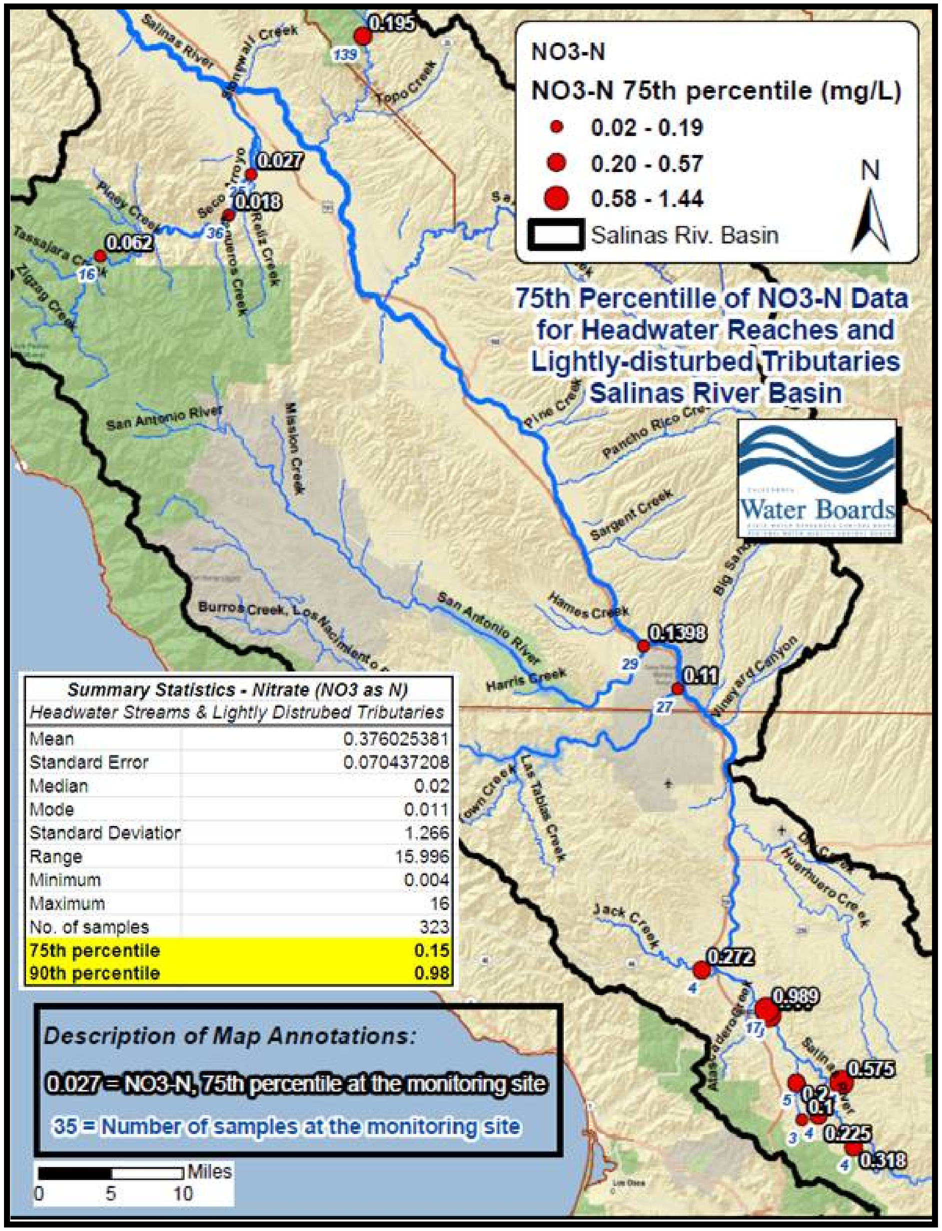
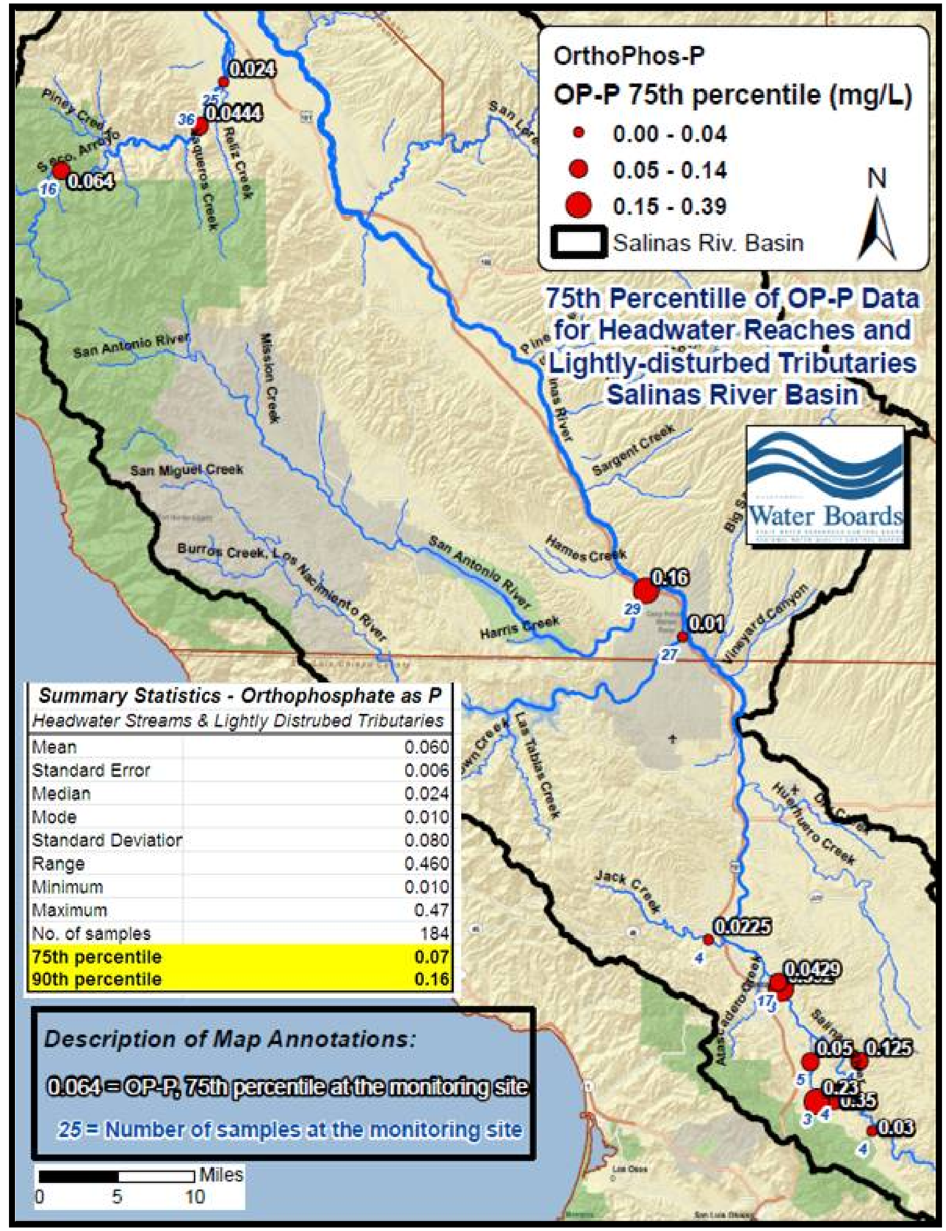
An important tenet of the California NNE approach (Tetra Tech, 2006 - refer back to footnote 4) 2Fis that targets should not be set lower than the concentrations expected under background or relatively undisturbed conditions. Further, guidance from researchers with expertise in central coast biostimulation issues indicates regulatory nutrient targets should not be more stringent (i.e., lower) than nutrient concentrations found in natural systems in the Salinas River basin (Dr. Marc Los Huertos6, California State University, Monterey Bay, personal communication Oct. 14, 2011).

Therefore, staff applied the USEPA reference stream methodology, to ensure that biostimulation nutrient targets are no more stringent than expected nutrient concentrations found in natural or lightly-disturbed headwater and tributary reaches in the Salinas River basin. USEPA's Technical Guidance Manual for Developing Nutrient Criteria for Rivers and Streams (USEPA, 2000 - refer back to footnote 2) describes an approach to establish a nutrient reference condition. The approach is to establish the upper 75th percentile of a reference population of streams. The 75th percentile was chosen by USEPA since it is likely associated with minimally impacted conditions, and will be protective of designated 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."

The following figures illustrate the range and statistics of nitrate (as N) and orthophosphate (as P) concentrations in headwater reaches and lightly disturbed tributaries of the Salinas River basin. Note that the 75th percentiles for this population of stream data are 0.15 mg/L nitrate-N, and 0.07 mg/L orthophosphate-P. 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 for total phosphorus[7]. Also noteworthy is that the 90th percentile of nitrate-N in Salinas River basin reference streams is 0.98 mg/L. This suggests that nitrate-N in reference stream conditions typically never exceeds about 1 mg/L except in outlier or anomalous conditions.

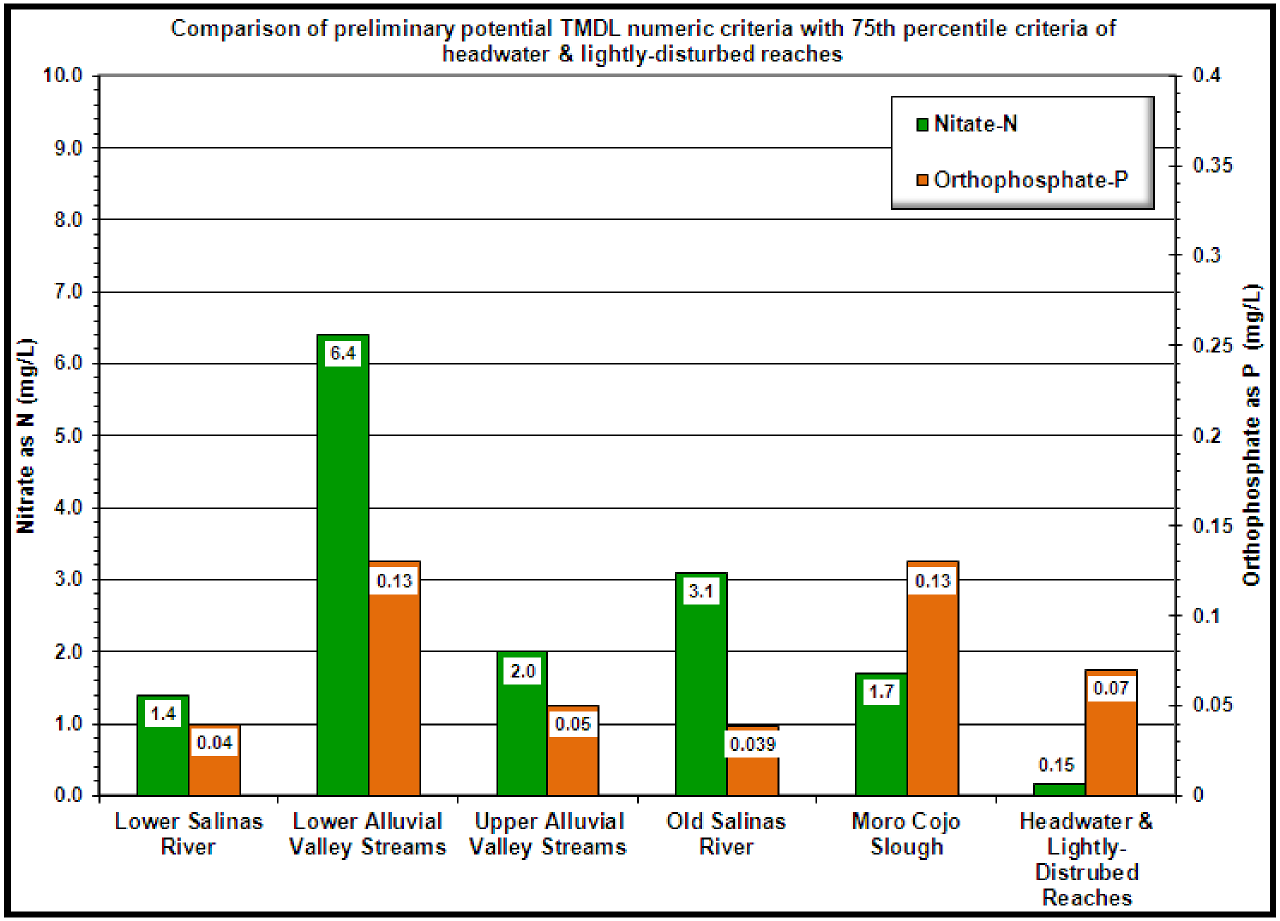
[6] Dr. Marc Los Huertos in an Assistant Professor of Science and Environmental Policy at California State University, Monterey Bay. Dr. Los Huertos has substantial research experience with agricultural water quality, aquatic ecology, and biostimulation in the California central coast region.

[7] USEPA. 2000. Ambient Water Quality Criteria Recommentations. 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.


NO3-N
NO3-N 75th percentile (mg/L)
0.02 - 0.19
0.20 - 0.57
0.58 - 1.44
Salinas Riv. Basin
N
75th Percentille of NO3-N Data for Headwater Reaches and Lightly-disturbed Tributaries Salinas River Basin
Water Boards
Summary Statistics - Nitrate (NO3 as N)
Headwater Streams & Lightly Distrubed Tributaries
Mean 0.376025381
Standard Error 0.070437208
Median 0.02
Mode 0.011
Standard Deviatior 1.266
Range 15.996
Minimum 0.004
Maximum 16
No. of samples 323
75th percentile 0.15
90th percentile 0.98
Description of Map Annotations:
0.027 = NO3-N, 75th percentile at the monitoring site
35 = Number of samples at the monitoring site
Miles
0 5 10
0.195
0.027
0.018
0.062
0.1398
0.11
0.272
0.989
0.575
0.225
0.318
Salinas River
Stonewall Creek
Topo Creek
Piney Creek
Tassajara Creek
Zigzag Creek
Reliz Creek
San Antonio River
Mission Creek
Pine Creek
Pancho Rico Creek
Sargent Creek
Hames Creek
Harris Creek
Big Sandy
Vineyard Canyon
Burros Creek, Los Nacimiento
Las Tablas Creek
Jack Creek
Huerhuero Creek
Atascadero Creek

OrthoPhos-P
OP-P 75th percentile (mg/L)
0.00 - 0.04
0.05 - 0.14
0.15 - 0.39
Salinas Riv. Basin
N
75th Percentille of OP-P Data for Headwater Reaches and Lightly-disturbed Tributaries Salinas River Basin
Water Boards
Summary Statistics - Orthophosphate as P
Headwater Streams & Lightly Distrubed Tributaries
Mean 0.060
Standard Error 0.006
Median 0.024
Mode 0.010
Standard Deviatior 0.080
Range 0.460
Minimum 0.010
Maximum 0.47
No. of samples 184
75th percentile 0.07
90th percentile 0.16
Description of Map Annotations:
0.064 = OP-P, 75th percentile at the monitoring site
25 = Number of samples at the monitoring site
Miles
0 5 10
0.024
0.0444
0.064
0.16
0.01
0.0225
0.0429
0.05
0.125
0.35
0.03
Piney Creek
Reliz Creek
San Antonio River
Mission Creek
San Miguel Creek
Burros Creek, Los Nacimiento River
Harris Creek
Hames Creek
Sargent Creek
Vineyard Canyon
Las Tablas Creek
Jack Creek
Huerhuero Creek
Atascadero Creek

D.9.1 Comparison of Preliminary Numeric Criteria with 75th Percentile Numeric Criteria of Headwater Reaches

The preliminary and potential TMDL numeric criterion developed previously in this appendix with the 25th percentile approach and the Calif. NNE approach are show below relative to the 75th percentile criterion for headwater and lightly-disturbed reaches in the Salinas River basin. Generally, most of the previously developed potential criterion are not less than the 75th percentile reference stream criterion, and therefore conform to technical guidance that nutrient targets should not be lower than nutrient concentrations found in natural systems. However, note that the preliminary orthophosphate criteria for the lower Salinas River, the alluvial fan and plain stream reaches (Gabilan Creek, Natividad Creek, Alisal Creek), and the Old Salinas River are lower than the 75th percentile of orthophosphate at reference site conditions. As such, these preliminary nutrient criteria may be over-protective for these stream reaches. Accordingly, the orthophosphate target for the lower Salinas River, for the alluvial fan and plain stream reaches, and the Old Salinas River will be set at the less stringent 75th percentile criteria in reference streams (i.e., 0.07 mg/L orthophosphate as P)



D.10 Seasonal Biostimulatory Numeric Targets

D.10.1 Basis for Dry-Season and Wet-Season Numeric Targets

Photo documentation, field observations, and input provided by researchers[8] with expertise in eutrophication issues in Elkhorn Slough and the lower Salinas Valley indicate clear evidence of algae problems and biostimulation in the summer months, and that eutrophication is primarily a summer-time water quality problem in coastal confluence waterbodies and streams of northern Monterey County (for example, see following figure).

There is also some evidence of periodic and episodic excessive chlorophyll levels in winter months, based on available water quality data. 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

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[8] Personal communications: Ken Johnson, Ph,D. (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)

ultimately into the ocean; in other words the residence time of nutrients in inland streams 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, the nutrient numeric criteria develop in preceding sections of this appendix are proposed to apply during the dry season (May 1 to October 31) when excessive algal growth and biostimulation problems appear to be unequivocal.

However, there is some evidence of episodic excessive chlorophyll concentrations in the winter months. There is also substantial scientific uncertainty about the extent to which winter-time nitrogen phosphorus and nitrogen loads from valley floor and headwater reaches of the project area ultimately contribute to summer-time biostimulation problems in downstream receiving waterbodies. Loading during the winter months may have little effect on summer algal densities[9]. 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 summertime biostimulation problems in the project area or in downstream receiving waterbodies is currently uncertain. It is important to note that, in particular, phosphorus loads from headwater reaches which ultimately may be released from sediments when reduction-oxidation conditions changes may be a consequence of decades of natural loads that have nothing to do with current activities (personal communication, Dr. Marc Los Huertos, Oct. 17, 2011).

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[10] have similarly incorporated seasonal targets for nutrients for the same reasons.

At this time, staff proposes a TMDL nitrate 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 Basin Plan numeric objective for nitrate (i.e., the 10 mg/L MUN objective). 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 nitrate is 8 mg/L. The basis for identifying the 8 mg/L wet-season nitrate-N target is as follows:

1) Photo documentation, field observations, water quality data, and input provided by researchers (refer back to footnote 8) 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, and in Elkhorn Slough. 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 similarly established a nutrient TMDL for inland stream in southern California which contained a winter time nitrogen target of 8 mg/L, based on the application of a 20% margin of safety to the Basin Plan's numeric objective of nitrate and to account for uncertainty regarding winter time algae problems[11].

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

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

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-nitrogen MUN objective) 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[12,13]. Therefore, the 10 mg/L nitrate-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 orthophosphate 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 orthophosphate. Unfortunately, there are currently no established numeric water quality objectives for phosphates in the Basin Plan on which to base a less stringent wet-season target. However, phosphate targets for streams have been adopted in some other states. The State of Nevada adopted a total phosphate target of 0.3 mg/L for Class B streams, and for most reaches of Class A streams. As such, the proposed wet-season biostimulatory target for orthophosphate is 0.3 mg/L. The basis for identifying the 0.3 mg/L wet-season orthophosphate-P target is as follows:

The basis for this proposal is as follows:

1) Photo documentation, field observations, water quality data, and input provided by researchers (refer back to footnote 8) 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, and in Elkhorn Slough. 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 adopted a total phosphate numeric criteria of 0.3 mg/L for Class B streams, and for most reaches of Class A streams[14]

3) USEPA nutrient target development guidance recognizes the use of established concentration thresholds from published literature (refer back to footnote 2)

4) A wet season value of 0.3 mg/L comports well with the high end of orthophosphate concentrations found in reference conditions in the Salinas River basin (i.e., lightly-disturbed and natural stream systems). As shown in Section D.9, the 90th percentile, and the maximum concentrations of reference conditions in the Salinas River basin range from 0.16 mg/L to 0.47 mg/L orthophosphate, respectively. Therefore, 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 (i.e., 0.16 to 0.47 mg/L) that

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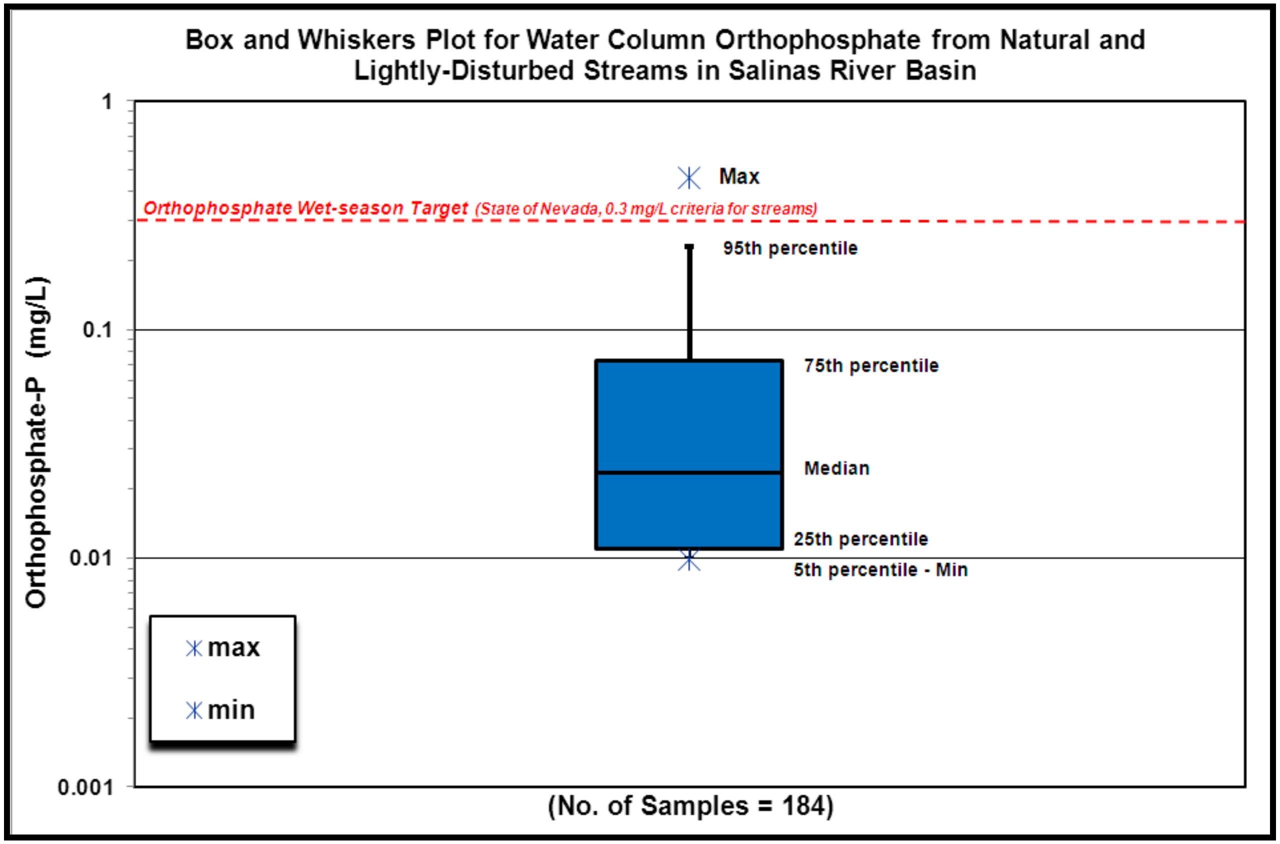
[12] University of California, Santa Cruz. 2010. Final Report: Long-term, high resolution nutrient and sediment monitoring and characterizing in-stream primary production. Proposition 40 Agricultural Water Quality Grant Program. Dr. Marc Los Huuertos, Ph.D., project director.

[13] 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

[14] USEPA, 1988. Phosphorus – Water Quality Standards Criteria Summaries: A Compilation of State/Federal Criteria. (Sept. 1988)

can plausibly be expected under relatively undisturbed or reference conditions (see following figure). In other words, 0.3 mg/L is consistent with high-end orthophosphate concentrations found in natural and lightly-disturbed stream systems in the Salinas River basin, 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 summertime biostimulation ultimately resulting from winter time loading, the Water Board may consider extending the more stringent dry season numeric targets to 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 project area streams to not exhibit some natural variability , including concentrations that will ultimately be marginally higher than the proposed biostimulatory targets, as well as lower. Therefore, dry-season targets, which are based on USEPA statistical methodologies are established as the geomean values of dry-season samples.

D.11 Final TMDL Numeric Targets for Biostimulatory Substances

Waterbody Type	Geomorphology & Stream Characteristics	Project Area Stream Reaches	Allowable Nitrate-N (mg/L)	Allowable Orthophosphate-P (mg/L)	Methodology for Developing Numeric Target	Notes Pertaining to Development of Targets
Alluvial Valley Flood Plain River	Alluvial valley river. Alluvial flood plain. Low ambient turbidity 13% average canopy cover; sandy substrate	Lower Salinas River – Gonzalez to Salinas River Lagoon	**1.4** **Dry Season Samples (May 1-Oct31)** **8.0** **Wet Season Samples (Nov. 1-Apr. 30)**	**0.07** **Dry Season Samples (May 1-Oct. 31)** **0.3** **Wet Season Samples (Nov. 1-Apr. 30)**	Statistical Analysis (USEPA percentile-based approaches) Supported by Calif. NNE approach (NNE benthic biomass model tool) Wet-season targets based on Central Coast Basin Plan nitrate objectives and State of Nevada phosphate criteria for streams	Generally low ambient turbidity (5 NTU-25th percentile), sandy substrate, good sunlight penetration, low to moderate canopy cover indicates risk of biostimulation at relatively low concentrations of nutrients.
Lower Alluvial Valley streams and sloughs	Alluvial basin floor and alluvial floodplains; Moderate ambient turbidity; Muddy to earthen substrates and fine-grained soil conditions; almost no canopy cover	Tembladero Slough all reaches Merritt Ditch dwnstrm of Merritt Lake Reclamation Canal downstream of Hartnell Rd. to confluence w/Tembladero Slough Alisal Slough all reaches Espinosa Slough from Espinosa lake to confluence with Reclamation Canal Santa Rita Creek all reaches	**6.4** **Dry Season Samples (May 1-Oct31)** **8.0** **Wet Season Samples (Nov. 1-Apr. 30)**	**0.13** **Dry Season Samples (May 1-Oct. 31)** **0.3** **Wet Season Samples (Nov. 1-Apr. 30)**	Statistical Analysis (USEPA percentile-based approaches) Supported by Calif. NNE approach (NNE benthic biomass model tool) Wet-season targets based on Central Coast Basin Plan nitrate objectives and State of Nevada phosphate criteria for streams	muddy and fine-grained substrates and local soil conditions result in relatively high ambient turbidity (30 NTU – 25th percentile) which precludes good sunlight penetration of water column; risk of biostimulation occurs at relatively higher nutrient concentrations.
Upper Alluvial Valley tributaries	Alluvial fans, alluvial plains and alluvial terraces, low to moderate ambient turbidity; generally silty or sandy substrates and soil conditions, canopy cover generally 20% or lower.	Gabilan Creek all reaches Natividad Creek all reaches Alisal Creek upstream of Hartnell Rd.	**2.0** **Dry Season Samples (May 1-Oct31)** **8.0** **Wet Season Samples (Nov. 1-Apr. 30)**	**0.07** **Dry Season Samples (May 1-Oct31)** **0.3** **Single Sample Max. Wet Season Samples (Nov. 1-Apr. 30)**	Statistical Analysis (USEPA percentile-based approaches) Supported by Calif. NNE approach (NNE benthic biomass model tool) Wet-season targets based on Central Coast Basin Plan nitrate objectives and State of Nevada phosphate criteria for streams	Relatively low ambient turbidity (<1 NTU-25th percentile), silty or sandy substrates and local soil conditions. Canopy cover generally 40% or less Sunlight penetration likely moderate. These stream reaches are currently not expressing a full range of biostimulatory indicators. They are however, discharging elevated nutrient loads to impaired downstream waterbodies. Nutrient targets are toprotect against downstream impacts and against the risk of biostimulation in these stream reaches.

Waterbody Type	Geomorphology & Stream Characteristics	Project Area Stream Reaches	Allowable Nitrate-N (mg/L)	Allowable Orthophosphate-P (mg/L)	Methodology for Developing Numeric Target	Notes Pertaining to Development of Targets
Moro Cojo Slough	Tidal Flats. Low ambient turbidity, minimal canopy cover	Moro Cojo Slough, all reaches	**1.7 (TOTAL NITROGEN)** **Dry Season Samples (May 1-Oct31)** **8.0** **Wet Season Samples (Nov. 1-Apr. 30)**	**0.13** **Dry Season Samples (May 1-Oct31)** **0.3** **Wet Season Samples (Nov. 1-Apr. 30)**	Statistical Analysis (USEPA percentile-based approaches) Supported by Calif. NNE approach (NNE benthic biomass model tool) Wet-season targets based on Central Coast Basin Plan nitrate objectives and State of Nevada phosphate criteria for streams	Generally low ambient turbidity (4 NTU), good sunlight penetration, low canopy cover indicates risk of biostimulation at low concentrations of nutrients. Note that **Nitrate-N is likely only a small fraction of total N** in the water column at site 306MOR, likely due to elevated biological uptake of NO3 in tidal flat environment and sequestration of N in other phases
Old Salinas River	Coastal flood plain and tidal flats Moderately high ambient turbidity, minimal canopy cover.	Old Salinas River from outflow @ Salinas River Lagoon to Old Salinas River at Potrero Rd.	**3.1** **Dry Season Samples (May 1-Oct31)** **8.0** **Wet Season Samples (Nov. 1-Apr. 30)**	**0.07** **Dry Season Samples (May 1-Oct31)** **0.3** **Wet Season Samples (Nov. 1-Apr. 30)**	Statistical Analysis (USEPA percentile-based approaches) Supported by Calif. NNE approach (NNE benthic biomass model tool) Wet-season targets based on Central Coast Basin Plan nitrate objectives and State of Nevada phosphate criteria for streams	muddy and fine-grained substrates and local soil conditions result in relatively high ambient turbidity (30 NTU – 25^{th} percentile) which precludes good sunlight penetration of water column; risk of biostimulation occurs at relatively higher nutrient concentrations.