Memorandum

DATE:	July 15, 2016
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SUBJECT: **Clear Lake Nutrient TMDL Progress Information Update Request**

Purpose: At the request of the Central Valley Regional Water Quality Control Board (Regional Board) staff, the Sacramento Valley Water Quality Coalition (Coalition) is providing the TMDL (Total Maximum Daily Load) staff information to assist them in preparation of its 2016 update of the Clear Lake Nutrient TMDL. In 2006, the Regional Board adopted the TMDL with the goal of achieving a 40% reduction in non-point source contributions. Nonpoint source dischargers – the U.S. Bureau of Land Management, the U.S. Forest Service, irrigated agricultural dischargers and Lake County – were given a load allocation of 85,000 kg phosphorus per year. As specified in the TMDL responsible parties may choose to estimate their phosphorus loading through monitoring.

A Memorandum of Understanding (MOU) developed in October 2008 documented an agreed upon roadmap for a collective approach among all the “responsible parties” for proceeding with the development of the Nutrient TMDL and resulted in a five (5) year plan. The Coalition in coordination with the Lake County Farm Bureau’s Lake County Farm Bureau Education Corporation (LCFBEC) conducted water quality monitoring as part of the 5-year plan.

The health and clarity of Clear Lake is essential to the economic vitality of the agricultural tourism industry surrounding the lake. This memorandum provides both results of that monitoring and information on management practices documented by the LCFBEC in 2007, current efforts to increase the use of management practices and additional goals the LCFBEC will consider as more becomes know about the causes of algae blooms in Clear Lake.

Email information request (Mark Cady, RWQCB)

Several specific questions regarding progress toward achieving the goals of the Clear Lake Nutrient TMDL were asked by Water Board ILRP staff in 2011:

1. Have there been changes to the agricultural land use from 2006? If so, what conversions have taken place? Are there now more acres under irrigation?

2. If yes, can you credibly estimate how these land use changes have affected the sediment/nutrient load inputs into Clear Lake?

3. Have growers in the area implemented any new BMPs or increased implementation of "old" BMPs since 2006?

4. Are the new BMPs or increased implementation of "old" BMPs achieving the 40% sediment load reduction as specified in the TMDL/Basin Plan?

5. If not known, how does the coalition intend to find out?

These questions were originally addressed by the Coalition and LCFBEC in a 2012 memorandum documenting the results of the monitoring and other information requested. The remainder of this memorandum updates key information provided in the 2012 memo for the purpose of addressing these questions and assessing progress towards achieving the goals of the TMDL.

1. Have there been changes to the agricultural land use?

There were substantial changes in agricultural land use in the Clear Lake watershed between 2002 and 2010, with little change from 2010 to 2016, based on Lake County Agriculture Department annual crop reports. Nearly all of the non-rangeland agricultural acreage in Lake County is within the Clear Lake watershed comprising primarily the drainages for Middle Creek, Scott Creek, and Kelsey Creek. The crop acreages for the county are therefore an accurate indicator for assessing changes in the Clear Lake region. Crop reports available for 2002-2010 were reported previously and are updated with reported acreage for 2011-2015 for the purpose of this evaluation.

Excluding rangeland, the majority of agricultural acreage in Lake County in 2010 was comprised of grapes, feed pasture, walnuts, and pears. Irrigated pasture, vegetables, and other fruit and nut crops make up a minor percentage of the total acreage (~5%). The distribution of crop types was essentially unchanged from 2010 to 2016. Crop reports for Lake County indicate that total agricultural acreage has decreased by about 10% from 2002 to 2010, but has increased in 2016 a few percentage points to about 94% of the bearing acreage planted in 2002. Although there were significant shifts in the types of crops planted from 2002 – 2010, the percentages of different crops has remained stable from 2010 to 2016. The largest change from 2002 has been the 47% increase in acreage planted in grape vineyards (2,598 additional acres planted since 2002). There have been substantial decreases in feed pasture crops (-2,528 acres) and pears (-1,013 acres) since 2002, but the acreage of these crops has remained relatively stable since 2010. Total acreage planted in walnuts has increased steadily from about 15% in 2002 to 22% in 2016. Overall, these changes have resulted in grapes comprising nearly half (47% in 2016) of the total planted acreage (up from 30% in in 2002).

The increase in vineyard acreage is even more dramatic when compared to the "non-compliant period" (1990-1991) defined in the TMDL. Total vineyard acreage in 1991 was approximately 3,000 acres, and the current vineyard acreage of ~8,000 acres represents a 170% percent increase since 1991. It is instructive to note that the period when this conversion to vineyard acreage began corresponds with an increase in the average clarity in Clear Lake (Figure 1). This does not suggest that conversion to vineyards was the cause of the improved clarity, but it is strong evidence that conversions to vineyards were not responsible for decreases in lake clarity.

Most of the agriculture in Lake County is irrigated, and the total irrigated acreage has also decreased by about 6% between 2002 and 2016. There may be a greater reduction in the actual amount of water applied because the wine grapes are commonly grown under a deficit irrigation program, and are never flood-irrigated. Based on these factors, there is an expected greater than proportional decrease in sediment and phosphorus loading based on the reduced irrigation runoff from agriculture.

2. How have these changes in agricultural land use affected sediment and nutrient loads?

The decrease in overall irrigated agricultural acreage translates directly to less runoff from irrigated lands. How the net decrease in agriculture land use affects overall sediment and nutrient loads remains less clear, because at least some of the change has likely been due to conversion to residential land uses.

It is possible that the process of converting acreage to vineyards over the past 20 years may have resulted in some short-term increases in sediment loading (and associated phosphorus loads), due solely to the process of preparing the soils for planting the grape vines. Because grapes are long-term perennial crops, this is not expected to have a long-term effect. Although most of the agricultural acreage in the Clear Lake watershed already consists of perennial crops (~81% is grapes, walnuts, pears), it is expected that the long-term impact of the shift to vineyard acreage will be to continue to reduce net sediment loads. Additionally, some of the the acreage converted to winegrapes in the Red Hills area was previously planted in dry farmed walnuts. These walnut orchards were characterized as *"…not irrigated and poorly managed, leading to erosion problems on the steeper slopes in the 1980s and 1990s*". Conversion of these orchards to sustainably managed winegrapes has had the effect of significantly decreased erosion from this area.

3. Have growers in the area implemented any new BMPs or increased implementation of "old" BMPs?

There is evidence that BMP implementation increased significantly. In 2003, when the boom in acres planted in vineyards was in full swing, Erosion Control Plans for new vineyards reviewed by the Lake County Winegrape Growers Association Erosion Education Committee, which included representatives of Lake County, California Department of Fish and Game, Lake County Resource Conservation District, and other agencies responsible for resource conservation.

The results of a 2007 survey by Lake County Farm Bureau Watershed Program indicated that about 90% of the vineyard acreage was maintaining a permanent or winter annual cover crop. The survey results indicated that growers accounting for about 78% of the acreage have either adopted a soil erosion control program or were working, researching or planning a farm water quality plan in 2007. This agrees closely with what the Lake County Winegrape Commission (LCWC) reported in 2011 – that 70% of the vineyard acreage and 145 winegrape growers have begun the process to become certified as sustainable winegrowers as part of the California Sustainable Winegrowing Alliance (CSWA[1]). The LCWC also reported in 2014 that more than 70 percent of Lake County growers have participated in their Code of Sustainable Winegrape Practices Self-Assessment Workbook and expect to increase that number every year (LCWC 2014). Management practices

[1] http://www.sustainablewinegrowing.org/aboutswp.php

promoted by the CSWA include soil management and cover cropping for erosion control, and irrigation management (for crop quality, energy efficiency and runoff control), and nutrient management practices.

Additional details of the level of current implementation of practices relevant to erosion control and sediment and phosphorus load reduction are also documented in the Lake Subwatershed's proposal for the ILRP reduced monitoring alternative[2]. The proposal includes the results of the 2015 Farm Evaluations for the entire Lake County subwatershed. Selected results of the Farm Evaluations are summarized in **Table 1**. Some specific results of particular relevance to the TMDL include these widely employed practices:

- 95% of growers get the professional assistance of PCA, CCA, agronomist, soil scientist, or NRCS when preparing crop fertility plan.
- 72.3% of growers report no potential to discharge sediment to surface waters
- More than 90% use drip, sprinklers, or microdrip as their primary method of irrigation
- 78% use cover crops or native vegetation to reduce erosion
- 75% use minimum tillage to minimize erosion potential

Nearly all growers also use additional irrigation and cultural practices to minimize erosion potential and soil loss from their irrigated lands. All of these practices are expected to continue to have a significant positive effect on reducing sediment and phosphorus loads to Clear Lake.

4. Are the new BMPs or increased implementation of "old" BMPs achieving the 40% sediment load reduction as specified in the TMDL/Basin Plan?

There is evidence that the increased implementation of management practices by agriculture and other responsible non-point sources named in the TMDL is decreasing sediment and phosphorus loads to Clear Lake. Increased clarity has been observed in Clear Lake (Figure 1 and Figure 2) since erosion control measures were implemented by Lake County beginning in the early 1990s. The following is excerpted from a report by the Lake County Water Resources Department Report (Algae in Clear Lake) on the Lake County website (http://bit.ly/uMWJSI):

> "*Starting in the summer of 1990, lake clarity improved significantly. This improved clarity has continued until the present. This graph shows the Secchi Depth (the depth into the water at which a black and white checked plate is visible) in the Upper Arm from 1969 through 2008.*
>
> *During the 1991-1994 time period, University of California researchers led by Drs. Peter Richerson and Thomas Suchanek analyzed lake water quality data collected for the previous 15 years, conducted experiments and evaluated the Clear Lake system. Unfortunately, little data was available during the period of improved clarity since 1990. The "Clean Lakes Report" determined that excess phosphorus is a major cause, however, iron limits the growth of blue-green algae. The Report hypothesized that the increased clarity observed in 1990 was due to drought conditions. The Report recommends numerous strategies to reduce*

[2] Lake County Farm Bureau Education Corporation. 2016. Lake County Reduced Monitoring Management Practices Alternative (DRAFT). January 29, 2016.

> *phosphorus loading (which also reduce iron loading), including stream channel and wetland protection and rehabilitation, and erosion reduction.*
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> *The improved water clarity and reduced blue-green algal blooms continued into the new millennium. DWR data collected since the Clean Lakes Report was evaluated by Lake County staff in 2002. The improved clarity continued, in spite of the wet years of 1995, 1997 and 1998, indicating the improved clarity was probably not drought related. Surprisingly, phosphorus and total nitrogen concentrations in the lake did not change substantially when the lake clarity increased. Cursory review of the data did not provide evidence of chemical changes that led to the improved clarity and reduced blue-green algal blooms in Clear Lake."*

Water quality monitoring conducted by the Coalition for the ILRP, and by Lake County for the TMDL from 2007-2016 continues to indicate that sediments and phosphorus concentrations have decreased in waters that flow into Clear Lake since 2000. Results from these monitoring efforts are summarized in Table 2. Compared to results reported in the 2004 TMDL technical report by TetraTech[3], the average concentrations of TSS and total phosphorus were much lower for the 2007-2008 TMDL monitoring and for ILRP monitoring results for 2007-2011 and for subsequent monitoring conducted from 2011-2016. These results continue to support a conclusion that significant sediment loading reductions have already been realized and that the 40% reduction targets for agriculture have been achieved before the TMDL compliance deadline.

The average total phosphorus load estimated using the ILRP data for Middle Creek was ~66 kg/day, for the 2007-2011 monitoring period. The watershed contributing to the Middle Creek sampling location is approximately 80 square miles, and accounts for approximately 20% of the contributing Clear Lake watershed of 411 square miles. Based on an area-proportional allocation of the total TMDL load allocation for Clear Lake (20% of 239 kg/day = 48 kg/day), the average loads measured at Middle Creek for 2007-2011 appear to be approaching the overall TMDL goal of a 40% reduction. The TMDL allocation assigned to the combined watersheds of Scotts Creek and Middle Creek is 69 kg/day. However, this allocation is premised on a 60% reduction for these combined watersheds that anticipated substantial additional reductions expected from the Middle Creek Flood Damage Reduction and Ecosystem Restoration Project.

Implementation of the Clear Lake TMDL relies heavily on the Middle Creek Flood Damage Reduction and Ecosystem Restoration Project. The Project has a goal to acquire 1,650 acres of reclaimed land at the north end of Clear Lake to restore it to wetlands, and is expected to significantly improve water quality in Clear Lake by reconnecting Middle Creek to these historical wetlands. Diversions of flows through the wetland area are estimated to reduce the *total* phosphorus load to Clear Lake by up to 28 percent. The Scotts Creek and Middle Creek watersheds, which comprise approximately one half of the Clear Lake watershed, drain through Rodman Slough adjacent to the Project area. These two watersheds are estimated to contribute 57 percent of the inflow and 71 percent of the phosphorus loading to Clear Lake. Restoring wetlands on the north end of the lake has been estimated to potentially reduce phosphorus loading by 40% as the Middle/Scotts Creek watershed contributes over 50% of the total sediment load to the lake

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[3] *Total Maximum Daily Load for Nutrients in Clear Lake, Lake County, California. Final Technical Report*. Prepared for Central Valley Regional Water Quality Control Board by TetraTech. December 2004.

(RWQCB 2012). This restoration project was originally scheduled to begin construction in 2012 and be completed by 2015, but land acquisition is still ongoing. As of March 26, 2015, thirteen flood prone residential homes and 367 acres of land have been purchased. An additional 676 acres of property, including three flood prone homes are currently in the acquisition process. (County of Lake, 2015).

5. If a 40% sediment load reduction can't be definitively demonstrated at this time, how will the Coalition intend to find out if the TMDL goals are being met?

Consistent with the approach outlined in the TMDL and working in coordination with the other non-point source responsible parties and the Regional Water Board, the Coalition will continue to evaluate the progress toward achieving the goals of the TMDL. The specific future actions planned by the Coalition to monitor and evaluate progress are:

- Continue ILRP monitoring of related analytes in Middle Creek (ongoing) with periodic evaluations as required for ILRP Management Plan reporting.

- Periodically survey all Lake County Coalition members to document Management Practice implementation (as required by the SVWQC WDR).

Table 1. Selected Results from Lake County 2015 Farm Evaluations

Farm Evaluation Questions	Responses
Who do you have help develop your crop fertility plan?	95% get the professional assistance of PCA, CCA, agronomist, soil scientist, or NRCS when preparing crop fertility plan.
Does your farm have the potential to discharge sediment to off-farm surface waters?	72.3% report no potential to discharge sediment to surface waters.
Irrigation Practices	>90% use drip, sprinklers, or microdrip as their primary method of irrigation.

Irrigation Practices for Managing Sediment and Erosion	Total Acres	% of Total Acres
Use drip or micro-irrigation to eliminate irrigation drainage	6,376	68.0%
No irrigation drainage due to field or soil conditions	6,202	66.2%
The time between pesticide applications and the next irrigation is lengthened as much as possible to mitigate runoff of pesticide residue	3,105	33.1%
Shorter irrigation runs are used with checks to manage and capture flows	2,599	27.7%
No Selection	791	8.4%
Catchment Basin	754	8.0%
Tailwater Return System	519	5.5%
Use of flow dissipaters to minimize erosion at discharge point	262	2.8%
In-furrow dams are used to increase infiltration and settling out of sediment prior to entering the tail ditch	123	1.3%
Other	62	0.7%

Cultural Practices to Manage Sediment and Erosion	Total Acres	% of Total Acres
Cover crops or native vegetation are used to reduce erosion.	7,284	77.7%
Minimum tillage incorporated to minimize erosion.	7,052	75.2%
Soil water penetration has been increased through the use of amendments, deep ripping and/or aeration.	3,050	32.5%
Vegetated ditches are used to remove sediment as well as water soluble pesticides, phosphate fertilizers and some forms of nitrogen.	2,847	30.4%
Subsurface pipelines are used to channel runoff water.	2,479	26.4%
Creek banks and stream banks have been stabilized.	2,366	25.2%
Vegetative filter strips and buffers are used to capture flows.	2,239	23.9%
No storm drainage due to field or soil conditions.	1,521	16.2%
Hedgerows or trees are used to help stabilize soils and trap sediment movement.	1,473	15.7%
Sediment basins / holding ponds are used to settle out sediment and hydrophobic pesticides such as pyrethroids from irrigation and storm runoff.	1,449	15.5%
Berms are constructed at low ends of fields to capture runoff and trap sediment.	1,335	14.2%
Field is lower than surrounding terrain.	1,146	12.2%
Storm water is captured using field borders.	1,031	11.0%
Crop rows are graded, directed and at a length that will optimize the use of rain and irrigation water.	649	6.9%
No Selection	464	4.9%
Other	20	0.2%

Table 2. Monitoring results for major Clear Lake tributaries, 1992 – 2016.

		Averages for Monitoring Period			
Site	**Parameter**	**1992-2000 (TMDL Report, 2004)**	**2007-2008 (Clear Lake TMDL Monitoring)**	**2007-2011 (SVWQC)**	**2011-2016 (SVWQC)**
Middle Creek	Total P, mg/L	0.51	0.275	0.067	0.032
	Ortho-P, mg/L	0.15	0.078	0.013	0.023
	TSS, mg/l	512	246	20.6	8.0
	Avg. Discharge, cfs	not reported	828.5	184	13.7
Kelsey Creek	Total P, mg/L	0.38	0.154	—	—
	Ortho-P, mg/L	0.16	0.084	—	—
	TSS, mg/l	381	125	—	—
	Avg. Discharge, cfs	not reported	748	—	—
Scott Creek	Total P, mg/L	0.36	0.356	—	—
	Ortho-P, mg/L	0.12	0.099	—	—
	TSS, mg/l	344	207	—	—
	Avg. Discharge, cfs	not reported	987	—	—

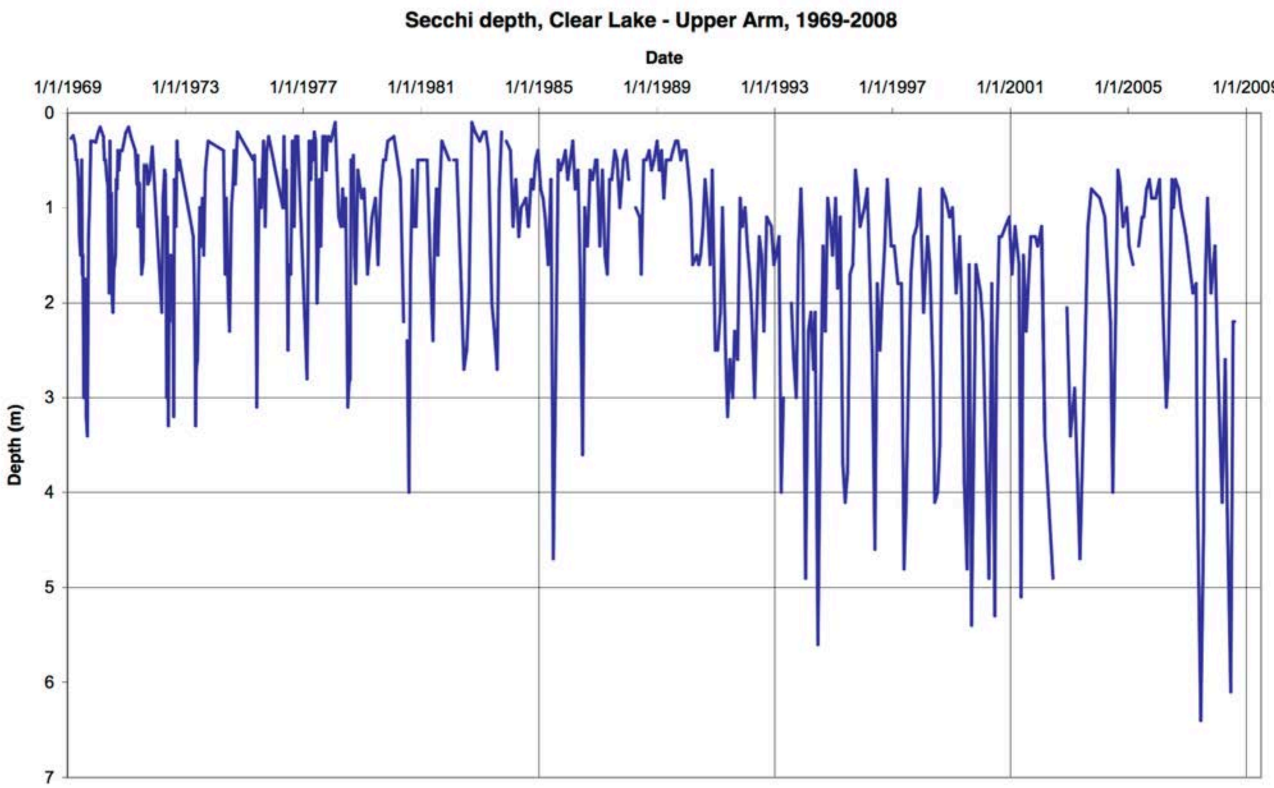

Figure 1. From Lake County Algae in Clear Lake website (http://www.co.lake.ca.us/Assets/WaterResources/Algae/Secchi+Depth$!2c+Upper+Arm.pdf).

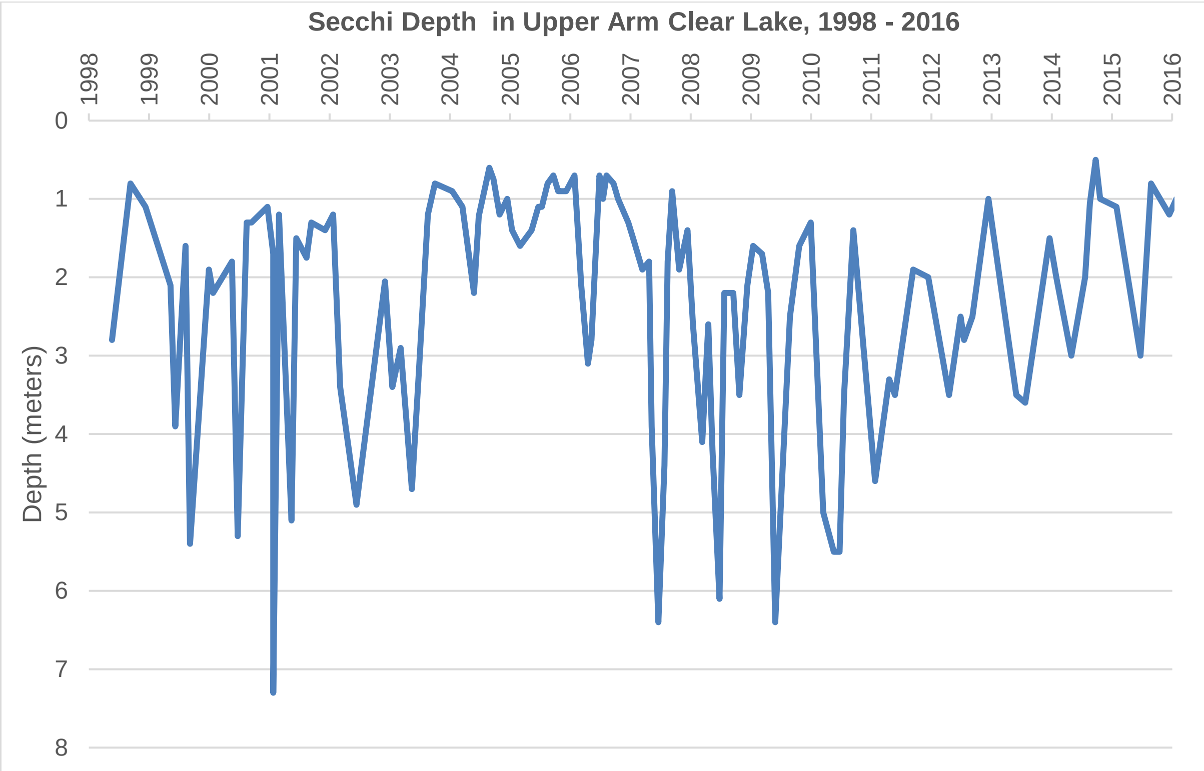

Figure 2. Secchi Depth in Clear Lake Upper Arm, 1998 – 2016.