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Technical Memorandum

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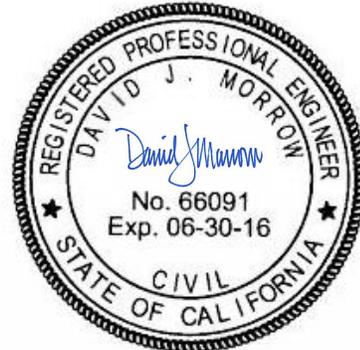
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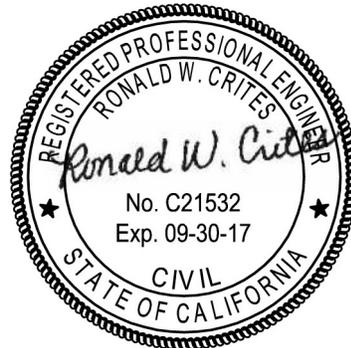
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Executive Summary

This Technical Memorandum 1 (Tech Memo 1) describes the latching loading rates for biochemical oxygen demand (BOD) and applied total nitrogen as regulated in the Waste Discharge Requirements (WDRs). The reported violations of BOD loadings are analyzed and the key reporting requirements are described. Finally the management of BOD loading in more “real time” is proposed.

Section 1: Regulatory Status

1.1 Regulatory Requirements

The land application of process water is regulated under Waste Discharge Requirements (WDR) Order R5-2013-0144 dated December 5, 2013. The requirement for biochemical oxygen demand (BOD) loading rate is that the maximum irrigation cycle average loading shall not exceed 100 lb/acre-day for any given field. The total nitrogen loading rate shall not exceed the annual crop demand in lb/acre-year.

1.1.1 Reporting Requirements

The Monitoring and Reporting Program (MRP) states that the BOD loading rate is to be calculated daily and reported monthly. The BOD loading rate is to be reported for each field, not each check. The WDR requires the use of the following equation:

The mass of BOD applied to each Land Application Area (LAA) field as an irrigation cycle average shall be calculated using the following formula:

$$M = \{ 8.345(CV) + M_x \} \div \{A (CT)\}$$

Where: M = mass of BOD applied to each LAA field in lb/ac/day/irrigation cycle

C = concentration of BOD in mg/L based on the average of the three most recent wastewater monitoring results

V = volume of wastewater applied to the LAA field in millions of gallons per day during the irrigation cycle

A = area of the LAA field irrigated in acres

CT = cycle time (i.e., irrigation cycle length), days

M_x = BOD mass from other sources (e.g., cattle manure, Settling

Pond solids, and residual solids) in pounds

8.345 = unit conversion factor

1.2 Regulatory Actions

On November 20, 2015 the Regional Water Quality Control Board (Regional Water Board) issued a tentative Cease and Desist Order (CDO). It alleged that the LAA received excessive BOD loadings during August and September. It also cited excessive nitrogen loading on the MS6 field that was planted to rice.

Section 2: Land Application System

The process wastewater is land applied using both border strip surface irrigation and center pivot sprinkler irrigation. The center pivot sprinkler was installed in field MS24 in August 2015.

2.1 Land Application Operation

Surface irrigation consists of border strip that are typically 30 ft wide and 1,200 ft long. The application period varies by field and ranges from 2 to 6 days. The drying time ranges from 6 to 8 days. The total cycle of irrigation ranges from 8 to 14 days. Drying is a critical part of the total cycle and cycle times less than 8 days should be avoided.

The center pivot operates in field MS24 and covers 135 acres. Center pivots are typically run continuously during peak periods with a rotation period of 12 to 48 hours. The center pivot is idled during times of insufficient irrigation water and/or when field operations need to be performed.

2.2 Water Quality Data and Characterization

For this TM the critical wastewater constituents are BOD and total nitrogen. For 2015 the weekly values for BOD and total nitrogen are presented in Table 1. For BOD loading rate calculations the running average of the last 3 values is used. The July 23 sample result was not used in the calculations because it was not tested within the required hold time and appears to be an outlier. The September 10th sample is also considered an outlier because it was taken during an upset condition; however, it was used in the rolling average calculations. As a result of using this high value the September BOD loading rates were biased on the high side for the three weeks affected.

Table 1. BOD and Nitrogen Concentrations		
Date	BOD, mg/L	Nitrogen, mg/L
JULY		
July 9, 2015	212	19
July 16, 2015	1,020	46
July 23, 2015	73 ¹	8.1 ¹
July 30, 2015	2,300	77
AUGUST		
August 6, 2015	2,400	100
August 13, 2015	1,580	61
August 20, 2015	1,120	46
August 27, 2015	1,470	56
SEPTEMBER		
September 3, 2015	1,410	61
September 10, 2015	4,400 ²	130
September 17, 2015	1,200	57
September 24, 2015	1,200	57
OCTOBER		
No samples were taken for October	--	

1. BOD testing done outside of hold times. 7/23 result not used in calculations.

2. Sample taken during a period of solids removal from the settling pond and is therefore higher than representative.



2.3 Wastewater BOD Loading Rates

Wastewater BOD loading rates were calculated using the equation in section 1.1. BOD concentrations were generally higher than historical ranges, averaging 1,506 mg/L, due to increased production, startup issues with the expanded production facilities, and water conservation measures. Wastewater flow rates were 1.6 mgd for 2015 compared to the WDR limit of 4.3 mgd.

For the 27 alleged violations out of over 100 total irrigation cycles of the maximum BOD loading rate in the CDO, revised calculations are shown in Table 2. Of the 27 alleged violations, only 10 appear to be violations on a full field basis using the revised calculations of cycle time, BOD concentration, and field area consistent with the MRP. Tables with additional details are provided in Attachment A. Table A-2 shows the total exceedances based on recalculations for the processing season. Table A-3 shows there would only be 10 exceedances if the outlier value of 4,400 mg/L for September 10th was not included.

Item	Field	Date	Reported BOD Loading by Check, lb/ac/day	Calculated BOD Loading by Field, lb/ac/day	Review Notes
1	MS2	Aug 28 - Aug 29	109	26	1, 2, 3, 4
2	MS3	Aug 29 - Aug 30	153	20	1, 2, 3, 4
3	MS6	Aug 8 - Aug 14	134	194	2, 3, 4
4	MS6	Aug 23 - Aug 26	195	118	2, 3, 4
5	MS11	Aug 8 - Aug 9	199	130	2, 3, 4
6	MS11	Aug 14 - Aug 17	146	25	2, 3, 4
7	MS15	Aug 17 - Aug 19	108	12	1, 2, 3, 4
8	MS16	Aug 11 - Aug 13	134	22	1, 2, 3, 4
9	MS16	Aug 13 - Aug 15	104	22	1, 2, 3, 4
10	MS18a	Aug 14 - Aug 16	122	29	1, 2, 3, 4
11	MS18a	Aug 17 - Aug 19	147	29	1, 2, 3, 4
12	MS24	Aug 15 - Aug 18	118	118	
13	MS24	Aug-16	118	48	2, 3
14	MS2	Sept 16 - Sept 17	127	59	1, 2, 3, 4
15	MS5	Sept 8 - Sept 9	155	18	1, 2, 3, 4
16	MS14	Sept 8 - Sept 10	216	198	1, 2, 3, 4
17	MS14	Sept 12 - Sept 18	198	109	2, 3, 4
18	MS14	Sept 18 - Sept 20	113	109	2, 3, 4
19	MS14	Sept 23 - Sept 25	118	103	1, 2, 3, 4
20	MS14	Sept 27 - Sept 30	103	44	2, 3, 4
21	MS15	Sept 15 - Sept 16	192	46	2, 3, 4
22	MS15	Sept 23 - Sept 25	150	82	2, 3, 4
23	MS16	Sept 13 - Sept 15	131	108	1, 2, 3, 4

Table 2. Application Exceeded BOD Loading Limits					
Item	Field	Date	Reported BOD Loading by Check, lb/ac/day	Calculated BOD Loading by Field, lb/ac/day	Review Notes
24	MS16	Sept 15 - Sept 16	151	108	1, 2, 3, 4
25	MS16	Sept 24 - Sept 26	138	75	1, 2, 3, 4
26	MS18a	Sept 2 - Sept 3	113	30	1, 2, 3, 4
27	MS18b	Sept 25 - Sept 26	154	64	2, 3

1. LAA reported as individual checks instead of total field area.
2. Flows taken from different cycle period than reported.
3. BOD taken from different cycle period than reported.
4. Cycle periods were calculated by check and not application field.

The LAA field area of 485 acres will support a flow of up to 3.9 mgd at a loading rate of 100 lb/acre-day with a BOD concentration of 1,506 mg/L (2015 average 3-week concentration). Conversely, if the 2015 flow of 1.6 mgd is used for 2016, an average BOD of 3,630 mg/L could be land applied.

2.4 Surrogates for BOD Loading Rates

The BOD test requires 5 days to conduct and typical turnaround times in laboratory reporting are 7 to 10 days or more. As a result, the time between sampling for BOD and obtaining the results can be 2 to 3 weeks. Applications are made to the land without knowing what the BOD loading will be until after the fact.

There are two possible alternatives to managing BOD loadings before the test results are known – (1) correlation with the tonnage of tomatoes processed, or (2) correlation to the brix or sugar content of the wastewater. Brix has been directly correlated with sugar content in most fruits and can be correlated to the BOD in wastewater.

At the beginning of the season the BOD mass can be estimated by using the tonnage of tomatoes to be processed in the first few weeks. The required acres of field area can then be used each day and the fields rotated based on expected BOD loading rather than the hydraulic loading.

Using the brix correlation requires a number of BOD tests and brix readings to be conducted early in the season. Once the correlation is obtained, the expected BOD concentration can be estimated from the brix test, which can be conducted onsite within minutes. Some tomato processors have found a better correlation with BOD and brix than with BOD and COD. When higher-than-normal brix readings occur, the operators can reduce the application period to each field and increase the cycle time to account for the higher BOD loading expected. There can also be a check on the processing operations to see if the reason for the increased brix readings can be found and corrected.

2.5 Wastewater Nitrogen Loading Rates

The CDO noted that the nitrogen loading rate to field MS 6 exceeded the crop uptake rate. Field MS 6 was planted to rice in July 2015. Rice is not an appropriate crop for two reasons. First, it has a low nitrogen uptake rate of approximately 110 lb/acre-yr, as compared to sudan grass or other forage grasses. Secondly, the crop needs to be flooded and not dried out between applications, which results in a high initial hydraulic and BOD loading rate and the likely creation of anaerobic conditions with resultant odors. It is recommended that rice not be planted in 2016 or subsequent years.

Section 3: Conclusions

The following conclusions are drawn from the analysis in this TM.

1. Seventeen of the 27 violation of BOD loading rate limits were incorrectly reported as exceeding the 100 lb/acre-day limit due to a variety of reasons including (a) using the area of the check and not the area of the field, (b) not using the entire cycle time from beginning of the application to a field until the subsequent initial loading, and (c) using BOD and flow data from an earlier cycle.
2. The average BOD in 2015 increased to 1,506 mg/L from the 2014 average of 595 mg/L.
3. The revised number of exceedances is 15 based on the values in Table A-2 and that number would be reduced to 10 violations for the year if the outlier 4,400 mg/L sample was excluded.
4. The 485 acres of cropland can support the expected 2016 flows of 3.1 mgd without exceeding the BOD loading limit.
5. Use of the BOD test alone makes it difficult to manage the loading rates proactively due to the 2 to 3 week lag time between samples taken and results obtained.
6. The brix test for sugar content can be correlated to the BOD test and the brix results can be available the same day as the samples are taken.
7. The brix results can alert the operators of the land application system that higher-than-normal BOD results can be expected and allow them to take corrective actions.
8. The use of rice as a land application crop with food processing wastewater is not a good idea. The nitrogen uptake is limited and the BOD loading can be excessive due to the need for continuous watering in early growth stages.

Section 4: Recommendations

The recommendations from this TM are as follows.

1. Morning Star should implement a real-time program of twice weekly brix testing and correlate the readings to the BOD concentrations in the wastewater.
2. Operators should use the brix results to predict the BOD being applied to keep the loading rate below 100 lb/acre-day.
3. The cycle time must include adequate resting and drying to avoid organic overloading, especially of the surface irrigation areas.
4. Conversion of surface irrigation to sprinkler irrigation is recommended in the long term for fields amenable to sprinkler irrigation.
5. Growing rice or similar crops is not recommended.

Attachment A: Running Average BOD Values

Table A-1. Revised 3-Week BOD Running Average

Table A-2. Total BOD Application Exceedances of Effluent Limit

Table A-3. Total BOD Application Exceedances to Effluent Limit

Table A-1. Revised 3-Week BOD Running Average	
Week	BOD, mg/L
JULY	
2	212
3	616
4	616
5	1,177
AUGUST	
1	1,907
2	2,093
3	1,700
4	1,390
5	1,907
SEPTEMBER	
1	1,333
2	2,427
3	2,337
4	2,267

Table A-2. Total BOD Application Exceedances <i>(Based on Revised BOD Calculations)</i>		
Date	Field	BOD loading, lb/ac/day
JULY		
July 25 - Aug 4	MS6	149
AUGUST		
Aug 1 - Aug 7	MS16	119
Aug 1 - Aug 9	MS11	130
Aug 8 - Aug 14	MS6	194
Aug 12 - Aug 13	MS24	118
Aug 15 - Aug 18	MS24	118
Aug 22 - Aug 27	MS6	118
SEPTEMBER		
Sept 1 - Sept 6	MS14	127
Sept 5 - Sept 16	MS16	108
Sept 8 - Sept 10	MS14	198
Sept 10 - Sept 13	MS15	192
Sept 12 - Sept 20	MS14	109
Sept 18 - Sept 22	MS18b	153
Sept 19 - Sept 21	MS15	150
Sept 23 - Sept 25	MS14	103

Table A-3. Total BOD Application Exceedances (Based on Revised BOD Calculations and Outlier Removed)		
Date	Field	BOD loading, lb/ac/day
JULY		
July 25 - Aug 4	MS6	149
AUGUST		
Aug 1 - Aug 7	MS16	119
Aug 1 - Aug 9	MS11	130
Aug 8 - Aug 14	MS6	194
Aug 12 - Aug 13	MS24	118
Aug 15 - Aug 18	MS24	118
Aug 22 - Aug 27	MS6	118
SEPTEMBER		
Sept 1 - Sept 6	MS14	127
Sept 8 - Sept 10	MS14	109
Sept 10 - Sept 13	MS15	105

Note: Removed September 10th lab result from calculations.