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DATE: 6 November 2015

SUBJECT: Cooling Pond Seepage Estimate, Morning Star Packing Company, Williams Facility, Colusa County

Purpose

This technical memorandum was prepared to explain the attached pond seepage estimate calculations for the expanded portion of the cooling pond located at the Morning Star Packing Company in Williams.

Background

On 5 November 2015, we were asked to estimate the seepage rate from the expanded portion of the cooling pond at the Morning Star Packing facility. We used Morning Star's 1 October 2015 response (NOV Response) to our 11 September 2015 Notice of Violation and the July 2015 through September 2015 monthly Self-Monitoring Reports (SMRs) for information used in the estimate.

Water Board Seepage Rate Estimate

We staff calculated the estimated seepage rate based on the following inputs and assumptions:

Pond Area

Based on the *Cooling Pond Grading and Dimension Plan* prepared by Siegfried Engineering and included in the 1 October 2015 NOV Response, the new pond has a water surface area of approximately 52 acres. During construction of the new portion of the pond, a portion of the existing pond was taken out of service. Based on the *Site Demolition and Topographic Plan* prepared by Siegfried Engineering and also included in the 1 October 2015 NOV Response, approximately 12 acres of the existing pond were taken out of service during the pond expansion project. Using these estimated sizes, the net expansion of the cooling pond surface area is assumed to be approximately 40 acres.

Hydraulic Conductivity

According to the Wallace and Kuhl 15 April 2015 *Morning Star Packing Company Cooling Pond Expansion Geotechnical Engineering Report* included in the NOV Response, the bottom of the pond was to be scarified to a depth of 12 inches and uniformly compacted during pond construction. Board staff does not have a construction report to verify that this was done, but for the purpose of this estimate, we assumed that this occurred. Based on boring logs (also included in the NOV Response) from three borings advanced in the footprint of the pond expansion (D-006 through D-008), the native material at the base of the pond is clay from the ground surface to groundwater. Based on the Wallace and Kuhl report, groundwater is approximately five feet below the bottom of the pond. Actual groundwater elevations below the pond are likely shallower than five feet below the bottom of the pond based on the Discharger's monitoring reports[1]; however, the Wallace and Kuhl values were used to provide a conservative seepage estimate from the pond. A hydraulic conductivity of $1X10^{-6}$ cm/sec was assumed for the one-foot thick compacted layer and $1X10^{-5}$ cm/sec was assumed for the four foot thick layer of native soil between the compacted layer and the top of groundwater. An average hydraulic conductivity (k) of $3.57X10^{-6}$ cm/sec was calculated based on the following formula[2] and used in the seepage estimate.

$$k_{average} = \frac{d}{\frac{D_1}{k_1} + \frac{D_2}{k_2}}$$

Where:
d = total thickness of soil liner
D_1 = thickness of soil horizon 1
k_1 = hydraulic conductivity of horizon 1
D_2 = thickness of soil horizon 2
k_2 = hydraulic conductivity of horizon 2

Depth of Water in the Pond

The base of the pond was assumed to be level and at an elevation of 88 ft mean sea level (msl). The top of the berm on the pond was assumed to be 96.5 ft msl based on the Siegfried Engineering *Site Demolition and Topographic Plan*. Using freeboard measurements from this pond reported in the June 2015 through September 2015 monthly SMRs, the pond elevation ranged from 92.9 ft msl to 94.1 ft msl with an average of 93.6 ft msl between 9 July 2015 and 24 September 2015. The average water depth of 5.6 ft (93.6-88) was used in the estimate. The first reported freeboard measurement found in the monthly SMRs following pond construction was a two foot measurement reported for 30 June 2015. No freeboard measurements were reported after 30 June 2015 until the pond was in operation and the 9 July 2015 measurement of 3.3 feet of freeboard was reported. We assumed that the cooling pond was full at the beginning of the processing season.

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[1] Based on groundwater elevation data found in Morning Star's *First Quarter 2015 Groundwater Monitoring Report*.

[2] United States Department of Agriculture, Natural Resources Conservation Service, 2008, *Part 651, Agricultural Waste Management Field Handbook, Appendix 10D, Design and Construction Guidelines for Waste Impoundments Lined with Clay or Amendment-Treated Soil*. Rev.1, March 2008.

Calculation
The seepage rate was calculated using the following equation[2] derived from Darcy's Law.

$$Q = k * \frac{H + d}{d} * A$$

Where:
Q = total seepage through area A
k = hydraulic conductivity
H = vertical distance between the top of the pond water to the base of the pond
d = thickness of soil layer
A = cross sectional area perpendicular to the flow

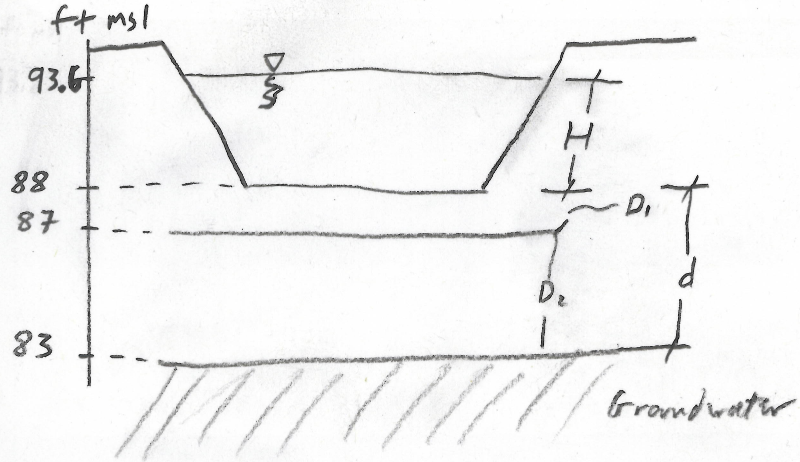
Conclusion
Board staff calculated a pond seepage rate of approximately 276,300 gallons per day. Calculations used to prepare this estimate are found in Attachment A.

Attachment 1: 11/6/2015 Morning Star Pond Seepage Estimate Calculations

Morning Star Pond Seepage Estimate - Attachment A

11/6/2015

Mike Fischer



$H = 5.6$ ft

$D_1 = 1$ ft

$D_2 = 4$ ft

$d = 5$ ft

$k_1 = 1 \times 10^{-6}$ cm/sec

$k_2 = 1 \times 10^{-5}$ cm/sec

$A = 40$ acres $= 1{,}742{,}400$ ft^2

Calculate k_{ave}.

$$k_{ave} = \frac{d}{\frac{D_1}{k_1} + \frac{D_2}{k_2}} = \frac{5}{\frac{1}{1\times10^{-6}} + \frac{4}{1\times10^{-5}}} = \frac{5}{1{,}400{,}000} = 3.57\times10^{-6} \text{ cm/sec}$$

Convert k_{ave} cm/sec to ft/day

$$3.57\times10^{-6} \text{ cm/sec} \left(86{,}400 \frac{\text{sec}}{\text{day}}\right)\left(0.0328 \frac{\text{ft}}{\text{cm}}\right) = 0.010 \text{ ft/day}$$

$$Q = k_{ave}\left(\frac{H+d}{d}\right) \times A$$

$$Q = 0.010 \text{ ft/day} \left(\frac{5.6 \text{ ft} + 5 \text{ ft}}{5 \text{ ft}}\right) \times 1{,}742{,}400 \text{ ft}^2$$

$$Q = 36{,}939 \text{ ft}^3/\text{day}$$

Q ft/day to gal/day

$$Q = 36{,}939 \text{ ft}^3/\text{day} \left(\frac{7.48 \text{ gal}}{\text{ft}^3}\right) \approx 276{,}300 \text{ gal/day}$$