EPA’s Draft Aluminum Criteria

Published: July 28, 2017

Comments Due: Sept. 20, 2017
1988 Aluminum Criteria

• Acute criteria = 750 $ug/L$ (1 hour exposure)
• Chronic criteria = 87 $ug/L$ (4 day exposure)
• Not adopted as a water quality objective
  – Not in Santa Ana Basin Plan
  – Not in California Toxics Rule or National Toxics Rule
  – Sometimes used as narrative translator (ex. 303d)
• Many known problems with the 1988 criteria
2017 Draft Aluminum Criteria

• Variable criteria, adjusted for:
  – pH
  – Hardness
  – Dissolved Organic Carbon (DOC)

• EPA provides spreadsheet tool to calculate **Total Recoverable Aluminum** concentration

• Not binding until the state approves the criteria as a water quality standard.
Comparison: New vs. Old

Table 1: 2017 Draft Aluminum Aquatic Life Criteria Compared to Current 1988 Criteria\(^a\)

<table>
<thead>
<tr>
<th>Version</th>
<th>Freshwater Acute (1 day, total aluminum)</th>
<th>Freshwater Chronic (4-day, total aluminum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017 Draft AWQC Criteria</td>
<td>1,400 µg/L</td>
<td>390 µg/L</td>
</tr>
<tr>
<td>(MLR normalized to pH = 7, hardness = 100 mg/L, DOC = 1 mg/L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1988 AWQC Criteria</td>
<td>750 µg/L</td>
<td>87 µg/L</td>
</tr>
<tr>
<td>(pH 6.5 – 9.0, across all hardness and DOC ranges)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) Values are recommended not to be exceeded more than once every three years on average. Note: Values will be different under differing water chemistry conditions as identified in this document.

Alum Application Program

- Alum (aluminum sulfate) is 9% aluminum
- 40 mg/L of Alum = 3,600 ug/L of aluminum
  \[(40 \text{ mg/L (ppm)} = 40,000 \text{ ug/L (ppb)}\]
- Binds with phosphorus to form aluminum phosphate (inert and insoluble)
- Site-specific testing demonstrated that alum was not toxic in Canyon Lake water
### Estimated Criteria for Canyon Lake

<table>
<thead>
<tr>
<th>EPA Spreadsheet Tool*</th>
<th>ACUTE (CMC)</th>
<th>CHRONIC (CCC)</th>
</tr>
</thead>
</table>
| Constrained Input Values  
\(pH=8.2, \text{ Hardness}=150, \text{ DOC}=5.0\) | 4,400 \(\mu\text{g/L}\) | 2,300 \(\mu\text{g/L}\) |
| Unconstrained Input Values  
\(pH=8.2, \text{ Hardness}=300, \text{ DOC}=20.0\) | 8,000 \(\mu\text{g/L}\) | 2,800 \(\mu\text{g/L}\) |
| Table K-7 & Table K-8 Values (draft)  
\(pH=8.0, \text{ Hardness}=300, \text{ DOC}=5.0\) | 4,700 \(\mu\text{g/L}\) | 2,000 \(\mu\text{g/L}\) |

EPA advises discretion in applying spreadsheet tool when site-specific input values are outside the range of values used to develop the model equation.

*EPA Aluminum Criteria Calculator V.1.0.xlsx*
Focus of Comment Letter

- Develop separate warm & cold water criteria.
- Expand model domain to include higher hardness values (>150 mg/L) common to arid west waters.
- Expand model domain to include higher DOC values (>5 mg/L) common in warm water lakes.
- Affirm ability to use the Water Effects Ratio (WER) procedure to develop site-specific aluminum criteria.
- Special consideration/exception for Alum applications; at a minimum, only the acute criteria should be applied to applications made in accordance with label.
Lake Elsinore and Canyon Lake TMDL Water Quality Monitoring Update – 2016-17 Summary

Watershed Monitoring
### Summary of 2016-2017 Watershed Monitoring and Nutrient Loads

<table>
<thead>
<tr>
<th>Number and Location Description</th>
<th>Annual Flow (Mgal)</th>
<th>Annual Event Mean Storm Concentration (mg/L)</th>
<th>Estimated Annual Load (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total Nitrogen</td>
<td>Total Phosphorus</td>
</tr>
<tr>
<td>Site 3 - Salt Creek at Murrieta Road</td>
<td>1,596</td>
<td>2.07</td>
<td>0.62</td>
</tr>
<tr>
<td>Site 4 - San Jacinto River at Goetz</td>
<td>2,802</td>
<td>2.03</td>
<td>1.23</td>
</tr>
<tr>
<td>Site 6 - San Jacinto River at Ramona Expressway</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Site 30 - Canyon Lake Spillway</td>
<td>4,850</td>
<td>1.85</td>
<td>0.36</td>
</tr>
<tr>
<td>Site 1 - San Jacinto River at Cranston Guard Station</td>
<td>6,194</td>
<td>Not Measured</td>
<td>Not Measured</td>
</tr>
</tbody>
</table>
### Summary of 2016-2017 Monthly Flow

<table>
<thead>
<tr>
<th>Mean Monthly Flow (cfs)</th>
<th>Site 3 - Salt Creek</th>
<th>Site 4 - San Jacinto River</th>
<th>Site 6 - San Jacinto River at Ramona Expressway</th>
<th>Site 30 - Canyon Lake Spillway</th>
<th>Site 1 - San Jacinto River at Cranston Guard Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>0.00</td>
<td>0.00</td>
<td>-</td>
<td>3.10</td>
<td>0.05</td>
</tr>
<tr>
<td>August</td>
<td>0.00</td>
<td>0.00</td>
<td>-</td>
<td>2.89</td>
<td>0.03</td>
</tr>
<tr>
<td>September</td>
<td>0.00</td>
<td>0.00</td>
<td>-</td>
<td>0.16</td>
<td>0.01</td>
</tr>
<tr>
<td>October</td>
<td>0.17</td>
<td>0.00</td>
<td>-</td>
<td>0.15</td>
<td>0.02</td>
</tr>
<tr>
<td>November</td>
<td>3.67</td>
<td>3.01</td>
<td>-</td>
<td>0.67</td>
<td>0.05</td>
</tr>
<tr>
<td>December</td>
<td>23.51</td>
<td>32.95</td>
<td>-</td>
<td>25.80</td>
<td>14.41</td>
</tr>
<tr>
<td>January</td>
<td>43.55</td>
<td>90.61</td>
<td>-</td>
<td>176.06</td>
<td>72.75</td>
</tr>
<tr>
<td>February</td>
<td>9.01</td>
<td>14.48</td>
<td>-</td>
<td>25.04</td>
<td>125.53</td>
</tr>
<tr>
<td>March</td>
<td>0.73</td>
<td>0.31</td>
<td>-</td>
<td>6.39</td>
<td>86.86</td>
</tr>
<tr>
<td>April</td>
<td>0.00</td>
<td>0.00</td>
<td>-</td>
<td>1.03</td>
<td>15.60</td>
</tr>
<tr>
<td>May</td>
<td>0.00</td>
<td>0.00</td>
<td>-</td>
<td>2.98</td>
<td>5.71</td>
</tr>
<tr>
<td>June</td>
<td>0.00</td>
<td>0.00</td>
<td>-</td>
<td>0.27</td>
<td>0.84</td>
</tr>
<tr>
<td><strong>Mean Annual Flow (cfs)</strong></td>
<td><strong>6.98</strong></td>
<td><strong>12.26</strong></td>
<td>-</td>
<td><strong>20.56</strong></td>
<td><strong>27.77</strong></td>
</tr>
</tbody>
</table>
## Summary of 2016-2017 Rainfall

<table>
<thead>
<tr>
<th>Monthly Rainfall (inches)</th>
<th>Lake Elsinore</th>
<th>Perris CDF</th>
<th>Pigeon Pass</th>
<th>Hemet / San Jacinto</th>
<th>Winchester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jul</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Aug</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Sep</td>
<td>0.08</td>
<td>0.08</td>
<td>0.00</td>
<td>0.16</td>
<td>0.12</td>
</tr>
<tr>
<td>Oct</td>
<td>0.24</td>
<td>0.35</td>
<td>0.78</td>
<td>0.34</td>
<td>0.28</td>
</tr>
<tr>
<td>Nov</td>
<td>0.98</td>
<td>0.90</td>
<td>1.35</td>
<td>1.09</td>
<td>1.03</td>
</tr>
<tr>
<td>Dec</td>
<td>3.60</td>
<td>3.21</td>
<td>3.94</td>
<td>3.20</td>
<td>3.17</td>
</tr>
<tr>
<td>Jan</td>
<td>6.68</td>
<td>6.04</td>
<td>6.78</td>
<td>6.23</td>
<td>4.86</td>
</tr>
<tr>
<td>Feb</td>
<td>3.02</td>
<td>2.06</td>
<td>2.61</td>
<td>2.86</td>
<td>2.31</td>
</tr>
<tr>
<td>Mar</td>
<td>0.03</td>
<td>0.02</td>
<td>0.16</td>
<td>0.21</td>
<td>0.06</td>
</tr>
<tr>
<td>Apr</td>
<td>0.02</td>
<td>0.00</td>
<td>0.02</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>May</td>
<td>0.27</td>
<td>0.06</td>
<td>0.26</td>
<td>0.25</td>
<td>0.08</td>
</tr>
<tr>
<td>Jun</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.02</td>
</tr>
<tr>
<td>Annual Rainfall (Inches)</td>
<td><strong>14.92</strong></td>
<td><strong>12.72</strong></td>
<td><strong>15.90</strong></td>
<td><strong>14.34</strong></td>
<td><strong>11.93</strong></td>
</tr>
</tbody>
</table>
2016-2017 Annual Hydrograph

Site 3 - Salt Creek at Murrieta Road
USGS 11070465

Discharge (cfs)
2016-2017 Annual Hydrograph

Site 4 - San Jacinto River at Goetz Road
USGS 11070365
2016-2017 Annual Hydrograph

Site 30 - Canyon Lake Spillway
USGS 11070500

Flow (cfs)
2016-2017 Annual Hydrograph

Canyon Lake Level (ft.)

Water Level

Spillway

Canyon Lake at Railroad Canyon Dam Spillway

Graph showing water level and spillway at Canyon Lake.
2016-2017 Annual Hydrograph

Site 1 - San Jacinto River at Cranston Guard Station
USGS 11069500
**Wet Event #1**

December 16-18, 2016

Rainfall: 0.43 to 0.78 inches

Sites: Salt Creek and San Jacinto
Wet Event #2

January 19-22, 2017

Rainfall: 1.32 to 2.0 inches

Sites: Salt Creek, San Jacinto, and Canyon Lake
Wet Event #3
February 17-20, 2017
Rainfall: 0.97 to 1.66 inches
Sites: Salt Creek, San Jacinto, and Canyon Lake
## Summary of 2008-2017 Nutrient Concentrations

<table>
<thead>
<tr>
<th>Monitoring Year</th>
<th>Site 3 - Salt Creek</th>
<th>Site 4 - San Jacinto River</th>
<th>Site 30 - Canyon Lake Spillway</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TN (mg/L)</td>
<td>TP (mg/L)</td>
<td>TN (mg/L)</td>
</tr>
<tr>
<td>2008-2009*</td>
<td>3.0/3.1</td>
<td>0.8/1.3</td>
<td>1.4/3.1</td>
</tr>
<tr>
<td>2009-2010*</td>
<td>1.5/1.9</td>
<td>0.6/1.0</td>
<td>1.6/3.2</td>
</tr>
<tr>
<td>2010-2011*</td>
<td>1.5/2.2</td>
<td>0.4/0.5</td>
<td>1.4/2.2</td>
</tr>
<tr>
<td>2011-2012</td>
<td>1.9</td>
<td>0.3</td>
<td>2.2</td>
</tr>
<tr>
<td>2012-2013</td>
<td>1.9</td>
<td>0.3</td>
<td>2.1</td>
</tr>
<tr>
<td>2013-2014</td>
<td>2.7</td>
<td>0.9</td>
<td>1.8</td>
</tr>
<tr>
<td>2014-2015</td>
<td>2.2</td>
<td>0.5</td>
<td>1.8</td>
</tr>
<tr>
<td>2015-2016</td>
<td>2.5</td>
<td>0.5</td>
<td>2.4</td>
</tr>
<tr>
<td>2016-2017</td>
<td>2.1</td>
<td>0.6</td>
<td>2.0</td>
</tr>
</tbody>
</table>

*Values shown for nutrient concentrations are minimum/maximum
NS-Not sampled
## Summary of 2008-2017 Nutrient Loads

<table>
<thead>
<tr>
<th>Monitoring Year</th>
<th>Site 3 - Salt Creek</th>
<th>Site 4 - San Jacinto River</th>
<th>Site 30 - Canyon Lake Spillway</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flow (Mgal)</td>
<td>TN (kg)</td>
<td>TP (kg)</td>
</tr>
<tr>
<td>2008-2009*</td>
<td>529</td>
<td>6,085/6,125</td>
<td>1,541/2,642</td>
</tr>
<tr>
<td>2009-2010*</td>
<td>1,282</td>
<td>7,474/9,180</td>
<td>2,960/4,804</td>
</tr>
<tr>
<td>2010-2011*</td>
<td>1,946</td>
<td>5,112/7,484</td>
<td>1,370/1,704</td>
</tr>
<tr>
<td>2011-2012</td>
<td>249</td>
<td>1,843</td>
<td>238</td>
</tr>
<tr>
<td>2012-2013</td>
<td>147</td>
<td>1,025</td>
<td>180</td>
</tr>
<tr>
<td>2013-2014</td>
<td>411</td>
<td>4,268</td>
<td>1,409</td>
</tr>
<tr>
<td>2014-2015</td>
<td>511</td>
<td>4,661</td>
<td>1,257</td>
</tr>
<tr>
<td>2015-2016</td>
<td>515</td>
<td>5,647</td>
<td>1,447</td>
</tr>
<tr>
<td>2016-2017</td>
<td>1,596</td>
<td>12,366</td>
<td>4,026</td>
</tr>
</tbody>
</table>

*Values shown for nutrient loads are minimum/maximum
NS-Not Sampled
NA-Not Available
Lake Elsinore and Canyon Lake TMDL Water Quality Monitoring Update – 2016-17 Summary

In-Lake Monitoring
Station Locations – Lake Elsinore
Station Locations – Canyon Lake
Total Nitrogen – Lake Elsinore 2016-2017
Total Nitrogen – Lake Elsinore Historic Data

No data available from June 2012-July 2015

TMDL target of 0.75 mg/L is annual average to be attained by 2020
Total Phosphorus – Lake Elsinore 2016-2017

2020 TMDL Target
Total Phosphorus – Lake Elsinore Historic Data

No data available from June 2012–July 2015

TMDL target of 0.1 mg/L is annual average to be attained by 2020
Total Dissolved Solids– Lake Elsinore 2016-2017
Total Dissolved Solids– Lake Elsinore Historic Data

No data available from June 2012-July 2015

Basin Plan Objective
Total Nitrogen – Canyon Lake 2016-2017

- **Main Basin**
- **East Basin**

**2020 TMDL Target**
Total Nitrogen – Canyon Lake Historic Data

TMDL target of 0.75 mg/L is annual average to be attained by 2020
Total Phosphorus – Canyon Lake 2016-2017

- **Main Basin**
- **East Basin**
- **Alum Application**

**2020 TMDL Target**
Total Phosphorus – Canyon Lake Historic Data

- **Main Basin (Average of CL07 & CL08)**
- **East Basin (Average of CL09 & CL10)**
- **TMDL Target**

No data available from May 2005-July 2007; June 2012-Sept 2013

TMDL target of 0.1 mg/L is annual average to be attained by 2020
Satellite Imagery – Chlorophyll July 2016

Lake Elsinore

Canyon Lake

**Data gaps in eastern arm due to high cirrus clouds**
Satellite Imagery – Chlorophyll August 2016

Lake Elsinore

Canyon Lake

**Data gaps due to large floating cyanobacterial slicks**
Satellite Imagery – Chlorophyll September 2016

**Data gaps due to large floating cyanobacterial slicks**
Satellite Imagery – Chlorophyll October 2016

Lake Elsinore

Canyon Lake

**Data gaps in eastern arm due to high cirrus clouds**
Satellite Imagery – Chlorophyll December 2016

Lake Elsinore

Canyon Lake

**Data gaps due to large floating cyanobacterial slicks**
**High chlorophyll-a readings in Canyon Lake due to turbidity interference**
Satellite Imagery – Turbidity after January Storms

Canyon Lake
Satellite Imagery – Chlorophyll April 2017

Lake Elsinore

Canyon Lake
Satellite Imagery – Chlorophyll June 2017

Lake Elsinore

Canyon Lake
Lake Elsinore Chlorophyll – 2016-2017

Chlorophyll-a (μg/L)

2015 TMDL Target
2020 TMDL Target

Surface
Integrated
Lake Elsinore Chlorophyll – Integrated Historic Data

- **LEE1**
- **LEE2**
- **LEE3**
- **TMDL Target 2015**
- **TMDL Target 2020**
Canyon Lake Chlorophyll – 2016-2017

Chlorophyll-a (μg/L)

Main Basin - Integrated
East Basin - Integrated
Alum Application
2015 TMDL Target
2020 TMDL Target

August 2016
September 2016
October 2016
December 2016
February 2017
April 2017
June 2017
Canyon Lake Chlorophyll – Integrated Historic Data

No data available from October 2002-August 2007; June 2012-Sept 2013
2015 TMDL target of 40 µg/L is annual average to be attained by 2015
2020 TMDL target of 25 µg/L is annual average to be attained by 2020
Lake Elsinore and Canyon Lake TMDL Water Quality Monitoring Update – 2016-17 Summary

Dissolved Oxygen Monitoring
Lake Elsinore Dissolved Oxygen – LE02 Water Column Mean vs. 1m from Bottom 2016-2017

- Water Column Mean
- 1m from Bottom

Dissolved Oxygen (mg/L)

July 2016
August 2016
September 2016
October 2016
December 2016
February 2017
April 2017
June 2017

TMDL Target
Lake Elsinore Dissolved Oxygen – LE02 Water Column Mean Historic Data

Lake Elsinore Dissolved Oxygen - Depth Average

No data available from June 2012-July 2015

TMDL target of 5 mg/L is depth average to be attained by 2015
Lake Elsinore Dissolved Oxygen – LE02 1m from Bottom

Historic Data

No data available from June 2012-July 2015

TMDL target of 5 mg/L is 1m off lake bottom to be attained by 2020
Canyon Lake Dissolved Oxygen – Main Basin Epilimnion vs. Hypolimnion 2016-2017

Mean of Sites CL07 & CL08

Dissolved Oxygen

- Water Column Mean
- Epilimnion
- Hypolimnion

No stratification in December-February
Not sampled in July 2016
Canyon Lake Dissolved Oxygen – East Basin Epilimnion vs. Hypolimnion 2016-2017

Mean of Sites CL09 & CL10

Dissolved Oxygen

- Water Column Mean
- Epilimnion
- Hypolimnion

Dissolved Oxygen (mg/L)

August 2016
September 2016
October 2016
December 2016
February 2017
April 2017
June 2017

TMDL Target

No stratification in Sept (CL10) & Dec/Feb (both)
Not sampled in July 2016
Dissolved Oxygen – Diurnal Variability

Lake Elsinore Dissolved Oxygen Profile - LE02

December 2015

June 2016

Dissolved Oxygen (mg/L)

Depth (m)
# Lake Elsinore Dissolved Oxygen – Morning vs. Afternoon TMDL Compliance July 2015 to June 2017

<table>
<thead>
<tr>
<th>Site</th>
<th>TMDL DO Target</th>
<th>Time of Measurement</th>
<th># of Events</th>
<th># Events in Compliance</th>
<th>Percent of Events in Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LE01</strong></td>
<td>2015 Water Column Mean</td>
<td>Morning</td>
<td>14</td>
<td>9</td>
<td>64%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Afternoon</td>
<td>13</td>
<td>10</td>
<td>77%</td>
</tr>
<tr>
<td></td>
<td>2020 1m from Bottom</td>
<td>Morning</td>
<td>14</td>
<td>6</td>
<td>43%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Afternoon</td>
<td>13</td>
<td>5</td>
<td>38%</td>
</tr>
<tr>
<td><strong>LE02</strong></td>
<td>2015 Water Column Mean</td>
<td>Morning</td>
<td>14</td>
<td>7</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Afternoon</td>
<td>13</td>
<td>9</td>
<td>69%</td>
</tr>
<tr>
<td></td>
<td>2020 1m from Bottom</td>
<td>Morning</td>
<td>14</td>
<td>7</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Afternoon</td>
<td>13</td>
<td>5</td>
<td>38%</td>
</tr>
<tr>
<td><strong>LE03</strong></td>
<td>2015 Water Column Mean</td>
<td>Morning</td>
<td>14</td>
<td>9</td>
<td>64%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Afternoon</td>
<td>14</td>
<td>10</td>
<td>71%</td>
</tr>
<tr>
<td></td>
<td>2020 1m from Bottom</td>
<td>Morning</td>
<td>14</td>
<td>7</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Afternoon</td>
<td>14</td>
<td>7</td>
<td>50%</td>
</tr>
</tbody>
</table>
Lake Elsinore Dissolved Oxygen – Morning vs. Afternoon
TMDL Compliance by Season July 2015 to June 2017

Plotting mean difference in Morning vs. Afternoon DO values

* = Statistically Significant Morning vs. Afternoon

Note: Positive values represent periods when DO increased from morning to afternoon, negative values indicate a decrease in DO from morning to afternoon
## Canyon Lake Dissolved Oxygen – Morning vs. Afternoon TMDL Compliance July 2015 to June 2017

<table>
<thead>
<tr>
<th>Site</th>
<th>TMDL DO Target</th>
<th>Time of Measurement</th>
<th># of Events</th>
<th># Events in Compliance</th>
<th>Percent of Events in Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Morning</td>
<td>11</td>
<td>10</td>
<td>91%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Afternoon</td>
<td>9</td>
<td>9</td>
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</tr>
<tr>
<td>CL07</td>
<td>2015 Epilimnion</td>
<td>Morning</td>
<td>11</td>
<td>11</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Afternoon</td>
<td>9</td>
<td>9</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>2020 Hypolimnion</td>
<td>Morning</td>
<td>11</td>
<td>1</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Afternoon</td>
<td>9</td>
<td>2</td>
<td>22%</td>
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<tr>
<td>CL08</td>
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<td>11</td>
<td>11</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Afternoon</td>
<td>9</td>
<td>9</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>2020 Hypolimnion</td>
<td>Morning</td>
<td>11</td>
<td>2</td>
<td>18%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Afternoon</td>
<td>9</td>
<td>1</td>
<td>11%</td>
</tr>
<tr>
<td>CL09</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Afternoon</td>
<td>8</td>
<td>8</td>
<td>100%</td>
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<tr>
<td></td>
<td>2020 Hypolimnion</td>
<td>Morning</td>
<td>7</td>
<td>3</td>
<td>43%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Afternoon</td>
<td>8</td>
<td>5</td>
<td>63%</td>
</tr>
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</table>

Note: Only events shown are those when thermal stratification was present at the time of monitoring. No measurements were taken in the afternoon for October 2015 or September 2016 events.
Canyon Lake Dissolved Oxygen – Morning vs. Afternoon
TMDL Compliance by Season July 2015 to June 2017

Plotting mean difference in Morning vs. Afternoon DO values

* = Statistically Significant Morning vs. Afternoon

Note: Positive values represent periods when DO increased from morning to afternoon, negative values indicate a decrease in DO from morning to afternoon

No difference in mean DO was observed between morning and afternoon in epilimnion or hypolimnion at Site CL07 during summer periods
Lake Elsinore Dissolved Oxygen
Do In-Lake Sondes Represent Lake-wide Conditions?

Hand-held Profiles vs. In-lake Sondes July 2015 to June 2017

• Data points represent individual 1-m depth readings
• Hand-held meter readings were taken immediately adjacent to in-lake sondes with maximum 30-minute time difference
Lake Elsinore Dissolved Oxygen – July 2015 to June 2017
Do In-Lake Sondes Represent Lake-wide Conditions?

Grand Avenue Sonde

Morning

Afternoon

Dissolved Oxygen (mg/L)

Date

Hand-held meter and In-lake sonde in general agreement

Hand-held meter and In-lake sonde not in agreement

Data points represent water column means
Lake Elsinore and Canyon Lake TMDL Water Quality Monitoring Update – 2016-17 Summary

Cyanobacterial Toxin Monitoring
Lake Elsinore Cyanotoxin Bloom
Water Samples 2016-2017

Human Health Thresholds
Caution = 0.8 ug/L
Warning = 6.0 ug/L
Danger = 20 ug/L
Lake Elsinore Cyanotoxin Bloom Scum Samples 2016-2017

**Human Health Thresholds**
- Caution = 0.8 ug/L
- Warning = 6.0 ug/L
- Danger = 20 ug/L

<table>
<thead>
<tr>
<th>Sampling Date</th>
<th>Boat Ramp - Scum</th>
<th>Center Lake - Scum</th>
<th>Elsinore West Marina - Scum</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/27/16</td>
<td>30,000</td>
<td>2,000</td>
<td>500</td>
</tr>
<tr>
<td>8/1/16</td>
<td>90,000</td>
<td>60,000</td>
<td>3,000</td>
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<tr>
<td>8/9/16</td>
<td>15,000</td>
<td>4,000</td>
<td>200</td>
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<tr>
<td>8/18/16</td>
<td>10,000</td>
<td>3,000</td>
<td>100</td>
</tr>
<tr>
<td>8/29/16</td>
<td>12,000</td>
<td>2,000</td>
<td>500</td>
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<tr>
<td>9/19/16</td>
<td>8,000</td>
<td>1,000</td>
<td>100</td>
</tr>
<tr>
<td>10/5/16</td>
<td>5,000</td>
<td>1,000</td>
<td>50</td>
</tr>
<tr>
<td>12/8/16</td>
<td>1,000</td>
<td>300</td>
<td>10</td>
</tr>
<tr>
<td>7/27/17</td>
<td>10,000</td>
<td>2,000</td>
<td>500</td>
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</table>
Questions?
Back Up Slides
## Cyanotoxin Concentrations– Lake Elsinore 2016-2017

<table>
<thead>
<tr>
<th>Analytes</th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>July 27</td>
<td>Aug 1</td>
<td>Aug 9</td>
<td>Aug 18</td>
<td>Aug 29</td>
<td>Sept 19</td>
<td>Oct 5</td>
<td>Dec 8</td>
<td>Feb 2</td>
<td>Apr 7</td>
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<tr>
<td>La Laguna Boat Ramp - Scum</td>
<td>26500</td>
<td>19450</td>
<td>382</td>
<td>26000</td>
<td>23425</td>
<td>6600</td>
<td>201</td>
<td></td>
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<tr>
<td>La Laguna Boat Ramp - Surface Water</td>
<td>5.36</td>
<td>11.6</td>
<td>77.5</td>
<td>5950</td>
<td>27.5</td>
<td>19.4</td>
<td>2.35</td>
<td>4.19</td>
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<tr>
<td>Center Lake - Depth Integrated Water</td>
<td>5.3</td>
<td>8.9</td>
<td>7.2</td>
<td>30.6</td>
<td>13.5</td>
<td>20</td>
<td></td>
<td></td>
<td>1.4</td>
<td></td>
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<tr>
<td>Center Lake - Scum</td>
<td>93500</td>
<td></td>
<td></td>
<td></td>
<td>3110</td>
<td>70</td>
<td>114</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Center Lake - Surface Water</td>
<td></td>
<td>161</td>
<td>10.6</td>
<td>15.3</td>
<td></td>
<td>1.59</td>
<td>3.87</td>
<td>1.2</td>
<td></td>
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<tr>
<td>Elm Grove Beach - Surface Water</td>
<td></td>
<td>326</td>
<td>163</td>
<td>172</td>
<td>10900</td>
<td>35</td>
<td>56</td>
<td>2.79</td>
<td>2.7</td>
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</table>

### California CyanoHAB Trigger Levels for Human Health (ug/L)

<table>
<thead>
<tr>
<th>Toxin</th>
<th>Caution – Action Trigger</th>
<th>Warning – Tier 1</th>
<th>Danger – Tier 2</th>
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</thead>
<tbody>
<tr>
<td>Microcystin</td>
<td>0.8</td>
<td>6.0</td>
<td>20</td>
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</table>
Revision of the Lake Elsinore & Canyon Lake Nutrient TMDL

Implementation Framework
Presentation Outline

• Review of completed draft TMDL elements
• Consideration of concentration based allocations
• Implementation framework
• Supplemental project options
• Schedule
Completed Draft TMDL Elements
TMDL Elements

- Draft chapters 1-6 submitted to Task Force
- Remaining elements for TMDL include implementation and monitoring
Allocations

• 2004 TMDL
  – 10 year average mass

• Draft TMDL revision
  – Hydrology representative of reference watershed (zero imperviousness)

• Concentration-based approach to TMDL revision
  – Demonstrate with lake models that natural mass based allocation is not best water quality
  – Allows for managed lake condition – prevent future Lake Elsinore desiccation
Concentration-Based Allocations

- Allows current runoff volumes at reference concentrations
- Encourages delivery of more water volume to lakes
  - Recycled water and stormwater runoff
- Water quality benefit of higher lake levels, flushing, dilution of TDS
- Linkage analysis to compare in lake response for mass and concentration based allocations
- Which allocation approach yields highest attainable use (HAU)

Preliminary results from Anderson, 2016.
## Concentration-Based Allocations

- Increased volume with watershed development

<table>
<thead>
<tr>
<th>Lake Segment</th>
<th>Average Reference Volume (AFY)</th>
<th>Average Current Volume (AFY)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canyon Lake (Main Lake)</td>
<td>3,997</td>
<td>5,802</td>
<td>1.452</td>
</tr>
<tr>
<td>Canyon Lake (East Bay)</td>
<td>1,797</td>
<td>2,546</td>
<td>1.417</td>
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<tr>
<td>Lake Elsinore</td>
<td>6,903</td>
<td>9,087</td>
<td>1.316</td>
</tr>
</tbody>
</table>
Concentration-Based Allocations

- Reference concentration from Cranston Guard Station data
- Comparable to grab samples from other mostly undeveloped sites in SJR watershed
Concentration-Based Allocations

- Reference concentration versus reference mass based allocations
- Allowable TP as kg/yr

<table>
<thead>
<tr>
<th>Lake Segment</th>
<th>Reference Volume, Reference TP Concentration</th>
<th>Current Volume, Reference TP Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canyon Lake (Main Lake)</td>
<td>1,528</td>
<td>2,219</td>
</tr>
<tr>
<td>Canyon Lake (East Bay)</td>
<td>687</td>
<td>974</td>
</tr>
<tr>
<td>Lake Elsinore</td>
<td>2,640</td>
<td>3,475</td>
</tr>
</tbody>
</table>
Concentration-Based Allocations

- Reference concentration versus reference mass based allocations
- Allowable TN as kg/yr

<table>
<thead>
<tr>
<th>Lake Segment</th>
<th>Reference Volume, Reference TN Concentration</th>
<th>Current Volume, Reference TN Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canyon Lake (Main Lake)</td>
<td>4,684</td>
<td>6,800</td>
</tr>
<tr>
<td>Canyon Lake (East Bay)</td>
<td>2,106</td>
<td>2,984</td>
</tr>
<tr>
<td>Lake Elsinore</td>
<td>8,090</td>
<td>10,650</td>
</tr>
</tbody>
</table>
Concentration-Based Allocations

- Multi-decadal hydrologic average needed to represent Lake Elsinore inflows
- Concentration-based allocation would remove hydrology from allowable mass calculation
Implementation Framework

• Load reduction required = current minus allowable
• Allowable is increment attributable to anthropogenic influence
  – Hydrology
  – Nutrient concentrations
• Quantify reduction credits from ongoing implementation of existing controls
• Supplemental projects needed if existing controls do not provide required load reduction
Nutrient Load Reduction Credits

- Demonstration of Load Reductions from source control, structural, and in-lake nutrient controls
Existing controls

- Summary of nutrient reduction credits to each lake segment with ongoing implementation of existing controls
- Table based on 2015 deployment data

<table>
<thead>
<tr>
<th>Controls</th>
<th>TP (kg/yr)</th>
<th></th>
<th>TN (kg/yr)</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>CL – East</td>
<td>CL – Main</td>
<td>Lake Elsinore</td>
<td>CL – East</td>
</tr>
<tr>
<td>Source Control (street sweeping, CB cleaning)</td>
<td>163</td>
<td>414</td>
<td>488</td>
<td>543</td>
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<tr>
<td>Structural (WQMPs)</td>
<td>63</td>
<td>263</td>
<td>236</td>
<td>105</td>
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<tr>
<td>Agriculture CWAD (projected deployments)</td>
<td>166</td>
<td>289</td>
<td>1</td>
<td>357</td>
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<tr>
<td>In-Lake (Alum, LEAMS)</td>
<td>419</td>
<td>858</td>
<td>7,000</td>
<td>0</td>
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<tr>
<td>Total</td>
<td>811</td>
<td>1,824</td>
<td>7,725</td>
<td>1,005</td>
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</table>
Conformance Assessment
Conformance assessment for 2015 Deployments

- Supplemental projects needed if existing controls do not provide required load reduction
Conformance assessment for 2015 Deployments

- Canyon Lake – East Bay
- Further load reductions may not be required if response targets achieved

<table>
<thead>
<tr>
<th>Canyon Lake – East Bay</th>
<th>TP (kg/yr)</th>
<th>TN (kg/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mass-based</td>
<td>Concentration-based</td>
</tr>
<tr>
<td>Current External Load without BMPs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,858</td>
<td></td>
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<tr>
<td>Allowable Load</td>
<td>687</td>
<td>974</td>
</tr>
<tr>
<td>Load Reduction Required</td>
<td>1,171</td>
<td>884</td>
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<tr>
<td>Load Reductions Achieved (2015)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>811</td>
<td></td>
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<tr>
<td>Unmet Load Reductions</td>
<td>360</td>
<td>70</td>
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</tbody>
</table>
Conformance assessment for 2015 Deployments

- Canyon Lake - Main Lake
- Further load reductions may not be required if response targets achieved

<table>
<thead>
<tr>
<th>Canyon Lake – Main Lake</th>
<th>TP (kg/yr)</th>
<th></th>
<th>TN (kg/yr)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mass-based</td>
<td>Concentration-based</td>
<td>Mass-based</td>
<td>Concentration-based</td>
</tr>
<tr>
<td>Current External Load without BMPs</td>
<td>3,621</td>
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<td>16,959</td>
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<tr>
<td>Allowable Load</td>
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<td>2,219</td>
<td>4,684</td>
<td>6,800</td>
</tr>
<tr>
<td>Load Reduction Required</td>
<td>2,093</td>
<td>1,402</td>
<td>12,275</td>
<td>10,159</td>
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<tr>
<td>Load Reductions Achieved (2015)</td>
<td>1,824</td>
<td></td>
<td>2,708</td>
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<tr>
<td>Unmet Load Reductions</td>
<td>269</td>
<td>-422</td>
<td>9,567</td>
<td>7,451</td>
</tr>
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</table>
Conformance assessment for 2015 Deployments

- Lake Elsinore quantitative conformance assessment is still being developed
- Internal load accounts for majority of nutrients in water column
- Reducing external loads to reference levels requires much less credits than estimated to be achieved from ongoing in-lake controls
Supplemental Project Concepts
Alternatives Analysis

• Numerous prior broad scale alternatives analysis
  – CDM, 2013. CNRP and AgNMP

• TMDL revision summarize findings of prior analyses and characterize options

• Different controls for Canyon Lake and Lake Elsinore

• Numerous project specific studies
  – Alum, aeration, HOS, recycled water, dredging, levee, fishery management, well augmentation, etc.
Water Quality Strategies

- General categories
  - Nutrient reduction
  - Algae control
  - Oxygenation
  - Hydrologic Flushing

- Projects use one or more water quality strategies
- Quantification of benefits with lake models
EVMWD Effluent Polishing

- Reduce EVMWD effluent to 0.1 mg/L with additional chemical addition
- Currently permit for ~0.5 mg/L for 6000 AFY
- Achieving ~0.35 mg/L
- Increment below reference level is credit in concentration based approach
- Increase P reduction by ~1500 kg/yr
Alum in Lake Elsinore

- Already done for recycled water
- Via surface spreading or with inflows
- Ideally to be applied when pH is low
- Grand Lake St Mary’s – Ohio largest inland lake
  - Alum treatment over entire 12,680 acre lake surface
  - ~50 percent reduction in TP lakewide
- Treatment in San Jacinto River
Back Bay Wetlands

- Prior study involved routing of wet weather inflow through Back Bay wetland area
- Recirculation alternative to have continuous treatment of Lake Elsinore
Alum Treatment of Canyon Lake Inflows

- Continuous alum treatment of lake inflows
- More efficient flocculation with lower pH
- Eliminates timing decisions of winter/spring surface spreading
- Treated runoff may overflow to Lake Elsinore
- Prior concept level design
  - 5,000 gallon storage tank w/secondary spill containment
  - 15 gpm dual feed flow paced pumps w/telemetry
  - 1,000 ft 2” PVC feed pipe w/ anchors
  - Submerged downward emitter(s) w/screening
  - Order of magnitude capital cost - $100,000/station
  - Alum chemical cost and O&M
Hypolimnetic Oxygenation System

- Oxygenate Canyon Lake bottom waters
- Improves DO
- Reduce internal nutrient loads by ~70% phosphorus and 35% ammonia-N
- Limited benefit to East Bay
Dredging

- Remove sediment and source of internal nutrient load
- Cost prohibitive for a large treatment area
- Restores storage capacity filled in from decades of sedimentation
  - Canyon Lake sedimentation has reduced storage capacity from 13,000 AF to 8,000 AF
- Dry dredging in East Bay more efficient and cost effective
Indirect Potable Reuse

• Would add treated wastewater effluent near inflows of Canyon Lake to allow increased diversion at the existing intake by EVMWD

• Mutual water quality benefits
  – Enhanced flushing
  – Deeper water depths
  – Dilution of nutrients with AWT water

• Review Feasibility Study recommendations
Artificial Circulation in Canyon Lake

- Larger conveyance system
- SWP/Colorado River water
- IPR discharge
- Prior concept level design
  - Flow capacity: 8,000 gpm (or 11.5 mgd)
  - 16,350-ft, 30-inch pipeline
  - 400 HP Pump Station
  - Riser Intake with mechanical sluice gates
  - Riser Outfall
  - Rock protection at Intake/Outfall areas and over submerged pipe within lake
Biomanipulation

- Introduce fish species or zooplankton that feed on most problematic algae
- Fishery Management Plan
- Must account for TDS in update to FMP
Vegetation Management

- Active vegetation management
- Macrophyte along shoreline
- Lake level stabilization
- Floating islands
Ultrasonic Algae Control

- Uses ultrasonic waves to destroy algae cells
- Low ongoing operational cost, after initial capital cost
- Requires continuous operation to prevent growth
- Limited treatment area
- Potential for release of toxins into water column from dead algae cells
- Further study needed to assess impacts to non-target organisms

Algaecide

- Use of copper sulfate or hydrogen peroxide to temporarily reduce algae
- Improves effectiveness of other nutrient reduction strategies
Physical Harvesting

- Reduce algae in lake
- Removes nutrients and toxins in algae from system
San Jacinto River Gap

- Significant increase in annual average runoff volume
- Incentive upstream communities currently benefiting from Mystic Lake retention

Diversion/Retention of Runoff

- Increased watershed runoff retention
- Bypass flows in San Jacinto River to Temescal Creek
- Effectively eliminate nutrient load, but also source of most water to Lake Elsinore
- Water rights considerations
Allowing Lakebed Desiccation

- Allow for natural reset mechanism
Other Ideas?
Next Steps
TMDL Implementation Chapter

- Characterization of water quality strategies
- Estimation of water quality benefits with lake models
- Provides basis for updating CNRP and AgNMP
- Does not rank or recommend specific projects
Schedule

- Implementation chapter draft – October 15
- Monitoring chapter draft – November 1