Lake Elsinore and San Jacinto Watersheds Authority

Water Quality Monitoring Plan

for the Canyon Lake
Alum Application Program

August 2013

MWH®

BUILDING A BETTER WORLD

Canyon Lake Alum Effectiveness Water Quality Monitoring Plan

1.1 BACKGROUND

Canyon Lake is listed on the Clean Water Act Section 303(d) list as impaired for excessive nutrients and high bacteria concentrations. Consequently, the Santa Ana Regional Water Quality Control Board (Regional Board) adopted Resolution No. R8-2004-0037 in December 2004 to amend the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) to incorporate total maximum daily loads (TMDLs) for Lake Elsinore and Canyon Lake. The TMDLs address beneficial use impairment due to excessive nutrients (phosphorus and nitrogen) discharged to the lakes from various sources.

From 2006 to 2012, a formal monitoring program for Canyon Lake (in compliance with the TMDL program) was conducted. The in-lake samples were analyzed for a suite of parameters from four stations (two to three depths monitored bi-weekly in the wet season and three depths monitored once per month in the dry season). Reductions to the sampling program were adopted in 2011 (eliminating one of the sampling stations and several parameters).

To control nutrients and resultant algae blooms in Canyon Lake, the Lake Elsinore and San Jacinto Watersheds (LESJWA) Task Force is planning to implement five alum applications to the lake, from September 2013 to September 2015. Alum will be applied in two locations: the Main Lake and the East Bay. Water quality monitoring at four stations will establish the effectiveness of alum applications for phosphorus removal, and the resultant effect on algal concentrations and water quality.

Alum application in Canyon Lake is proposed in order to remove nutrients from the water column that contribute to algal blooms in the lake. By binding phosphorus and reducing algae growth, the continued use of alum is expected to reduce nutrient cycling and associated sediment oxygen demand in the lake sediments. The goal is compliance with the interim and final chlorophyll *a* TMDL targets. Alum application is also anticipated to indirectly increase dissolved oxygen in the hypolimnion as well as reduce the frequency of ammonia toxicity.

1.2 SAMPLE LOCATIONS AND SCHEDULE

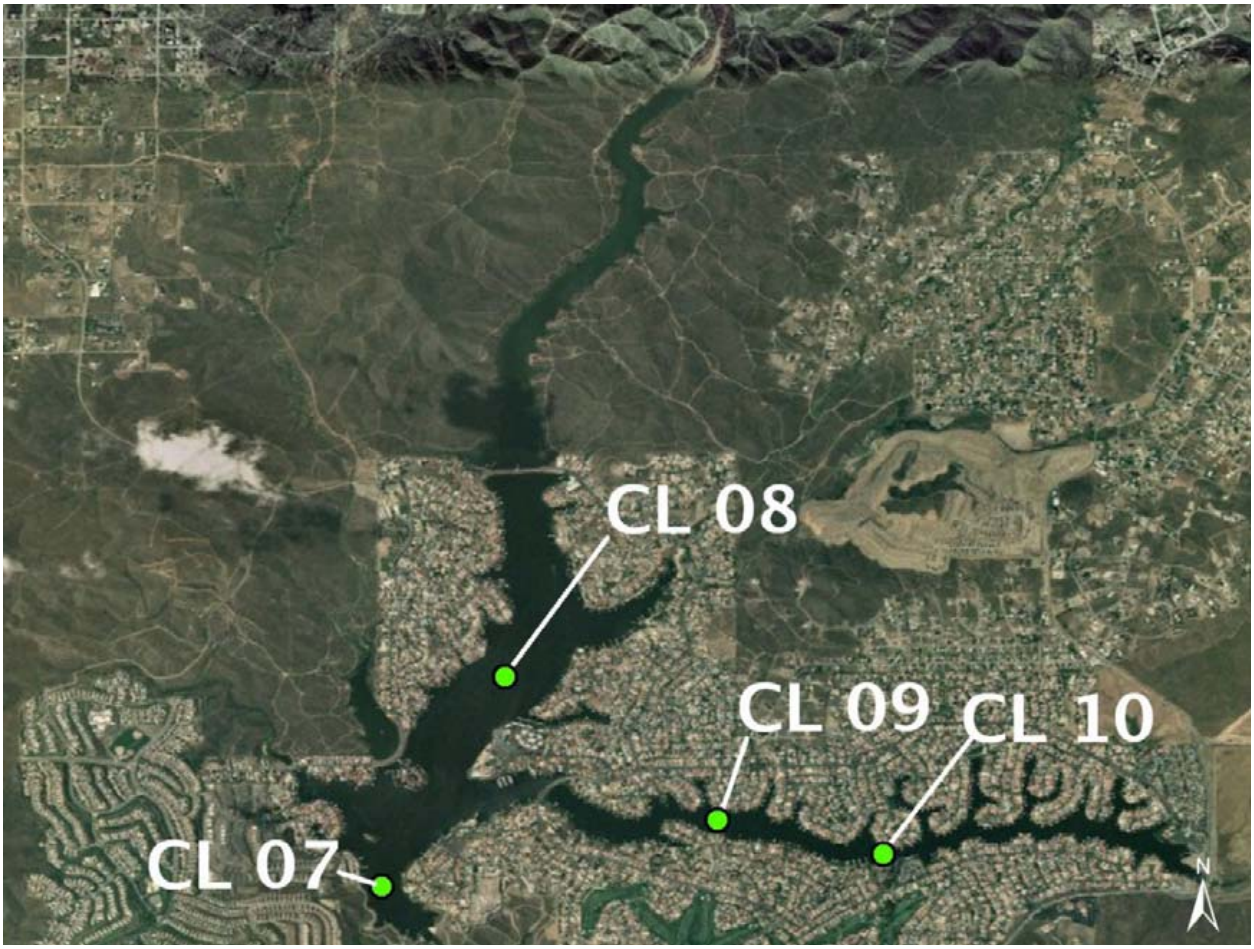
1.2.1 Sample Locations

Samples will be collected in the morning hours (approximately 0800 to 1200) at the following four stations (**Figure 1**):

- CL7 - deepest part of the lake near the dam (33 deg 40.675 N / -117 deg 16.517 W)
- CL8 - mid-lake, main body of lake (33 deg 41.296 N / -117 deg 16.155 W)
- CL9 - shallow site in the East Bay (33 deg 40.874 N / -117 deg 15.528 W)

- CL10 - shallow site without thermal stratification in the East Bay (33 deg 40.779 N / -117 deg 15.046 W)

Figure 1
Canyon Lake Monitoring Locations



1.2.2 Sampling Frequency

Water quality samples will be collected up to 25 times from September 2013 through September 2015 before and after five alum application events. Samples will be collected from the four monitoring sites (CL07, CL08, CL09, and CL10) once within one week prior to the alum application and four times following the alum applications. Post alum application sampling will occur weekly, or at variable intervals to accommodate collection of data after lake turnover. Each alum application is anticipated to take approximately 7 – 10 days to complete. A total of up to 25 water quality monitoring events will be conducted: 5 each, starting in September 2013, February 2014, September 2014, February 2015, and September 2015.

1.3 SAMPLING AND ANALYSIS PROTOCOLS

1.3.1 Sampling Equipment

Individual water samples and depth integrated samples will be collected from specified depths using a 2.2 L horizontal beta-plus type clear acrylic van Dorn Sampler. For depth integrated samples, a water sample will be collected at 1 meter intervals, and a consistent volume will be delivered to a polypropylene bucket, and mixed. A single homogenized sample will be poured from the bucket into the sample bottles. Samples will be collected in pre-cleaned brown opaque HDPE bottles, and kept on ice until returned to the laboratory. All samples will be stored at 4 degrees C until processed and preserved if necessary according to method protocols.

Depth profiles for temperature, pH, turbidity, and dissolved oxygen will be measured using a Hach Hydrolab DS-5 water quality sonde connected via a 30 m cable to a Surveyor 4 data display. Data will be collected at 1 meter intervals and recorded on field data sheets. Data will be transferred to and stored in an electronic database as soon as possible.

1.3.2 Water Quality Parameters

After collection, water quality samples will be returned to the California State University at San Bernardino (CSUSB) laboratory of Dr. James Noblet for analysis. Water quality parameters, collection location, analysis method, and quality control procedures are summarized in **Table 1**.

1.3.3 Reporting

Water quality monitoring results for each of the five alum application events will be summarized in a report. After each event, the data set will be expanded and the report updated. Report sections will include: Introduction, Background and Objective, Materials and Methods, and Results. Results will also be transmitted to LESJWA as an Excel file.

Table 1
Summary of Analysis Methods and Quality Control Procedures by Parameter

<table>
<tr><th>Parameter</th><th>Sample Collection</th><th>Sample Analysis</th><th>QA/QC Notes</th></tr>
<tr><td>Temperature</td><td rowspan="4">Vertical profile at each station (4 stations)
(1 m intervals)</td><td rowspan="4">Field Measurements
Hydrolab DataSonde 5 and Surveyor</td><td rowspan="4">• Hydrolab is calibrated against solutions of known pH, DO and turbidity each morning. Calibration check values are recorded on a Hydrolab calibration sheet.
• Concentration of DO standard is calculated from known temperature-dependence of O_2 solubility in water corrected for local atmospheric pressure/elevation; over a lab temperature (T) range of 20-25 °C and elevation of 1600 ft above MSL.
• Turbidity is calibrated against a 40 NTU Hach StablCal Primary turbidity standard.</td></tr>
<tr><td>Dissolved Oxygen (DO)</td></tr>
<tr><td>pH</td></tr>
<tr><td>Turbidity</td></tr>
<tr><td>Secchi Depth (transparency)</td><td>1 reading per station (4 stations)</td><td>Visual observation in field</td><td>• Measured to nearest 0.01 m</td></tr>
<tr><td>Total Phosphorus (TP)</td><td rowspan="9">Three samples per station (3 stations):
Epilimnion
Hypolimnion
Depth Integrated (when lake is stratified)

and

One single depth-integrated sample at East Bay station CL10</td><td>Laboratory Analyses:
SM 4500-P F (total); Lachat 10-115-01-4-B</td><td rowspan="9">• Laboratory duplicates at a frequency of no less than one per 10 samples. Duplicate analyses of field splits will be used to assess the precision of analytical methods. Duplicate analysis of a sample on the same instrument will provide instrumental precision data.
• Reference materials to be run with each batch of laboratory samples.
• Spike samples to be run at a frequency of no less than one per 20 samples or one per batch (whichever is more frequent).
• Matrix spike replicates to be run at a frequency of no less than one duplicate per 20 samples or one per batch (whichever is more frequent).
• Laboratory and field blanks.
• Samples for analysis of dissolved constituents will be filtered and acidified as appropriate.</td></tr>
<tr><td>Soluble Reactive Phosphorus (SRP)</td><td>SM 4500-P C (SRP)</td></tr>
<tr><td>Total Nitrogen (TN)</td><td rowspan="2">SM 4500-N C; Lachat 10-107-04-4-B
SM 4500-NH3 D</td></tr>
<tr><td>Ammonia (NH_3)</td></tr>
<tr><td>Aluminum – dissolved (Al_{diss})

Aluminum – total (Al_{total})</td><td>EPA 200.9</td></tr>
<tr><td>Total Dissolved Solids (TDS)</td><td>SM 2540 C</td></tr>
<tr><td>Total Suspended Solids (TSS)</td><td>SM 2450D</td></tr>
<tr><td>Chlorophyll a</td><td>SM 10200 H</td></tr>
</table>

Source for laboratory methods: American Public Health Association, American Waterworks Association, and Water Environment Federation. 1992 and 2005. Standard Methods for the Examination of Water and Wastewater, 18th and 21st Editions.