Introduction

Water quality data presented in this submittal was originally collected as part of routine limnological surveys by the San Francisco Public Utilities Commission [SFPUC] Natural Resources Division [NRD]. These surveys are conducted to evaluate water quality conditions in drinking water reservoirs managed by the SFPUC. Lake Merced, located in the southwest section of San Francisco, is one of six SFPUC regional reservoirs in the Bay Area that are surveyed on a routine basis. Lake Merced was included on the impaired waterbodies [303 d] list by the State Water Resources Control Board for low dissolved oxygen and high pH. Data collected at Lake Merced from 1997 through 2010 and summarized in this report are presented to more fully illustrate the water quality conditions in this reservoir and to support a request to delist the lake for these constituents.

Quality Assurance Procedures

Methods

Limnological surveys are conducted in reservoirs by trained biologists who collect water and phytoplankton samples for subsequent analysis and who deploy sensitive water quality instrumentation to provide depth integrated profiles of various water quality parameters. A summary data sheet from a typical limnological survey is attached to illustrate the parameters measured and how the data is presented. Depth integrated measurements of pH, dissolved oxygen [DO], temperature [C] and conductivity [umhos] are taken using a Hydrolab® Datasonde® and Surveyor® data logger. Samples collected for other parameters are preserved when collected and analyzed in the SFPUC ELAP-certified water quality laboratory within required holding time using EPA approved methods. Phytoplankton samples are identified to the genus or species level, if possible, using light microscopy by referencing established taxonomic keys. The data are compiled and presented to water operations managers during weekly meetings. Additionally, water resource managers summarize and analyze the data to monitor the water quality of Lake Merced, determine trends, and adjust the monitoring program accordingly.

Sampling stations in Lake Merced were selected based on depth. The deepest portions of the Lake were selected as characteristic of water quality for that area and sampled on a quarterly basis to reflect seasonal changes. Depth integrated sampling was conducted to provide a complete picture of water quality conditions throughout the water column. Latitude and longitude of the sampling locations are shown in Table 1. A map of the area is also included as Figure 1. Surveys are usually conducted between 10am and 2 pm on the day when they are scheduled. During the period from May 1997 to June 2010, there were 1103 measurements of dissolved oxygen and 1135 measurements of pH.

Table 1

Location name	Longitude	Latitude
Lake Merced South - Pump Station	122° 29.314′ W	37° 42.903′ N
Lake Merced South - Pistol Range	122° 29.832′ W	37° 43.272′ N
Lake Merced North	122° 29.683′ W	37° 43.610′ N
Lake Merced North East	122° 29.398′ W	37° 43.662′ N

Data Quality Objectives

The data quality objective for dissolved oxygen [DO] is to measure this parameter over a range from 0.0 to 20.0 mg/L with a resolution to 0.2 mg/L. The data quality objective for pH is to measure this parameter over a range from 0 to 14 standard pH units with a resolution to 0.2 pH. These criteria were met consistently throughout the 13 year period when the surveys were conducted.

Hydrolab® sensor specifications:

LDO (LED-Dissolved Oxygen)
Range: 0 - 60* mg/L
Accuracy: +/- 0.1 mg/L at <8 mg/L
+/- 0.2 mg/L at >8 mg/L
+/- 10% reading >20 mg/L
Resolution (Detection limit): 0.01 mg/L

* Exceeds Maximum Natural Concentrations

pH
Range: 0 to 14 pH units
Accuracy: +/- 0.2 units
Resolution: 0.01 units

Calibration Procedure

The Hydrolab portable water quality instrument is calibrated prior to each survey, which occur approximately twice a week. A calibration log is used to record instrument readings using different standards, date, limnologist's initials, and maintenance information and the log is maintained by the supervising biologist. A post-survey calibration check is also performed the next time the instrument is used. If calibration is unsuccessful, the instrument is recalibrated, repaired, or replaced, as necessary. Only data from calibrated instruments are included on field data sheets.

Dissolved Oxygen Calibration procedure summary

A water-saturated calibration procedure is the standard method for DO calibration. The Datasonde® (sonde) is connected to the handheld Surveyor 4a® with a data transfer cable and powered on. Tap water sufficient to fill the calibration cup is poured into a one-liter plastic vessel and capped. The vessel is shaken for approximately two minutes to saturate the water with oxygen. The saturated water is transferred to the calibration cup, making sure to submerge the LDO sensor and temperature probe, and that the cup is loosely placed on the sonde's bulkhead to allow for neutral pressure in the cup. After a period of two minutes, readings are observed to ensure that they are stable. The initial reading in mg/L is recorded in the calibration log. In the calibration screen on the Surveyor 4a®, the barometric pressure is entered from the closest weather station [San Francisco International Airport via internet] and the calibration prompt is activated. If a "calibration successful" message is displayed, the new dissolved oxygen reading in mg/L is recorded in the logbook. A failed calibration or excessive drift in readings will initiate user-level maintenance and troubleshooting. If the problem is not alleviated, factory service is required.

pH Calibration procedure summary

A two-point calibration procedure is used to calibrate the pH probe using both pH 7 and 10 reference solutions because of the slightly alkaline nature of the water bodies routinely sampled. The pH sensor and cup are given an initial rinse with deionized water and the cup is then filled with pH7 buffer, screwed onto the bulkhead, and gently shaken for a few seconds. The buffer solution is then discarded and fresh pH7 buffer is added to the cup to sufficiently cover the pH probe and temperature probe. After approximately two minutes, readings are checked for stability. The reading in the pH7 buffer is recorded in the logbook. The calibration screen is selected on the Surveyor 4a®, the correct buffer value corrected for temperature is entered, and the calibration command is prompted. If the calibration is accepted, then the same procedure is performed using pH10 buffer. At any time a calibration fails, or if readings show signs of drift or instability, maintenance is performed on the probe. If the probe is still not functioning properly after maintenance procedures are followed troubleshooting steps are performed to determine if a factory service is required.

Field data collection protocol

The Hydrolab Datasonde® probe is suspended by the data transfer cable and lowered into the water over the edge of an anchored boat on station. Upon nearing the expected depth of the water column, the probe is lowered gently until the bottom is reached. If the probe contacts the bottom abruptly, it is brought back to the surface, checked, and cleaned of mud as necessary. Once the probe is at the desired depth, measurements are taken after allowing the readings to stabilize which generally takes two minutes. Each

reading is stored in the proper file in the data logger. The probe is then raised to the next depth interval and the procedure is repeated. Field data are saved to the data logger and after each survey are uploaded to a personal computer as a "csv" file in the Laboratory. The data is then reviewed by the field Biologist, and if validated, transferred to a larger common digital database. The Supervising Biologist reviews and validates the data and it is released for distribution. Many utilities and research institutions use multi-probe portable electronic analyzers to take DO and pH measurements in estuaries, lakes and reservoirs and their use is now considered a standard for the industry.

Qualifications

SFPUC limnologists are professional, college-degreed biologists. Training on equipment and field sampling techniques is conducted by the Supervising Biologist that possesses years of experience conducting water quality surveys on SFPUC drinking water reservoirs. Field data collection is conducted according to detailed Standard Operating Procedures (SOPs) developed by the SFPUC, and in all applicable cases, in accordance with methods described in *Standard Methods for the Examination of Water and Wastewater*. All Hydrolab® calibration and maintenance methods are performed as per Hydrolab® protocols. Section staff attend Hydrolab® training workshops, which provide detailed description of field collection and calibration protocols.

Survey Results

Water quality data collected over the period 1997 to 2010 is shown in Attachment 1. The data is listed by sampling station, depth, date of collection [month;year] and constituent [DO or pH]. During the period from May 1997 to June 2010 a total of 1103 measurements of dissolved oxygen and 1135 measurements of pH were recorded.

Dissolved Oxygen

Of the 471 samples collected from the surface to 5' depth, only 5 measurements were less than the Basin Plan criteria of 5.0 mg/L dissolved oxygen. The criterion was met on a less frequent basis at the ten foot depth and less at greater depths near the sediment water interface. These results were more pronounced during warmer periods when the lake exhibits stratification. Warmer surface waters containing high levels of oxygen were present while water at the bottom of the lake became anoxic due to sediment oxygen demand and lack of water column mixing. This seasonal phenomenon is found in almost all natural water bodies and does not indicate the lake is impaired or fails to provide beneficial uses described in the San Francisco Bay Basin Plan. The lake fully provides freshwater aquatic habitat for fish, reptiles, amphibians and invertebrates and the local waterfowl that feeds on them. It also provides habitat for a year round put and take trout fishery supported by California Trout and the Department of Fish and Game. Lastly,

there have been no documented fish kills at the lake during the survey period that would indicate inadequate dissolved oxygen.

pH

Of the 1,135 pH samples collected at all depths, only 6 measurements exceeded a pH of 9 and only 155 exceeded a pH 8.5. pH measurements above 8.5 are usually indicative of diurnal algal photosynthesis. Freshwater algae take in dissolved carbon dioxide [CO2] from the water column effectively removing carbonic acid [H2CO3] and elevating the pH to the alkaline side of neutral. This phenomenon does not impair water quality or the value of aquatic habitat present in the lake. Freshwater fish and other aquatic life evolved under these chemical conditions and are generally unaffected by small daily or seasonal changes in pH.

Signature: _____ Date : August 13, 2010

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