LVMWD Report No. 2475.00

Water Quality in the Malibu Creek Watershed, 1971 – 2010

Existing conditions, historical trends and data inter-relationships

Submitted by the Joint Powers Authority of the Las Virgenes Municipal Water District and the Triunfo Sanitation District to the Los Angeles Regional Water Quality Control Board in compliance with Order No. R4-2010-0165 on March 30, 2011

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Introduction and Executive Summary

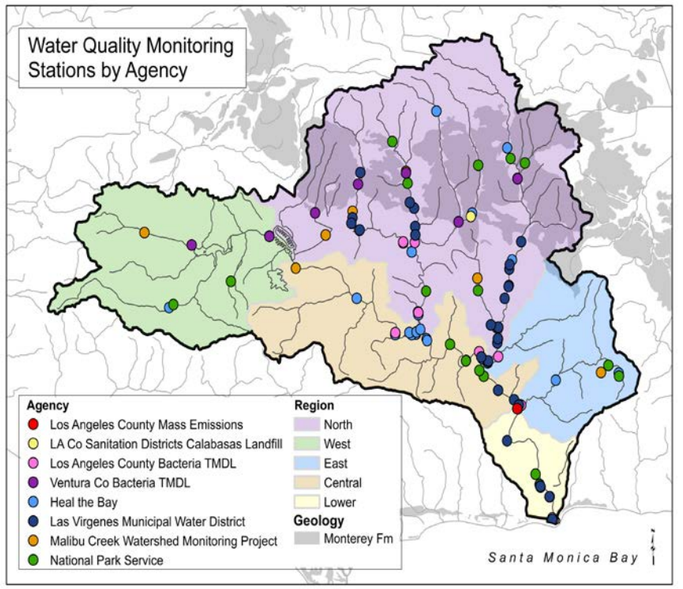
The Malibu Creek watershed is the largest watershed of northern Santa Monica Bay, California, draining just over 100 square miles of open space, rural and suburban development to Malibu Lagoon and Surfrider Beach, a world-famous surfing destination in the City of Malibu. In 2010, over 1.42 million people (about ten times the watershed's residential population) visited the watershed's shoreline with the bay in the City of Malibu between June 1 and September 30 (LACFD, 2010). The watershed is also well known to water quality regulators. State impaired waterbodies lists mandated under §303(d) of the federal Clean Water Act (CWA) document a long history of on-going mineral and biological water quality problems, ranging from high algal growth to exceedances of selenium, lead, mercury, chloride, sulfate, and specific conductivity (SC) water quality objectives. Poor quality ground and surface water has precluded its use for municipal drinking water supplies for over 50 years, and was one of the main drivers for local communities in the upper watershed to form their own water district to secure imported water supplies in the early 1960's.

Throughout this time, various agencies and organizations have monitored water quality in various portions of the watershed for a variety of reasons, ranging from regulatory compliance to environmental advocacy to academic interest. But as of 2010, the data from these programs had never been compiled into a single database and analyzed in its entirety to see if, collectively, we might gain a better idea of exactly where, how and *why* water quality in the watershed has been so poor, for so long.

On September 2, 2010, the Los Angeles Regional Water Quality Control Board (LARWQCB) adopted Order No. R4-2010-0165 renewing NPDES permit CA0056014 CI #4760 for the Tapia Water Reclamation Facility, jointly owned by Las Virgenes Municipal Water District and Triunfo Sanitation District, through a Joint Powers Authority (JPA). The Monitoring and Reporting Program (MRP) for the permit included a new requirement to facilitate the development of an updated comprehensive Watershed-wide Monitoring Program (WMP) for the Malibu Creek Watershed, in conjunction with other interested stakeholders. In addition, the MRP included a requirement for an analysis of 35 years of existing data from watershed management efforts, to be submitted before April 1st, 2011 to the LARWQCB Executive Officer. Pursuant to Order No. R4-2010-0165, this report describes the JPA's analysis of existing water quality data collected in the Malibu Creek watershed since 1971.

Some results were surprising, even startling. Electrical conductance data show Malibu Creek is an extraordinarily *salty* water body from its northern headwaters to the sea. Further investigation found the *composition* of its salt is also unique, with high levels of sulfate **three times greater** than the allowable standard, and nearly **ten times** greater than nearby coastal streams in the Santa Monica Mountains. We also discovered that, in addition to sulfate, natural levels of phosphate in undeveloped open space reference sites north of the 101 freeway are consistently 50 percent higher than the allowable limit, and selenium and many metals are also unusually high in both surface and groundwater in that area. A detailed natural source assessment (Section 3) discovered that this area drains the Monterey / Modelo Formation, a marine Tertiary age sedimentary geologic formation that is naturally enriched in sulfate, phosphate, nitrogen, selenium and the same metals we found in elevated concentrations in local creeks – and their algae and fish - that drain this unusual rock formation. The oil industry has known about the Monterey Formation for over half a century – it is one of the most economically important petroleum source rocks in the state, and is actively tapped for oil in the Santa Barbara channel and elsewhere in the state. It is also a known potential hazard to water quality and aquatic life according to the US Geological Survey (2002).

There are also areas within the Malibu Creek watershed that lie outside of the Monterey / Modelo Formation and appear unaffected by it. Our analysis surfaced some interesting findings in these areas, as well. For water suppliers, the combined mineral quality data, for example, provide new, geo-referenced information on where better quality groundwater might be found. For utility maintenance personnel, the data on electrical conductance and sulfate levels may help guide where special attention should be paid to galvanic corrosion and cathodic protection for underground pipes, regardless of what they carry. Regulators may be interested in the California Toxics Rule (CTR) test results from monitoring site RSW MC001U presented on page 66. All of the urban runoff from Malibu Creek's northern and western tributaries must pass by this station, yet in eighteen months of testing not one pesticide or other volatile or non-volatile compound was detected except for Bis(2-Ethylhexyl) phthalate which we suspect was a laboratory artifact. We expected to detect at least some of these compounds at this station, but we did not. And for recreational anglers, the combined data on metals and their sources may help them decide if eating the fish from a particular tributary poses an unacceptably high potential risk of ingesting heavy metals.



Looking beyond the data to the programs themselves, we found considerable overlap and redundant monitoring in the watershed, with 67 stations currently monitored by six organizations, often for the same parameters and goals. It is clear in retrospect that the bulk of our findings could have been made with a much smaller monitoring network, especially one coordinated across agencies for common objectives. To this end we hope our findings on geographically coincident stations will prompt some immediate consolidation across programs. We also hope all organizations in the watershed will join us in the weeks to come in evaluating the potential for a smaller, more intelligently focused monitoring effort to reduce the cost of the overall effort – and produce more useful information along the way for everyone interested in the waters of Malibu Creek. In Section 4 we provide some suggestions for how this might be evaluated using statistical tests of the data already collected in our current dataset.

Major Findings (summary)

Presented in the order they appear in our analysis. More detail for specific water quality parameters is provided in Section 2 (Analysis). More detail on natural sources is presented in Section 3 (Natural Source Assessment)

Mineral quality

1. General: Most mineral parameters tested show strong seasonal variation, peaking in the late dry season (April 15 – Nov. 15) and declining in winter, probably due to rain dilution. See page 27 and Section 3. Historical records show current levels of mineral quality parameters *predate urban development* in the watershed. See pages 27, 28, 42 and Section 3.
2. Chloride: Chloride levels never exceeded the 500 mg/L Basin Plan Water Quality Objective at any station. However, the 250 mg/L drinking water secondary MCL for chloride was exceeded in Medea Creek (2 of 3 sites) and Cheeseboro Creek (1 site). All three Medea Creek sites and the Cheeseboro Creek site also exceeded the chloride agricultural objective lower limit of 230 mg/L. See page 23. Chloride levels in Malibu Creek's western and eastern tributaries were consistently lower than its northern and central tributaries.
3. Selenium: The Basin Plan aquatic life objective for selenium (5µg/L) was exceeded in most of Malibu Creek's northern tributaries, with very high levels (2-4 times the objective) in Las Virgenes and Russell Creeks. See pages 24-25.
4. Specific conductance (SC). Malibu Creek water is brackish its entire length, with annual *median* specific conductance > 1,800 µS/cm in the lower creek below the Los Angeles County gauging station and > 2,000 in the upper creek above the gauge. The creek's northern headwaters in undeveloped areas above the 101 freeway are extraordinarily brackish (SC>3,000 µS/cm, with single-sample results > 4,000 µS/cm common. *A more detailed look at ionic composition in comparison with national data shows that Malibu Creek's mineral composition is almost unique in the United States.* See pages 26-29 and Section 3.
5. Sulfate. Sulfate levels in Malibu Creek's northern tributaries are very high (~3 times the 500 mg/L Basin Plan objective), and isotopic analysis of well water (Staal *et al.,* 1993) in this area matches the isotopic composition of Monterey / Modelo Formation rocks and confirms a natural geologic source. In Malibu Creek, the blending of this high sulfate northern tributary water with lower sulfate water from other tributaries (e.g. Cold Creek) results in sulfate levels that still rarely meet Basin Plan water quality objectives, especially in the dry season. Calcium and magnesium levels were measured in Cheeseboro Creek and lower Malibu Creek, and are also very high in relation to other coastal streams locally and other US streams nationally. See pages 30-31 and Section 3.
6. Total Dissolved Solids (TDS): Unusually high background levels of TDS in Malibu Creek and its northern tributaries exceed the 2,000 mg/L Basin Plan Water Quality Objective. See page 32 and Section 3.

Aquatic life

1. Ammonia. No exceedances detected at any station by any program over four decades.
2. Macroinvertebrates: 35 benthic macroinvertebrate bioassessments were conducted at seven sites in Malibu Creek from 2006-10 using the southern California Index of Biotic Integrity (IBI) scoring system. IBI scores were rarely better than "poor" at any monitored location. A review of the scientific literature found that benthic macroinvertebrate bioassessment scores are sensitive to high levels of sulfate, specific conductance and total dissolved solids (TDS) at concentrations regularly exceeded in Malibu Creek. See discussion of Pond *et al.* (2008) in Section 3.
3. Eutrophication and biostimulatory substances (nutrients): Compilation of nutrient data from upstream reference sites located in undeveloped areas north of the 101 freeway found naturally high background levels of phosphate and nitrate, higher than current water quality standards and well above those necessary to sustain high algal growth. We also identified a natural geologic source in these areas consistent with these exceedances (Section 3). However, the data also show that pH and dissolved oxygen (DO) levels, key measures of the *intensity* of eutrophication, were within regulatory limits at all stations except the east fork of upper Las Virgenes Creek (two DO exceedances) and Liberty Canyon Creek (two DO exceedances). See pages 48 and 49. *High algal growth in Malibu Creek is probably a natural phenomenon caused by the presence of high levels of biostimulatory substances in upstream marine Tertiary shales and siltstone in Malibu Creek's northern headwaters.* See page 37 and Section 3.
4. pH: No exceedances any station, any program. See page 48.
5. Dissolved Oxygen (DO): Wet season DO levels never exceeded regulatory standards in 523 samples measured at 84 sites. See page 49. Dry season DO levels met standards in 632 of 636 tests (99.4%), except for 2 exceedances in Liberty Canyon Creek and 2 exceedances in Las Virgenes Creek (east fork), as discussed in (3) above. There is also a strong seasonal component to DO, with higher values in winter. See page 49.

Human Health

1. Lead and Mercury: Lead and mercury levels have declined, with no exceedances in the last decade. See pages 55-56. However, lead levels in surface runoff from exposures of the Monterey / Modelo Formation immediately following rain events did exceed the 15 µg/L Basin Plan objective for drinking water. See First Rain Event results in Section 3.
2. Bacteria: Indicator bacteria levels (total and fecal coliform bacteria and *E. coli*) regularly exceed body contact limits following storm events and also during the summer on occasion. See pp. 57-64.
3. Drinking water maximum contaminant levels (MCLs): Malibu Creek and its northern tributaries exceed state and federal secondary MCLs for drinking water for multiple parameters (SC, TDS, sulfate, hardness, alpha and beta emission). Historical records for TDS, sulfate and hardness show their current levels predate urban development in the watershed. A sulfate isotopic analysis matches sulfate delta values with Monterey / Modelo Formation well water delta values (Staal *et al.*, 2003). A natural source is demonstrated for exceedances of these parameters. See our summary of Natural Sources below and Section 3.
4. Metals and metalloids: Crayfish and fish from Malibu Creek sometimes exceeded fish consumption guidelines for metals, including arsenic, chromium, copper, lead, nickel, selenium and silver. See page 67. The concentrations of 23 metals were tested in surface runoff and local creeks immediately following a small rain event in 2009. With the exception of selenium (highest in upper Las Virgenes Creek), the highest levels for all metals tested occurred in surface runoff from both freshly graded and weathered exposures of the Monterey / Modelo Formation (M Fm.) north of the 101 freeway in open space areas above all development. These levels were consistently higher than those measured in both urban runoff and in creeks outside of the Monterey / Modelo Formation. See "First Rain Event" results in Section 3. Their relative abundances and concentrations measured further downstream in Malibu Creek at station RSW-MC001 were also consistent with this natural source (i.e. lower than undiluted M Fm. runoff but higher than those measured in urban runoff). See CTR results, pages 66-67 and Section 3. Their relative abundances in M Fm. runoff were also consistent with those measured in algae, crayfish and fish from the CTR test site. Moderate to high selenium (Se) levels in water and fish tissue samples are consistent with Se and minor element levels in native rock and native runoff within the M / M Fm. north of the 101 freeway. We found no evidence of any human Se source in the watershed consistent with the levels measured. High levels occurred even upstream of anthropogenic nitrate sources. See Section 3.

Organic Compounds

1. "Sentinel" Station Non-detects. Aside from one detection of bis(2-ethylhexyl) phthalate, tests for 106 organic compounds (including 25 pesticides, 24 volatile organic compounds and 57 semi-volatile compounds) returned non-detections for 18 consecutive months at station RSW-MC001U in Malibu Creek, which serves as a sentinel station for pollutants coming into lower Malibu Creek from the upper watershed exclusive of Cold Creek. See pages 66-67.

Natural Source Assessment. Please see our water quality summary on page 71 and effects on beneficial uses synopsis on page 72, in addition to natural source findings already noted above for specific constituents.

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