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DRAFT
Los Angeles River Watershed Bacteria TMDL
Technical Report Section 8: Dry Weather Monitoring and Special Studies

Prepared for:

CLEANER RIVERS THROUGH EFFECTIVE STAKEHOLDER-LED TMDLS (CREST)

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8.1 Overview

Effective monitoring will be necessary to assess the dry weather conditions of the Los Angeles River and its tributaries and to assess the on-going effectiveness of efforts by dischargers to reduce bacteria loading to the Los Angeles River and meet allocations. Special studies may also be appropriate to provide further information about new data, new or alternative sources, and revised scientific assumptions. This section describes the required and recommended monitoring efforts for the dry weather components of the LA River Bacteria TMDL.

Specific monitoring requirements are not included in this TMDL for the three Water Reclamation Plants (WRPs) in the Watershed (DCT, LAG, and Burbank). Rather, provisions in the individual NPDES permits require sufficient monitoring to assess compliance with WLAs for the WRPs as well as ambient conditions in the receiving waters. WRP effluent and receiving water samples are generally monitored for bacteria on a weekly basis. Other non-MS4 NPDES Permittees (industrial wastewater and stormwater) will have their Permits updated, as necessary and appropriate, to include monitoring requirements consistent with the TMDL WLAs.

The dry weather component of this TMDL allows for MS4 Permittee compliance to be based on implementation of Load Reduction Strategies (**Section 7**). In addition, a non-LRS approach called "Traditional," is included, in which compliance is based solely on attainment of WLAs. Two types of LRSs are described in **Section 7**: Outfall-based and Downstream-based. The implementation approach selected by an MS4 affects the corresponding monitoring requirements.

For MS4 Permittees that have discharges to the LA River or tributaries, as described herein, there are two primary types of monitoring efforts for the TMDL (see **Table 1**):

- **MS4 Permittee Ambient Monitoring** (to assess waterbody conditions in the Watershed)
- **MS4 Permittee WLA Monitoring** (to assess attainment of WLAs), which varies with the alternatives noted above:
    - Load Reduction Strategy (LRS) and Compliance Monitoring
        - Outfall-based
        - Downstream-based
    - Traditional Implementation Strategy Compliance Monitoring

In order to highlight the complexity of the monitoring requirements herein, coarse cost estimates are provided in Table 1 for ambient and WLA monitoring efforts.

Optional Special Studies are also described herein, and may include monitoring components as these efforts are designed to generate additional information regarding WQOs, beneficial uses, and/or bacteria sources/fate/transport.

Table 1. Summary of Dry Weather Monitoring Requirements for LA River Bacteria TMDL[1]

Monitoring Type	Implementation Approach	Implementation Period	Number of Sites	Monitoring Frequency	Coarse Cost Estimate for TMDL Monitoring[5]
Ambient for *E. coli* [2]	All	Prior to Final TMDL Compliance Date	One (1) site in each LAR TMDL segment and trib	Monthly	~$2M [6]
		After Final TMDL Compliance Date	One (1) site in each LAR TMDL segment and trib	Sufficient frequency to evaluate status and trends and evaluate attainment of TMDL targets	TBD
WLA Compliance Monitoring for *E. coli* [2,3]	Outfall-based Load Reduction Strategy	Prior to submittal of LRS	All flowing MS4 outfalls	Six (6) snapshots [4]	~$17M [7]
		After execution of LRS	All flowing MS4 outfalls	Three (3) snapshots [4]	
	Downstream-based Load Reduction Strategy	Prior to submittal of LRS	One (1) site just downstream of proposed Solution	Monthly	Varies by Segment/Trib
		After execution of LRS	One (1) site just upstream of proposed Solution	Sufficient frequency to evaluate status and trends and evaluate attainment of TMDL targets	TBD
	Traditional	One (1) Year Prior to Final Compliance Date	All flowing MS4 outfalls	Nine (9) snapshots	~$13M [8]

1 – This table is a summary and does not include all details of monitoring requirements. See the corresponding subsections of this section for details.
2 – Monitoring of additional analytes such as human-specific indicators (e.g., human *Bacteroidales*) and pathogens (e.g., adenovirus) is encouraged but not required and not included in cost estimates.
3 – In the case that TMDL targets are demonstrated to be met at an in-stream ambient TMDL monitoring location, then the MS4 WLAs for the segment or tributary that corresponds to that in-stream monitoring location are assumed to be met, and the TMDL monitoring of outfalls is no longer required.
4 – Each snapshot, which measures flow and *E. coli* concentrations at all flowing MS4 outfalls along a segment/tributary, may occur over several days to avoid overwhelming staff and laboratories.
5 – Cost escalation (inflation) is not included. For WLA monitoring the numbers of outfalls were those that discharge to the LA River segments and tributaries, and thus the costs correspond to MS4 Permittees using a coordinated approach to outfall monitoring (i.e., if agencies performed monitoring individually, the costs would likely increase).
6 – This coarse cost estimate corresponds to monthly monitoring at 16 sites for 31 years.
7 – This coarse cost estimate is based on multiple LRS iterations in LA River segments and tributaries. Based on the proposed TMDL schedule (Section 7.10), the number of iterations ranged from four (Segment A and B) to two (Segment D). The numbers of outfalls were based on extrapolating the numbers of flowing drains during dry weather observed during the BSI Study in Segment B (Reach 2) and Segment D (Reach 4).
8 – This coarse cost estimate corresponds to conducting a total of nine snapshots in each LA River segment and tributary.

8.2 Ambient Monitoring by MS4 Permittees

An ambient (receiving) water monitoring program is necessary to assess water quality throughout the Los Angeles River and associated tributaries addressed by this TMDL. The MS4 and Caltrans storm water NPDES Permittees assigned WLAs are jointly responsible for implementing the ambient monitoring program. The details of the ambient water monitoring program will be provided in a Bacteria Coordinated Monitoring Plan (CMP), which must be submitted per the TMDL implementation schedule (see **Section 7.10**). To the maximum extent possible, the CMP for this TMDL should be coordinated with other watershed-wide monitoring programs including CMPs for other LA River TMDLs. For this TMDL, a CMP with the following characteristics would be approvable by the Regional Board Executive Officer (EO):

- **Number of sites**: the CMP should include one monitoring station in each LA River segment (5 sites) and tributary (11 sites) addressed under this TMDL (see **Table 1** in **Section 7**). MS4 Permittees may choose to incorporate additional sites as desired.
- **Measurements**: *E. coli* by USEPA-approved methods. Monitoring of additional analytes such as human-specific indicators (e.g., human *Bacteroidales*) and pathogens (e.g., adenovirus) is encouraged but not required.
- **Sample Collection Methods**: all samples shall be collected as grab samples.
- **Monitoring frequency**: the goal of the monitoring program varies between pre- and post-implementation, and thus the frequency varies accordingly:
    - *Pre-implementation period:* Prior to the final compliance dates for TMDL implementation, the goal of ambient monitoring is to assess spatial and temporal trends in bacteria concentrations. Monthly monitoring will provide sufficient data to assess changes in bacteria concentrations over the course of the implementation time period. LA River segments and tributaries addressed under this TMDL shall be monitored monthly prior to the final TMDL compliance date.
    - *Post-implementation period:* After the final compliance dates for TMDL implementation, the goal of ambient monitoring is to assess spatial and temporal trends in bacteria concentrations and attainment of water quality standards. MS4 Permittees shall propose a monitoring frequency sufficient to evaluate spatial and temporal trends and attainment of water quality standards in the CMP for post-TMDL monitoring. The number of sites included under the ambient monitoring program may be reduced (when compared to the pre-implementation period) to offset increased monitoring frequency, if appropriate.
- **Initiation of monitoring:** Ambient monitoring under the CMP shall be initiated two years after the effective date of the TMDL.

Over the course of TMDL implementation, it may be necessary to update or modify the CMP, which may be requested by letter to and approved by letter from the Regional Board EO.

8.3 MS4 Permittee WLA Compliance Monitoring

The WLAs for MS4 Permittees were developed on a mass-basis in units of MPN/day, and this TMDL requires outfall monitoring to confirm that these WLAs are attained. For MS4 Permittees that choose to comply with the dry weather components of this TMDL through implementation of an LRS identified in the Implementation Section (**Section 7**), monitoring is also necessary for implementation planning purposes (e.g., to determine the locations and numbers of BMPs).

As stated in Section 6 (Allocations), in the case that TMDL Targets are demonstrated to be met at an in-stream ambient TMDL monitoring location, then the MS4 WLAs for the segment or tributary that corresponds to that in-stream monitoring location are assumed to be met, and the TMDL monitoring of outfalls is no longer required.

8.3.1 Outfall-based Load Reduction Strategy Monitoring

Implementation of an Outfall-based LRS requires dry weather outfall monitoring both before and after implementation of the LRS. Pre-LRS monitoring is used to estimate the *E. coli* loading from MS4 outfalls to the LA River segment or tributary, and determine the location and number of Priority Outfalls as well as to support the identification of the types of implementation actions that are expected to be necessary to attain the MS4 WLAs. Post-LRS monitoring is used to evaluate the effectiveness of the implementation actions (i.e., determine if the WLA is attained) and to plan and design for additional implementation actions to meet the WLAs, if necessary.

For each Outfall-based LRS for a segment or tributary, an outfall monitoring program with the following characteristics would be considered sufficient for development of an LRS that is approvable by the Regional Board EO:

- **Number of sites**: outfall monitoring for each Outfall-based LRS shall take place at *all* MS4 outfalls that are discharging to a segment or tributary[1] during a given monitoring event. For reference, Segment B, which is 13.7 miles long, had a maximum of 39 outfalls that were flowing during the BSI Study during one event. A total of 51 outfalls were observed to be flowing over the course of all monitoring events (i.e., some outfall discharges were intermittent). To avoid overwhelming laboratories and field staff, it is acceptable for a single snapshot of a LA River segment or tributary to be spread out over several days (i.e., all samples do not have to be collected one the same day).
- **Measurements**: *E. coli* by USEPA-approved methods and flow rate. Sufficient dilutions should be used to avoid "greater than" results for *E. coli*. During the BSI Study, greater than ten million (10^7) MPN per 100mL were measured in a few dry weather discharges. Measurements of volumetric flow rate (e.g., in units of cubic feet per second) of the discharge from each outfall shall be conducted using methods similar to those of the BSI Study (CREST, 2008). Monitoring of additional analytes such as human-specific indicators (e.g., human *Bacteroidales*) and pathogens (e.g., adenovirus) is encouraged but not required.

[1] For MS4s that choose to not coordinate their efforts with other MS4s, then the monitoring locations would be all outfalls/pipes/channels/locations that convey runoff to the boundaries of the MS4's jurisdiction (e.g., city limits), in addition to any outfalls that discharge directly to the LA River/tributary.

- **Sample Collection Methods**: all samples (*E. coli* and flow rate) shall be collected as grab samples.
- **Monitoring frequency**: for each Outfall-based LRS, at least six (6) snapshots shall be conducted for pre-LRS monitoring[2], and at least three (3) snapshots shall be conducted for post-LRS monitoring. To the extent practicable given the TMDL implementation schedule (**Section 7.10**), the dry weather snapshots shall be spread out over at least two seasons (e.g., summer and winter of the same year or consecutive years). Note that six (6) pre-LRS snapshots plus three (3) post-LRS snapshots produces a total of nine (9) samples from all outfalls for each LRS, which would be available to assess attainment of the MS4 WLA. If the WLA is not attained, and follow-up actions are necessary under a new LRS, the three post-LRS snapshots provide additional information to develop the new LRS.
- **Period of monitoring**: pre-LRS outfall monitoring should be initiated with sufficient time to incorporate results into the Outfall-based LRS for BMP planning. Initiation of outfall monitoring two years prior to submittal of the Outfall-based LRS should provide sufficient time to collect samples and utilize results for development of the LRS and BMP strategies. Post-LRS monitoring should be initiated within six months of the completion of the last action at a Priority Outfalls ("completion" means that the BMP has begun operating and confirmed to be working properly) for the corresponding segment or tributary.

8.3.2 Downstream-based Load Reduction Strategy Monitoring

The dry weather component of this TMDL allows for MS4 Permittee compliance to be based on implementation of a Downstream-based LRS. Implementation of a Downstream-based LRS includes dry weather monitoring at the potential location of the Downstream Solution both before and after implementation of the LRS. Pre-LRS monitoring is used to estimate the *E. coli* loading of the waterbody and assist with planning and determination the characteristics of a proposed Downstream Solution that is expected to result in attainment of TMDL targets just downstream of its location. Post-LRS monitoring is used to evaluate the effectiveness of the implementation action (i.e., determine if the TMDL target is attained) and to plan and design for additional implementation actions, if necessary.

Downstream-based LRS monitoring is similar to the Ambient Monitoring Program approach (**Section 8.2**) and data collected through the Ambient Monitoring Program may be sufficient to develop and/or evaluate a Downstream-based LRS. In other words, for each Downstream-based LRS, an in-stream monitoring program that resembles that ambient monitoring program described in **Section 8.2** would be considered sufficient for development of an LRS that is approvable by the Regional Board EO, as follows:

- **Number of sites**: pre- and post-LRS monitoring would be conducted at a site immediately downstream of the proposed Downstream Solution. In some cases, however, such as full diversion or reuse, the effectiveness of the proposed Downstream Solution may *not* be dependent on the in-stream conditions; in this case pre-LRS monitoring is not necessary.

[2] For the first LRS, Segment B outfalls have already been monitored and additional pre-LRS outfall monitoring is not required.

- **Measurements**: *E. coli* by USEPA-approved methods and flow rate. Monitoring of additional analytes such as human-specific indicators (e.g., human *Bacteroidales*) and pathogens (e.g., adenovirus) is encouraged but not required. Flow rate should be measured using accepted field methods, either as point measurements or with a permanent flow gage.
- **Sample Collection Methods**: all samples shall be collected as grab samples.
- **Monitoring frequency**: monitoring through the ambient program will provide sufficient data to assess bacteria concentrations before and after implementation of a Downstream-based LRS.
- **Period of monitoring**: pre-LRS monitoring, if necessary, should be initiated with sufficient time to incorporate results into the Downstream-based LRS. One year of monthly in-stream monitoring upstream of the proposed Solution should be sufficient for development of a Downstream-based LRS. Post-LRS monitoring should be initiated within six months of the completion of the Downstream Solution ("completion" means that the Solution has begun operating and confirmed to be working properly). Post-LRS monitoring would be incorporated into the ambient monitoring program.

8.3.3 Traditional Implementation Approach Monitoring

For MS4s that choose to comply with this TMDL using a Traditional (non-LRS) approach, then an outfall monitoring program with the following characteristics would be considered sufficient for determination of WLA attainment:

- **Number of sites**: outfall monitoring shall take place at *all* MS4 outfalls that are discharging to a segment or tributary during a given monitoring event (also see footnote #1).
- M**easurements**: *E. coli* by USEPA-approved methods and flow rate. Sufficient dilutions should be used to avoid "greater than" results for *E. coli*. During the BSI Study greater than ten million (10^7) MPN per 100mL were measured in a few dry weather discharges. Measurements of volumetric flow rate (e.g., in units of cubic feet per second) of the discharge from each outfall shall be conducted using methods similar to those of the BSI Study (CREST, 2008). Monitoring of additional analytes such as human-specific indicators (e.g., human *Bacteroidales*) and pathogens (e.g., adenovirus) is encouraged but not required.
- **Sample Collection Methods**: all samples (*E. coli* and flow rate) shall be collected as grab samples.
- **Monitoring frequency**: at least nine (9) snapshots shall be conducted prior to the final WLA compliance date. The dry weather snapshots shall be spread out over at least two seasons (e.g., summer and winter of the same year or consecutive years).
- **Period of monitoring**: all outfall monitoring used to evaluate attainment with the WLA shall be conducted in the year prior to the final compliance date for the corresponding segment or tributary.

8.4 Special Studies

Special studies are an important aspect of TMDL implementation, as they can fill data gaps for both technical issues (e.g., bacteria sources/fate/transport) and policy issues (e.g., attainment of water quality standards). The CREST stakeholder group identified optional special studies that could support TMDL implementation and reopeners. The results of special studies submitted to the Regional Board EO shall be considered during subsequent TMDL reopeners (see the schedule in **Section 7.10**). For this TMDL, the following special studies are optional (i.e., not required):

- **Natural Source Exclusion studies**: natural, in-stream *E. coli* sources may contribute to WQO exceedance rates greater than those in reference watersheds, which were used to calculate the numbers of allowable exceedance days for TMDL Targets. The BSI Study found that in-stream sources along Segment B were non-human and of relatively large magnitude. Based on a weight-of-evidence approach, these *E. coli* sources were concluded to most likely be due to interactions of the LA River water column with birds, sediment, and/or environmental growth. A special study is recommended to further evaluate the relative magnitude of these sources and determine whether the TMDL Targets (i.e., numbers of allowable exceedance days) and WLAs established for Segment B are appropriate, and whether a Natural Source Exclusion is applicable. Uncharacterized sources could also be evaluated for other mainstem LA River segments and tributaries. Many sources that are non-human may not qualify for a Natural Source Exclusion, and thus it would be critical to evaluate whether identified sources were natural (e.g., birds using a migratory flyway) or driven by anthropogenic activities (e.g., rats and raccoons in storm drains).
- **Assess REC-1 beneficial use designations in the Watershed:** many portions of the LA River segments and tributaries exhibit conditions that may not be conducive to water contact use, including vertical, fenced walls, shallow flows, and WRP effluent-dominated flows. Use Attainability Analyses (UAAs) could be conducted to consider and support, if appropriate, Basin Plan amendments to establish sub-categories of, recreational beneficial use designations. If beneficial use designations were to change, and some waters were categorized as being subject to less frequent or zero recreational use, then implementation actions could be prioritized to focus on the REC-1 sites. UAAs may be particularly important for efforts by MS4s to implement a Downstream-based LRS approach (see **Section 7.7.3**).
- **Monitor reference watersheds and exceedance probabilities:** the calculations of allowable exceedance days for the TMDL targets were based on data from SCCWRP monitoring a large number of southern California sites over approximately two years (see **Section 3.2.2**). This TMDL could benefit from reference watershed monitoring at additional sites or over additional years. Of particular interest may be the "outlier sites" that were removed from the SCCWRP dataset and not used to calculate the TMDL targets. Further investigation could be performed to determine whether in fact these sites were outliers or whether frequent WQO exceedances naturally occur in some reference watersheds.
- **Conduct Monitoring of Pathogens to Assess Recreational Health Risks and Develop Site Specific Objectives:** using Quantitative Microbial Risk Assessment (QMRA), it may be possible to predict health risks in the Watershed based on monitoring of waterborne

pathogens. Types of pathogens that pose risks to recreational users include bacteria, viruses, and protozoa. The QMRA-derived risk profiles could potentially be used to develop site-specific water quality objectives (SSOs) for recreational water contact in the LA River watershed. The application of QMRA to develop bacteria SSOs is particularly relevant to Watersheds like the LA River, where water contact recreation is likely to infrequent to conduct epidemiological studies. In support of the *Criteria Development Plan*, a USEPA document is being developed for USEPA and USEPA contractors regarding the application of waterborne pathogen measurements to predict health risks in recreational waters (USEPA staff, personal communication). The Water Environment Research Foundation (WERF) is also developing a complementary document to describe a framework by which QMRA could be used in a tiered approach to develop SSOs. Seven primary pathogens-of-concern[3] are highlighted for risk assessment, as follows:

- *Campylobacter* (bacteria)
- Pathogenic *E. coli* (bacteria)
- Adenovirus (virus)
- Rotavirus (virus)
- Norovirus (virus)
- *Cryptosporidium* cysts (protozoa)
- *Giardia* oocysts (protozoa)

The methodologies used for an LA River QMRA study would likely be developed in coordination with a Peer Review committee comprised of experts in the fields of risk assessment, waterborne pathogen monitoring, and water quality standards. It would be critical to verify that State and Federal standards allow for QMRA to be used to develop SSOs, and that site-specific epidemiological studies are not required.

- **Evaluate effectiveness of Best Management Practices:** the effectiveness of BMPs is an important component of developing implementation strategies. Bacteria is a particularly challenging pollutant in regards to treatment by BMPs. Other than diversion and complete infiltration, there are few BMPs for which reported performance data indicates that they are consistently reliable for substantial bacteria reduction or elimination. In addition, non-structural controls/programs are attractive to MS4s for TMDL implementation; however, data regarding the effectiveness of such programs (e.g., aggressive water conservation programs with enforcement) are limited. Therefore, special studies are encouraged to assess effectiveness of both structural and non-structural BMPs for bacteria control.

[3] These seven pathogens are not solely derived from human fecal sources. Some can be discharged from both human and non-human fecal sources. However, each of these pathogens can cause illness in humans.