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DRAFT
Los Angeles River Watershed Bacteria TMDL – Technical Report Section 6: Dry Weather TMDL and Wasteload Allocations

Prepared for:

CLEANER RIVERS THROUGH EFFECTIVE STAKEHOLDER-LED TMDLS (CREST)

Prepared by:

CREST CONSULTING TEAM

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6.1 Introduction

The total maximum daily load (TMDL) is the maximum amount of pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the point and non-point sources in the watershed and a margin of safety. Numerically, the bacteria TMDL for the LA River Watershed can be expressed as:

$$TMDL = \sum WLA + \sum LA + MOS$$, where:

$TMDL$ = total maximum daily load [MPN/day]

WLA = wasteload allocations for point (NPDES-regulated) sources [MPN/day]

LA = load allocations for non-point sources [MPN/day]

MOS = margin of safety to account for uncertainty/error in TMDL development [MPN/day]

6.2 Load Duration Curve Approach

For dry weather conditions, the TMDL and allocations for the LA River Watershed Bacteria TMDL were generated using a load duration curve (LDC) approach. The LDC approach provides a simple methodology to calculate TMDLs and generate allocations. LDCs have been used in many TMDLs nationwide, including the Malibu Creek Bacteria TMDL. The loading rate units for the TMDL and allocations generated by the LDC approach are MPN/day.

6.2.1 DEVELOPMENT OF LOAD DURATION CURVES FOR THE LA RIVER WATERSHED

The LDC approach uses measured flow rates to calculate the TMDL for each LA River segment and tributary receiving an allocation. More accurately, the LDC represents the "allowable in-stream loading" because it is simply the in-stream flow rate multiplied by the single sample maximum (SSM) WQO[1]. Development of LDCs consists of two steps (see **Figure 1**):

1. The **flow** duration curve (plot of the cumulative frequency distribution of all measured daily average flow rates) is generated.
2. The flow duration curve is multiplied by the applicable WQO – in this case the SSM for *E. coli* (235 MPN/100mL). This step, which creates the **load** duration curve, effectively determines the "allowable in-stream loading", or assimilative capacity, of the waterbody. If in-stream concentrations are above the SSM WQO, then the allowable in-stream loading has been exceeded. The steps in Section 6.2.2 are adjustments to the assimilative capacity to account for upstream allocations.

[1] The SSM WQO is used to develop the LDC because (1) SSM has been used during previous LDC-based Bacteria TMDLs, including Malibu Creek and (2) the SSM WQO more closely corresponds to a "daily" value, which is consistent with the recent "Anacostia" decision and subsequent USEPA guidance (U.S. Court of Appeals for the D.C. Circuit in *Friends of the Earth, Inc. v. EPA, et al.*, No. 05-5015 [D.C. Cir. 2006]).

The LDCs in **Figure 1** (blue line in each plot) represents the allowable in-stream loading at the site, including discharges from upstream and from tributaries. In order to evaluate the current conditions relative to the TMDL, previously measured *E. coli* loading rates (based on flow rates from LA County flow gages and *E. coli* concentrations from the City of LA Status and Trends monitoring program) can be plotted with the LDC, as shown in **Figure 1.**

6.2.2 APPROACH FOR CALCULATION OF AVAILABLE LOADING FOR DRY WEATHER ALLOCATIONS

The LDCs provide the basis for determination of the loading available for WLAs. Development of WLAs for each LA River segment and tributary receiving allocations must incorporate the following three factors:

1. **Assimilative Capacity of the LA River segment or tributary –** the ability of the waterbody to assimilate bacteria loadings is largely a function of flow rate and bacteria decay.

2. **Loading from upstream mainstem segments of the LA River that have WLAs –** a portion of the assimilative capacity is allocated to upstream segments of the LA River. Thus, the WLA for a given mainstem LA River segment must account for the allowable in-stream loading for upstream reaches (e.g., allocations along Reach 2 must consider allocations for the upstream Reach 3).

3. **Loading from upstream tributaries that have WLAs –** similarly, a portion of available assimilative capacity is allocated to upstream tributaries that are assigned allocations. Thus, the WLA for a given mainstem LA River segment must account for the allowable in-stream loading for tributaries that discharge into that segment.

The effect of the allowable in-stream loading from upstream reaches and tributaries is largely a function of three factors: *E. coli* decay rate, downstream travel time and flow rate. These parameters were estimated to determine the loading available for WLAs as described below:

- ***E. coli* decay rate –** the decay, or die off, of *E. coli* can be dependent on numerous factors, but the most important parameters include sunlight intensity and temperature. As described in Section 2.2 of Appendix A, in 2003 SCCWRP conducted fresh- and marine water laboratory studies with conditions representative of southern California conditions (Noble et al., 2004). Researchers conducted studies under two sunlight and temperature conditions, called "winter" and "summer", and reported first-order exponential decay rates (k) for each (using the equation $C(t) = C_o e^{-kt}$). This TMDL will apply year around, and thus an exponential decay rate equivalent to the average of the summer and winter sunlight/temperature conditions in freshwater was assumed. Specifically, an exponential decay rate of 0.09 $hour^{-1}$ was applied. For comparison, *E. coli* decay rates reported by Sinton et al. (2002) under low (winter) sunlight ranged from 0.11-0.33 $hour^{-1}$, while decay rates under high (summer) sunlight ranged from 0.25-0.70 $hour^{-1}$. These rates are higher than the decay rate used herein (0.09 $hour^{-1}$), and thus the WLAs calculated herein are considered conservative.

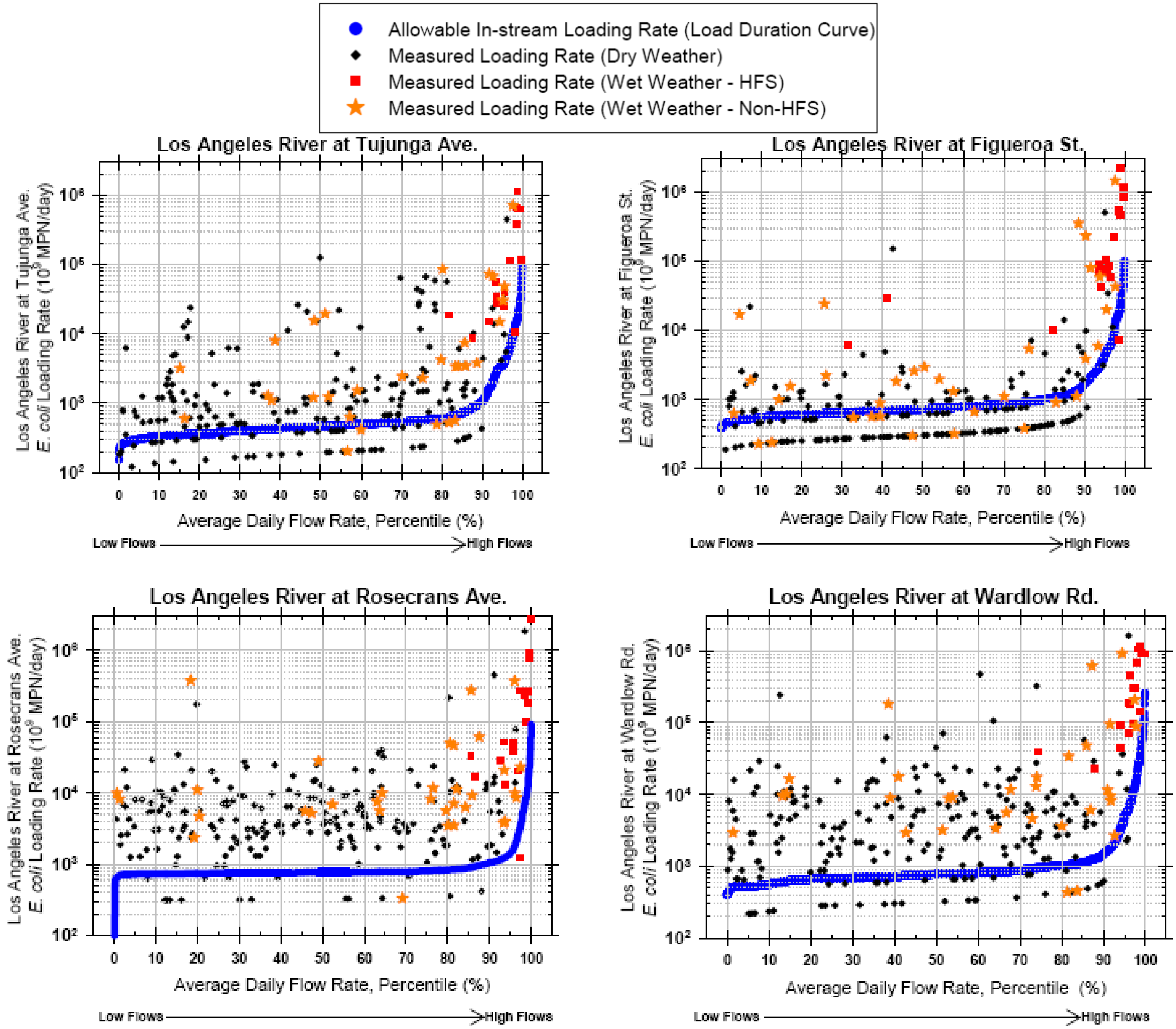

Figure 1. Load Duration Curves for LA River Sites with Flow Gage Stations and Comparison to Measured Loading Rates

The measured loading rates (diamonds, squares, and stars) are based on *E. coli* concentrations reported by the City of LA Status and Trends monitoring program (2001-2008) and the corresponding daily average flow rate at the nearby flow gage on the day of sample collection. Loading rates above the load duration curve (blue line) represent WQO exceedances.

- **Downstream travel times –** the amount of decay that takes place during downstream travel is dependent on travel time. Travel times were estimated based on outputs from the model developed for the dry weather LA River Metals TMDL (Watson et al., 2002; also see Figure 3-15 in the dry weather modeling report for the LA River Metals TMDL). The velocities at various locations along the LA River from Reach 6 to Reach 1 were estimated from the graphical model output. These velocities were integrated over downstream distance and used to estimate travel times from the LA River headwaters to Willow Street, including (1) locations at which LDCs were generated and (2) confluences with major tributaries.
- **Flow rates –** the assumed LA River and tributary flow rates affect the WLA calculation. Dry weather flow rates in the LA River and tributaries are relatively steady (i.e., the flow duration curves are "flat" for flow rates that occur during dry weather). Thus, the estimated median (50^{th} percentile) flow rate for each LA River segment and tributary was used for WLA calculations. This is consistent with the LA River Metals TMDL, which used the median LA River flow rates as the critical flow for WLA calculations. For most LA River and tributary locations, flow gage stations were available to estimate median flow rates. In some cases, however, available data for median estimates based on "grab" measurements of flow rate collected during the Tier 2 Study (CREST, 2006), the BSI Study (CREST, 2008), SCCWRP snapshots (Ackerman et al., 2003), or the City of Los Angeles Status and Trends monitoring. The number and source of flow rate measurements for each location can be found in **Table 1**.

6.2.3 APPROACH FOR CALCULATION OF DRY WEATHER WASTELOAD ALLOCATIONS

The WLA for non-WRP discharges to an LA River segment or tributary is the difference in (1) the allowable in-stream loading and (2) the sum of WRP WLAs and the decayed allowable in-stream loadings from upstream segments and tributaries. Thus, for a given segment of the LA River, the non-WRP WLA is calculated as follows:

Median Allowable In-stream Loading at Downstream End of Segment

\- *Decayed Median Allowable In-stream Loading at Upstream End of Segment*

\- *Decayed Median Allowable In-stream Loading for 303(d)-listed Tribs along Segment*

\- *Permit WLA for Water Reclamation Plants (WRPs) along Segment =*

WLA for All non-WRP Discharges to LA River Segment

For tributaries, the non-WRP WLA is simply the median allowable in-stream loading at the mouth minus the WLA for WRPs (if any) that discharge to the segment.

To illustrate the methodology described above, an example of the results for the LA River segment between Figueroa Street and Rosecrans Avenue is shown in **Figure 2**. The difference between the median LDC at Rosecrans Avenue and decayed median LDCs from upstream LA River site (Figueroa Street) and the tributaries in between (Arroyo Seco and Rio Hondo) is the loading available for WLAs, to be split among all NPDES-permitted (point) sources between Figueroa Street and Rosecrans Avenue. It should be noted that loadings from minor and unnamed tributaries are conveyed through the stormwater system and therefore are included in the WLAs for MS4 discharges (as opposed to being assigned separate WLAs).

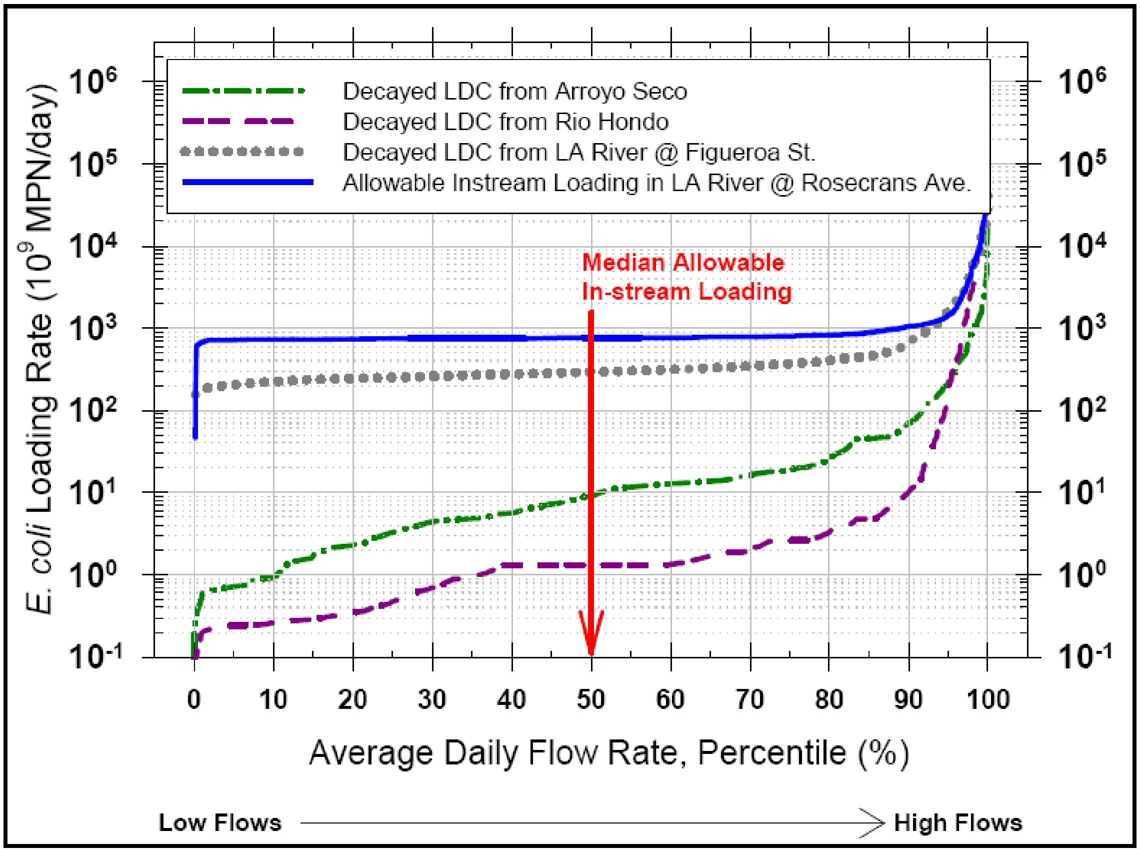

Figure 2. Example Load Duration Curve Approach for Calculation of Wasteload Allocations
The LA River segment shown is between Figueroa Street (Reach 3) and Rosecrans Avenue (Reach 2)

6.2.4 APPROACH FOR CALCULATION OF DRY WEATHER LOAD ALLOCATIONS

As described in the Section 4 (Source Assessment), the non-point sources in the Watershed include onsite wastewater treatment systems (OWTS), in-channel sources, and runoff from the headwaters. For this TMDL, bacteria discharges from OWTS are given a load allocation of zero. Discharges from the headwaters and in-channel sources are accounted for with the Exceedance Day Approach. Specifically, there is an allowable frequency that the SSM WQO can be exceeded (see **Table 4** of **Section 3**, Numeric Targets), which has not been accounted for during the wasteload allocation calculations. Thus the loading associated with allowable exceedances can be "allocated" as load allocations (LAs) for these natural/non-point sources. As such, natural and in-channel sources were not given a numeric LA (with units of MPN/day), but they have been properly accounted for during development of TMDLs and allocations. Note this approach is consistent with previous bacteria TMDLs in the region (e.g., Ballona Creek) in that all capacity below the allowable in-stream loading is allocated to the point sources in the Watershed, while a low rate of WQO exceedance is allowed and allocated to address exceedances from natural sources (which are considered non-point).

6.3 Dry Weather Wasteload Allocation Calculations

Using the methodology described above, TMDLs and WLAs were developed for the LA River and tributaries requiring allocations from its headwaters to near the mouth at Willow Street. All LA River reaches were given allocations, including Reach 3 and Reach 5 which are not on the current or proposed 303(d) list, but were identified during the TMDL analysis (**Section 1**) as being subject to WQO exceedances. Tributaries on the proposed or current 303(d) list were also given allocations[2].

6.3.1 LA RIVER SEGMENTS USED FOR WASTELOAD ALLOCATION DEVELOPMENT

As detailed in **Table 1**, WLAs in units of MPN/day were developed for five segments along the mainstem LA River (defined by cross streets/bridges) from its headwaters to near its mouth (see **Figure 3**):

- **Segment E**: Reach 6 – LA River headwaters to Balboa Boulevard
- **Segment D**: Reach 5 to middle Reach 4 – Balboa Boulevard to Tujunga Avenue
  Segment C: lower Reach 4 and Reach 3 – Tujunga Avenue to Figueroa Street
- **Segment B**: upper and middle Reach 2 – Figueroa Street to Rosecrans Avenue
- **Segment A**: lower Reach 2 and Reach 1 – Rosecrans Avenue to Willow Street

Note that the allocations were developed for five segments along the LA River (**Figure 3**) that do not correspond directly to the reaches utilized in previous TMDLs. Instead, these segments correspond with locations for which flow rate data are available, including permanent flow gage stations. By separating the LA River segments in this manner, it was possible to avoid extrapolation of flow rate data to segments for which flow rate data are not available. The drainage areas for each LA River segment are delineated in **Section 7**, including an analysis of the various agencies/cities that discharge into each segment. Also note that **Table 1** shows flow rates and travel times used to calculate TMDLs and WLAs, including the origin of data used to estimate median flow rates.

[2] Loadings from non-impaired tributaries, including minor and unnamed tributaries are also included in the calculated WLAs, essentially being treated as MS4 storm drain discharges, but they are not given individual allocations as allocations are not required.

Table 1. Summary of LA River Segments and Tributaries for which Dry Weather Allocations were Developed (also see Figure 3)

LA River Seg-ment	Included LA River Reaches	LA River Segment for which Dry Weather Wasteload Allocations are Required: Upstream End (median flow rate, cfs)	Downstream End (median flow rate, cfs)	Segment Length (miles)	Travel Time (hours)	Tributaries with Allocations along Segment: Name	Distance from Tributary Mouth to Downstream end of LA River Segment (miles)	Median Trib Flow Rate (cfs)	Travel Time from Tributary Mouth to Downstream end of LA River Segment (hours)
A	1 and 2	Rosecrans Ave.[F1] (133)	Willow St.[F2] (132)	7.09	5.20	Compton Creek[F3]	2.55	1.10	1.87
B	2	Figueroa St.[F4] (125)	Rosecrans Ave.[F1] (133)	13.74	10.43	Arroyo Seco[F5]	13.71	3.85	10.42
						Rio Hondo[F6]	1.63	0.25	1.20
C	3 and 4	Tujunga Ave.[F7] (82)	Figueroa St.[F4] (125)	12.17	8.59	Verdugo Wash[F8]	6.14	8.00	4.50
						Burbank Western Channel[F9]	7.80	13.85	5.72
D	4 and 5	Balboa Blvd.[F10] (10)	Tujunga Ave.[F7] (82)	7.83	7.05	Tujunga Wash[F11]	0.98	1.54	0.36
						Bull Creek[F12]	7.03	3.72	6.28
E	6	Confluence with Calabasas Creek/ Bell Creek[F13] (4.4)	Balboa Blvd.[F10] (10)	6.47	6.33	Aliso Canyon[F14]	2.78	3.71	2.72
						Dry Canyon[F15]	9.64	1.09	8.65
						McCoy Canyon[F15]	9.37	1.09	8.65
						Bell Creek[F15]	6.47	2.18	6.33

F1 – LA County flow gage (F34D) is near this site at Firestone Blvd. **F2** – LA County flow gage (F319) is near this site at Wardlow River Road. **F3** – LA County flow gage (F37B) is present at this location. **F4** – LA County flow gage (F57C) is present at this location. **F5** – LA County flow gage (F277) is present at this location. **F6** – LA County flow gage (F45B) is present at this location.

F7 – LA County flow gage (F300) is present at this location. **F8** – LA County flow gage (F252) is present at this location. **F9** – LA County flow gage (F285) is present at this location. **F10** – No flow gage is present at this location. Flow rate measurements from LA River at White Oak Avenue collected during the BSI Study were used (n = 6 measurements). **F11** – No flow gage is present at this location. Flow measurements from LA River at Tujunga Wash collected during both the BSI Study (n = 6 measurements) and Tier 2 Study (n = 6 measurements). **F12** – No flow gage is present at this location. Flow rate measurements from Bull Creek at Victory collected during the Status and Trends monitoring program (2004-2006) were used (n = 21 measurements). **F13** – No flow gage is present at this location. Flow rate measurements from LA River at Canoga Avenue collected during the BSI Study were used (n = 6 measurements). **F14** – No flow gage is present at this location. Flow rate measurements from Aliso Canyon Wash at Wilbur Avenue collected during the Status and Trends monitoring program (2004-2006) were used (n = 25 measurements). **F15** – No flow gage is present at this location. Flow rate measurements from LA River at Canoga Avenue collected during the BSI Study were used (n = 6 measurements), and the median flow rate (4.36 cfs) was split among Dry Canyon (25%), McCoy Canyon (25%) and Bell Creek (50%).

Figure 3. Los Angeles River Watershed and Segments for which WLAs were Developed

6.3.2 CALCULATIONS FOR LOADING AVAILABLE FOR WASTELOAD ALLOCATIONS BY LA RIVER SEGMENT

Shown in **Table 2** are the calculations of *E. coli* loadings available for WLAs for each LA River segment (in MPN/day, based on the methodology described in **Section 6.2.3**). Note the resulting loadings available for WLAs will be shared among all non-WRP NPDES-permitted discharges along each LA River segment. The distribution of this loading to the various types of NPDES discharges is described in the next subsection.

Effluent limits in the NPDES Permits for the three WRPs in the Watershed currently require (1) the median number of coliform organisms in effluent not to exceed 2.2 per 100 milliliters and (2) the number of coliform organisms cannot exceed 23 per 100 milliliters in more than one sample within any 30-day period. The WLAs for WRPs are set equal to 2 MPN/100mL of *E. coli*[3] times the flow rate (at the time of sampling). For calculation of non-WRP WLAs, however, the WRP flow rate was assumed to be equal to the WRP design flow[4].

[3] To be conservative for calculation of non-WRP WLAs, the permit limits of 2.2 MPN/100mL total coliform were converted directly to *E. coli*. Measurements of *E.coli* are reported in whole numbers, and thus 2 MPN/100mL was used.

[4] See **Table 4-2** in the Source Assessment for a summary of WRP design flows and permit requirements.

Table 2. Calculation of *E. coli* Loading Available for WLAs along LA River Segments[1]

LA River Segment E (Headwaters to Balboa Boulevard)	
Median allowable in-stream loading at Balboa Blvd.	59
- Decayed median allowable in-stream loading from Dry Canyon	-3
- Decayed median allowable in-stream loading from McCoy Canyon	-3
- Decayed median allowable in-stream loading from Bell Creek	-7
- Decayed median allowable in-stream loading from Alison Canyon Wash	-17
= Loading available for WLAs for all non-WRP NPDES Discharges	29
LA River Segment D (Balboa Boulevard to Tujunga Avenue)	
Median allowable in-stream loading at Tujunga Ave.	471
- Decayed median allowable in-stream loading from Balboa Blvd	-31
- Decayed median allowable in-stream loading from Bull Creek	-12
- Permit WLA for Tillman WRP	-6
- Decayed median allowable in-stream loading from Tujunga Wash	-9
= Loading available for WLAs for all non-WRP NPDES Discharges	413
LA River Segment C (Tujunga Ave to Figueroa Street)	
Median allowable in-stream loading at Figueroa St.	720
- Decayed median allowable in-stream loading from Tujunga Ave.	-218
- Decayed median allowable in-stream loading from Verdugo Wash	-31
- Permit WLA for Glendale WRP	-2
- Decayed median allowable in-stream loading from Burbank Western Channel	-48
= Loading available for WLAs for all non-WRP NPDES Discharges	421
LA River Segment B (Figueroa Street to Rosecrans Avenue)	
Median allowable in-stream loading at Rosecrans Ave.	764
- Decayed median allowable in-stream loading from Figueroa St.	-283
- Decayed median allowable in-stream loading from Arroyo Seco	-9
- Decayed median allowable in-stream loading from Rio Hondo	-1
= Loading available for WLAs for all non-WRP NPDES Discharges	471
LA River Segment A (Rosecrans Avenue to Willow Street)	
Median allowable in-stream loading at Willow St.	759
- Decayed median allowable in-stream loading from Rosecrans Ave.	-480
- Decayed median allowable in-stream loading from Compton Creek	-5
= Loading available for WLAs for all non-WRP NPDES Discharges	274

1 – All units are 10^9 MPN per day of *E. coli*

6.3.3 CALCULATIONS FOR LOADING AVAILABLE FOR WASTELOAD ALLOCATIONS FOR TRIBUTARIES

For tributaries the loadings available for dry weather WLAs, presented in **Table 3**, were calculated in the same manner as for the LA River. However, tributaries were not separated into multiple reaches and tributaries do not have major upstream tributaries. Thus, as detailed in **Section 6.2.3**, loading available for WLAs along tributaries was calculated as follows:

Median Allowable In-stream Loading at Mouth of Tributary

\- *Permit WLA for Water Reclamation Plants (WRPs) along Tributary =*

WLA for All non-WRP Discharges to Tributary

Table 3. Calculation of Loading Available for Dry Weather WLAs for All non-WRP Discharges to LA River Tributaries

Tributary	LA River Reach at Confluence	Median Flow Rate (cfs)	***E. coli* Loading Rate** (10^9 MPN/day)		
			Median Allowable In-stream Loading at Mouth (1)	**WLA for WRP Discharges to Tributary** (2)	**Loading Available for all Non-WRP NPDES Discharges from Headwaters to Mouth of Tributary** (1)-(2)
Compton Creek	1	1	6	0	6
Arroyo Seco	2	4	22	0	22
Rio Hondo	2	0.3	2	0	2
Verdugo Wash	3	8	46	0	46
Burbank Western Channel	3	14	80	2 [a]	78
Tujunga Wash	4	2	9	0	9
Bull Creek	5	4	14	6 [b]	8
Aliso Canyon Wash	6	4	21	0	21
Dry Canyon	6	1	6	0	6
McCoy Canyon	6	1	6	0	6
Bell Creek	6	2	13	0	13

a – This WLA is for City of Burbank WRP **b** – This WLA is for D.C. Tillman WRP

6.4 Final Dry Weather Allocations

The loadings available for WLAs are shared among the various types of NPDES-permitted discharges[5]. Allocations for specific discharge types were generated using the following assumptions:

1. **OWTS –** discharges of *E.coli* from OWTS in the Watershed are prohibited and given a LA of zero.
2. **Industrial Stormwater –** general and individual industrial NPDES stormwater permits in the Watershed (**Section 4.1.3** and **Table 4-3** in the Source Assessment)) prohibit dry weather discharges, and thus the dry weather WLA for industrial stormwater discharges is zero.
3. **Industrial Wastewater –** the individual NPDES permit for industrial wastewater discharges (see **Table 4-4** in the Source Assessment) do not include specific effluent limits or monitoring requirements for *E. coli*. It is expected that industrial wastewater discharges should not contain fecal indicator bacteria. Thus the dry weather WLA for industrial wastewater discharges is zero.
4. **Other NPDES Discharges –** there are multiple other (non-stormwater and non-wastewater) types of NPDES discharges (see **Table 4-5** in the Source Assessment), including discharges from construction sites. However, the permits for these discharges do not include specific effluent limits or monitoring requirements for *E.coli*. It is expected that these types of discharges should not contain fecal indicator bacteria. Dry weather discharges from construction sites are prohibited. Thus the dry weather WLA for "other" NPDES discharges is zero.
5. **Municipal Stormwater –** the MS4 NPDES Permittees in the Watershed are LA County and 84 co-Permittees, City of Long Beach, and Caltrans (see **Table 4-1** in the Source Assessment). Because the WLAs for all other types of non-WRP discharges (#2, #3, and #4 above) are zero, the WLAs for MS4 discharges are equal to the loading available for non-WRP discharges (as calculated in **Table 2** and **Table 3**)[6].
6. **Municipal Wastewater –** the three WRPs in the Watershed – D.C. Tillman, City of LA-Glendale, and Burbank – have NPDES permits that require (1) the median number of coliform organisms in effluent not to exceed 2.2 per 100 milliliters and (2) the number of coliform organisms cannot exceed 23 per 100 milliliters in more than one sample within any 30-day period. The WLAs for WRPs are set equal to 2 MPN/100mL of *E. coli*[7] times the flow rate at the time of sampling.

The final allocations for each LA River segment are shown in **Table 4**. The final allocations for LA River tributaries are shown in **Table 5**.

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[5] See **Section 4** for a description of the various types of NPDES permits in the Watershed.

[6] Discharges from the MS4 due to SSOs are not considered an MS4 discharge. Discharges from SSOs are prohibited. During monitoring of outfalls during implementation, verified SSO discharges (if any) will not be categorized as loading from the MS4.

[7] To be conservative for calculation of non-WRP WLAs, the permit limits of 2.2 MPN/100mL total coliform were converted directly to *E. coli*. The WRP permit limits, however, will not be adjusted due to this TMDL, they will continue to be based on the current coliform limits.

6.5 Implementation of Dry Weather Wasteload Allocations

The dry weather wasteload allocations developed herein are expressed as loading rates in units of MPN/day. These numeric wasteload allocations shall be incorporated into NPDES permits consistent with the assumptions and approach outlined in Section 7. [8] The WLAs are calculated such that their attainment will also result is attainment of the TMDL targets. Thus, in the case that TMDL targets are met at in-stream compliance points, then the MS4 WLAs for upstream segments are assumed to be met for TMDL implementation purposes (i.e., existing level of treatment/source control by MS4s for dry weather discharges is sufficient), and the TMDL monitoring of outfalls is no longer required (see Monitoring Section 8 [not yet developed]. However, already-implemented BMPs and source control measures must be continued and maintained. Any agency with zero dry weather discharge from its site/jurisdiction is considered in compliance with the dry weather components of this TMDL.

In the case of NPDES provisions for MS4 Permittees, the WLAs shall be attained by implementing BMPs consistent with the implementation strategy detailed in **Section 7**. One possible mechanism of compliance, as outlined in Section 7, is the implementation of a Load Reduction Strategy. That is, outfall monitoring will be used to develop a Monte Carlo (or equivalent) model of discharges from storm drain outfalls along each segment. The expected (median) storm drain loading based on the Monte Carlo (or equivalent) model will be used to determine the necessary load reduction, expressed as the number of storm drain outfalls (and types of proposed BMPs) that will be addressed during the subsequent TMDL implementation phase. The purpose of the proposed Load Reduction Strategy approach is to allow the MS4s to employ an adaptive and iterative approach to TMDL implementation, while ensuring the implemented actions are sufficient to eventually attain WLAs and water quality standards. Prior to the final date of this TMDL, timely and accurate implementation of the Regional Board-approved Load Reduction Strategies represents compliance with this TMDL, as described in **Section 7**.

During TMDL implementation, dry weather flow conditions in the LA River and/or its tributaries may change significantly due to a variety of factors, including altered discharge rates from the WRPs. Discharges from WRPs may increase due to changes to WRP operations to utilize available treatment capacity, or decrease due to additional effluent reuse. In this case, these WLAs would be re-calculated and revised during a TMDL reopener.

[8] The WRP permit limits, however, will not be adjusted due to this TMDL; they will continue to be based on the current coliform limits.

Table 4. Final Dry Weather LAs and WLAs for LA River Segments by NPDES Discharge Type

LA River Segment	Included LA River Reaches	LA River Segment for which Dry Weather Wasteload Allocations are Required		Wasteload and Load Allocations[1,2] (*E. coli* Loading Rate [10^9 MPN/day])					LA for Natural, Non-point Sources (Single Sample Maximum Exceedance Days)[6]
		Upstream End	Downstream End	WLA for WRP Discharges to Segment [3]	WLA for MS4 Discharges to Segment [4,5]	WLA for Industrial Stormwater and Wastewater Discharges to Segment	WLA for Other NPDES Discharges to Segment	LA for OWTS Discharges to Segment	
A	1 and 2	Rosecrans Ave.	Willow St.	0	274	0	0	0	5
B	2	Figueroa St.	Rosecrans Ave.	0	472	0	0	0	5
C	3 and 4	Tujunga Ave.	Figueroa St.	2 x Q [a]	422	0	0	0	5
D	4 and 5	Balboa Blvd.	Tujunga Ave.	2 x Q [b]	412	0	0	0	5
E	6	Headwaters	Balboa Blvd.	0	28	0	0	0	5

1 – The loading rates for WLAs and LAs are expressed in terms of discharge to the *waterbody* as opposed to the *watershed*. A source with an allocation of zero MPN/day could potentially discharge *E.coli* into the watershed and remain in compliance, given that zero MPN of the discharged *E.coli* reached the waterbody. Conversely, any agency with zero dry weather discharge from its site/jurisdiction is considered in compliance with the dry weather components of this TMDL.

2 – In the case that TMDL targets are met at in-stream compliance points , then the MS4 WLAs for upstream segments are assumed to be met (i.e., existing level of treatment/source control by MS4s for dry weather discharges is sufficient), and TMDL monitoring of outfalls is no longer required (see Section 8, Monitoring [not yet developed]). However, already-implemented BMPs and source control measures must be continued and maintained.

3 –The WRP permit limits, however, will not be adjusted due to this TMDL, they will continue to be based on the current coliform limits.

4 – When multiple MS4 Permittees drain into a segment, the WLA for MS4s is to be shared among MS4 Permittees based on drainage area.

5 – Discharges from the MS4 due to SSOs are not considered an MS4 discharge. Discharges from SSOs are prohibited. During monitoring of outfalls during implementation, verified SSO discharges (if any) will not be categorized as loading from the MS4.

6 – Natural, non-point sources are accounted for using the Exceedance Day Approach (see Section 3, Targets). That is, a small number of WQO exceedances are allowed due to natural, non-point sources that occur in natural watersheds. Thus, the allocations for non-point, natural sources are expressed as allowable days of exceedance of the SSM WQO at the compliance monitoring site(s). The reported number is based on daily sampling (see **Section 3.3.3** to determine corresponding number of exceedances for less frequent sampling).

a – This WLA is for City of LA-Glendale WRP.

b – This WLA is for D. C. Tillman WRP.

Q represents the WRP flow rate at the time the water quality measurement is collected and a conversion factor to 10^9 MPN/day based on the units of measurement for the flow rate.

Table 5. Final Dry Weather LAs and WLAs for LA River Tributaries by NPDES Discharge Type

Tributary Name	LA River Reach at Tributary Confluence	Wasteload and Load Allocations[1,2] (*E. coli* Loading Rate [10^9 MPN/day])					LA for Natural, Non-point Sources (Single Sample Maximum Exceedance Days)[6]
		WLA for MS4 Discharges to Tributary [3]	WLA for WRP Discharges to Tributary [4,5]	WLA for Industrial Stormwater and Wastewater Discharges to Tributary	WLA for Other NPDES Discharges to Tributary	LA for OWTS Discharges to Tributary	
Compton Creek	1	6	0	0	0	0	5
Arroyo Seco	2	22	0	0	0	0	5
Rio Hondo	2	2	0	0	0	0	5
Verdugo Wash	3	46	0	0	0	0	5
Burbank Western Channel	3	78	2 x Q [a]	0	0	0	5
Tujunga Wash	4	9	0	0	0	0	5
Bull Creek	5	8	2 x Q [b]	0	0	0	5
Aliso Canyon Wash	6	21	0	0	0	0	5
Dry Canyon	6	6	0	0	0	0	5
McCoy Canyon	6	6	0	0	0	0	5
Bell Creek	6	13	0	0	0	0	5

1 – The loading rates for WLAs and LAs are expressed in terms of discharge to the *waterbody* as opposed to the *watershed*. A source with an allocation of zero MPN/day could potentially discharge *E.coli* into the watershed and remain in compliance, given that zero MPN of the discharged *E.coli* reached the waterbody. Conversely, any agency with zero dry weather discharge from its site/jurisdiction is considered in compliance with the dry weather components of this TMDL.

2 –In the case that TMDL targets are met at in-stream compliance points , then the MS4 WLAs for upstream segments are assumed to be met (i.e., existing level of treatment/source control by MS4s for dry weather discharges is sufficient), and TMDL monitoring of outfalls is no longer required (see Section 8, Monitoring [not yet developed]). However, already-implemented BMPs and source control measures must be continued and maintained.

3 – When multiple MS4 Permittees drain into a segment, the WLA for MS4s is to be shared among MS4 Permittees based on drainage area.

4 –The WRP permit limits, however, will not be adjusted due to this TMDL, they will continue to be based on the current coliform limits.

5 – Discharges from the MS4 due to SSOs are not considered an MS4 discharge. Discharges from SSOs are prohibited. During monitoring of outfalls during implementation, SSO discharges (if any) will not be categorized as loading from the MS4.

6 – Natural, non-point sources are accounted for using the Exceedance Day Approach (see Section 3, Targets). A small number of WQO exceedances are allowed due to natural, non-point sources that occur in natural watersheds. Thus, the allocations for non-point, natural sources are expressed as allowable exceedance days at the compliance monitoring site(s). The reported number is based on daily sampling (see Section 3.3.3 to determine corresponding number of allowable exceedance days for less frequent sampling).

a – This WLA is for City of LA-Glendale WRP. **b** – This WLA is for D. C. Tillman WRP.

Q represents the WRP flow rate at the time the water quality measurement is collected and a conversion factor to 10^9 MPN/day based on the units of measurement for the flow rate.

6.6 Margin of Safety

A margin of safety (MOS) is required for each TMDL to account for potential uncertainty in the analysis of pollutant loading and corresponding response of in-stream conditions. To address uncertainty, this TMDL applies an implicit margin of safety through the use of conservative assumptions regarding the effect of *E. coli* discharges from storm drains on in-stream water quality.

An implicit margin of safety is used in this TMDL. Specifically, zero decay of storm drain loadings was included when determining the assimilative capacity of the LA River and its tributaries, which is a conservative assumption. Dry weather models used for bacteria TMDLs often include decay of all inputs including storm drain discharges (e.g., see the first equation on page 7-5 of USEPA *Protocol for Developing Pathogen TMDLs* [2001]). However, for calculation of WLAs for this TMDL, decay of storm drain *E. coli* discharges was assumed to be zero, resulting in conservative WLAs. That is, storm drain discharges of *E. coli* could potentially be higher than the MS4 WLAs and the TMDL targets would still be met. Thus, ignoring decay of storm drain-discharged *E. coli* during calculation of the WLAs represents an implicit MOS that addresses uncertainty associated with TMDL development.

While the MOS is implicit, its magnitude can be estimated as shown in **Table 6** and **Table 7** for the mainstem LA River and tributary segments, respectively. The following approach was used to estimate the MOS:

- MS4 WLAs were compared to the "potential" MS4 loading (i.e., the MS4 loading that could potentially occur and the TMDL still be met if decay was included).
- To determine the potential loading, the MS4 WLA values were used as the *final* downstream concentrations (C_f) in the exponential decay equation ($C_f = C_o e^{-kt}$) and the *initial* "before decay" concentrations (C_o) were then calculated. To estimate downstream travel times, the storm drain loading was assumed to originate at the mid-point along the segment or tributary. For tributaries, median velocities were based on measurements collected during the Tier 2 Study (CREST, 2006), BSI Study (CREST, 2008) and/or the City of Los Angeles Status and Trends monitoring.
- The difference between the potential loading and the WLA is equal to the MOS. For comparison, the percentage of potential loading reserved for the MOS is also calculated.

The magnitude and percentage of loading reserved for the MOS represents a significant component of the developed WLAs, and thus the implicit MOS is considered conservative and protective. As such, an explicit MOS is not needed.

Table 6. Magnitude of the Implicit Margin of Safety used for Dry Weather WLA Development for LA River Segments

LA River Segment	Included LA River Reach	LA River Segment for which Dry Weather Wasteload Allocations are Required		*E. coli* Loading Rate (10^9 MPN/day)			
		Upstream End	Downstream End	MS4 WLA (1)	Potential Allowable Storm Drain WLA if Decay is Included (2)	Margin of Safety (2)-(1)	% of MS4 Loading Reserved for MOS [(2)-(1)]/(2) x100%
A	1 and 2	Rosecrans Ave.	Willow St.	274	345	71	21%
B	2	Figueroa St.	Rosecrans Ave.	472	741	269	36%
C	3 and 4	Tujunga Ave.	Figueroa St.	422	640	218	34%
D	4 and 5	Balboa Blvd.	Tujunga Ave.	412	561	149	26%
E	6	Headwaters	Balboa Blvd.	29	37	8	21%

Table 7. Magnitude of the Implicit Margin of Safety used for Dry Weather WLA Development for Tributaries

Tributary	LA River Reach at Con-fluence	Tributary Length[1] (miles)	Estimated Median Water Velocity in Tributary (feet/sec)	***E. coli* Loading Rate** (10^9 MPN/day)			
				MS4 WLA (1)	**Potential Allowable Storm Drain WLA if Decay is Included** (2)	**Margin of Safety** (2)-(1)	**% of MS4 Loading Reserved for MOS** [(2)-(1)]/(2)x100%
Compton Creek	1	9	1.1 [a]	6	11	4	40%
Arroyo Seco	2	10	2.1 [b]	22	30	7	25%
Rio Hondo	2	14	0.5 [b]	1	8	7	82%
Verdugo Wash	3	10	2.4 [a]	46	60	14	23%
Burbank Western Channel	3	14	2.2 [a]	78	120	42	35%
Tujunga Wash	4	10	2.0 [b]	9	12	3	27%
Bull Creek	5	7	3.0 [a]	8	16	8	52%
Aliso Canyon Wash	6	10	1.6 [a]	21	33	11	35%
Dry Canyon	6	4	2.0 [c]	6	7	1	12%
McCoy Canyon	6	4	2.0 [c]	6	7	1	12%
Bell Creek	6	9	2.0 [c]	13	17	4	26%

1 – Tributary length based on GIS analysis.

a – Median velocity was estimated based on measurements collected by the City of LA Status and Trends monitoring program (2004-2006). Between 2 and 24 measurements were available for each tributary.

b – Median velocity was estimated based on measurements collected by (1) the City of LA Status and Trends monitoring program (2004-2006) and (2) the BSI Study (CREST, 2008). Between 7 and 11 measurements were available for each tributary.

c – Velocity measurements were unavailable for these tributaries. The median velocity from all tributary velocity measurements (n = 87 measurements) was used.

6.7 Natural Source Exclusion

Under the natural sources exclusion implementation provision of the updated bacteria objectives, after all anthropogenic sources of bacteria have been controlled such that they do not cause an exceedance of the single sample objectives, a certain frequency of exceedance of the single sample objectives shall be permitted based on the residual exceedance frequency in the specific water body. The residual exceedance frequency shall define the background level of exceedance due to natural sources. The 'Natural Sources Exclusion' approach may be used if an appropriate reference system cannot be identified due unique characteristics of the target water body. This approach is consistent with the State Antidegradation Policy (State Board Resolution No. 68-16) and with federal antidegradation requirements (40 CFR 131.12). Application of the Natural Source Exclusion to the LA River Watershed would affect the TMDL targets and thus the wasteload allocations developed herein.

Special studies conducted along Reach 2 of the LA River have identified potential non-point sources of *E. coli* that may contribute to WQO exceedances. However, loading of *E. coli* from the MS4 along Reach 2 was also shown to contribute to WQO exceedances. If the targets for this TMDL continue to be exceeded after the MS4s have reduced their loading to below the WLAs, and the WLAs have been shown to be appropriate based on review of recent data (e.g., flow rates in the LA River and tributaries), then Reach 2 may be a potential candidate waterbody for the natural sources exclusion. The process of evaluating compliance with WLAs and targets, including consideration of special studies information, is described in the Implementation Section (Section 7). After MS4 loading of *E. coli* has been reduced to below the WLA, if the responsible agency for Reach 2 (or other segment) intends to pursue a Natural Source Exclusion, it will conduct a natural sources study in order to determine its eligibility for such an exclusion. If the Natural Sources Exclusion is appropriate, a Basin Plan Amendment can be developed with stakeholder participation for Regional Board consideration.

6.8 References

Ackerman, D., K. Schiff, H. Trim and M. Mullin (2003). "Characterization of Water Quality in the Los Angeles River." Bulletin of the Southern California Academy of Sciences 102(1): 17-25.

CREST (2006). Cleaner Rivers through Effective Stakeholder-led TMDLs. Tier 2 Dry Season Bacteria Source Assessment of the Los Angeles River. Report can be found at http://www.crestmdl.org/reports/index.html. December 2006.

CREST (2008). Cleaner Rivers through Effective Stakeholder-led TMDLs. Los Angeles River Bacteria Source Identification Study: Final Report. Report can be found at http://www.crestmdl.org/reports/index.html November 2008. .

Noble, R. T., I. M. Lee and K. C. Schiff (2004). "Inactivation of indicator micro-organisms from various sources of faecal contamination in seawater and freshwater." *Journal of Applied Microbiology* 96(3): 464-472.

Sinton, L.W., C.H. Hall, P.A. Lynch and R.J. Davies-Colley (2002). Sunlight inactivation of fecal indicator bacteria and bacteriophages from waste stabilization pond effluent in fresh and saline waters. *Applied Environmental Microbiology* 68: 1122-1131.

USEPA, 2001. *Protocol for Developing Pathogen TMDLs* (1st edition). EPA 841-R-00-002.

Watson, B., S. Peene, T. Fleming and D. Ackerman (2002). "A Two-Phased Approach for Simulation of Nutrients and Pathogens in the Los Angeles River Watershed." Proceedings from StormCon.