Tetra Tech Inc.

Attachment C:
Revised RAA

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CONTENTS

1.0 MODELING SYSTEM USED FOR RAA

1.1 LSPC

The Loading Simulation Program in C++ (LSPC) was the watershed model selected to evaluate baseline hydrology and pollutant loading conditions. LSPC simulates hydrology, sediment, and pollutant generation, transformation, and transport on land, as well as fate and transport within streams (Shen et al., 2004; USEPA, 2003; Tetra Tech and USEPA, 2002). The WMMS model, which includes LSPC, was updated to improve local, more current, conditions based on recent monitoring data for the area of interest. The LSPC watershed modeling system includes Hydrologic Simulation Program FORTRAN (HSPF) algorithms and additionally integrates a geographical information system (GIS), comprehensive data storage and management capabilities, and a data analysis/post-processing system into a convenient Windows interface. The algorithms of LSPC are identical to a subset of those in the HSPF model, with some additions. LSPC is freely distributed by the U.S. Environmental Protection Agency (EPA) Office of Research and Development in Athens, Georgia, and is a component of EPA's National Total Maximum Daily Load (TMDL) Toolbox (www.epa.gov/athens/wwqtsc/index.html).

1.2 SUSTAIN

The System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN) was the model selected to evaluate and select regional BMP designs to meet water quality objectives. SUSTAIN was developed by the USEPA to support selection of BMPs in urban watersheds (USEPA, 2009; www.epa.gov/water-research/system-urban-stormwater-treatment-and-analysis-integration-sustain). The performance of stormwater control measures is simulated with a process-based continuous simulation BMP module, which routes flow and pollutant transport through identified structural BMPs. To optimize the selection and placement of BMPs, SUSTAIN iteratively runs different combinations of BMP properties, varied within a specified range, to generate a cost-effectiveness curve. The recommended BMP sizes and diversion rates to BMPs are based on the most cost-effective scenario.

2.0 BASELINE CRITICAL CONDITIONS AND REQUIRED POLLUTANT REDUCTION

2.1 WATERSHED MODEL DEVELOPMENT AND CALIBRATION

The LA County WASOP watershed model was calibrated for all of LA County, based on monitoring data from 1990 through 2006. Updates to the County WASOP watershed model used a tailored approach, with more recent, localized monitoring data, where the Los Angeles River and San Gabriel River watersheds were calibrated separately. The objective of the LSPC model development was to achieve the best model fit possible and due to the highly managed conditions in the upper reaches of the watersheds. While soil type and slope are already reflected in the hydrologic response unit (HRU) definitions at the land use level, the calibration effort focused on parameter adjustments that best captured the site-specific conditions in the respective watersheds. The LAR and SGR watersheds were calibrated separately, based on 15 flow stations and 1 water quality station in LAR and 11 flow stations and 1 water quality station in SGR (Figure 2-1). The area of calibration focused on the drainage area to the most downstream monitoring station in each watershed, which was the water quality station for both. The EWMP boundary contains the participating jurisdictions in the Rio Hondo/San Gabriel River Water Quality Group. While the City of Azusa was a member of this Water Quality Group, they have elected to continue implementing the 2016 EWMP within their jurisdictional area, and therefore, are not included as a member agency participating in this rEWMP update.

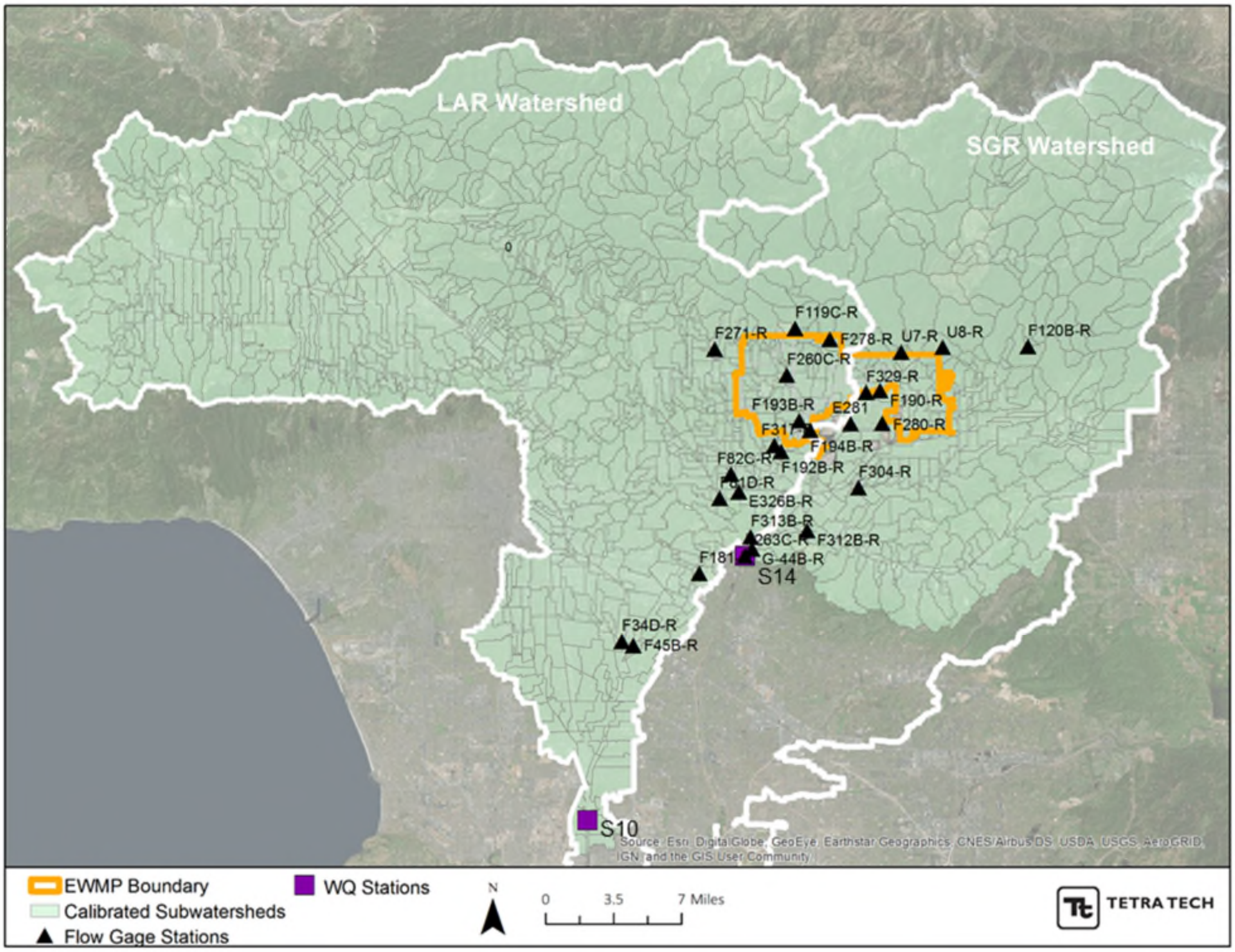


Figure 2-1. Monitoring stations for recalibration effort.

2.1.1 Hydrology Model Calibration

The calibration period was 10/1/1990 through 4/30/2012 based on the available monitoring data, obtained from LA County. Flow monitoring stations along the main stem were prioritized, and the calibration process first focused on the most upstream stations and then worked downstream. The following subsection focuses on the prioritized monitoring stations, though all available monitoring data was referenced in the calibration process. Hydrologic calibration followed the standard operating procedures for the model described in USEPA (2000), Donigian et al. (1984) and Lumb et al. (1994). An iterative approach was used to refine parameters from the WMMS set up influencing the water balance of the modeled system. Daily, monthly, seasonal, and total modeled flow volumes were compared to observed data, and error statistics were calculated for the percent difference, along with the Nash-Sutcliffe coefficient of model fit efficiency (NSE) for daily average flows. Unlike relative error on volumes, NSE (Nash and Sutcliffe 1970) is a measure of the ability of the model to explain the variance in the observed data. Values may vary from -∞ to 1.0. A value of NSE = 1.0 indicates a perfect fit between modeled and observed data, while values equal to or less than 0 indicate the model's predictions of temporal variability in observed flows are no better than using the average of observed data. The accuracy of a model increases as the value approaches 1.0 and an NSE of 0.75 or greater on monthly flows constitutes a good modeling fit for watershed applications. The baseline adjustment coefficient (Garrick et al. 1978), which is also presented, is a modified version of the NSE, but can be interpreted similarly.

The percent volume errors were then compared to recommended tolerance targets from Donigian et al. (1984) and Lumb et al. (1994). Targets are show in Table 2-1 and represent long term averages for relative error. In general, meeting these targets indicates that a model calibration can be rated as “very good”. In contrast, failure to achieve these targets does not indicate that the model is unusable, but rather indicates a need to consider the impacts of model uncertainty on decisions. Values for hydrologic parameters were set in accordance with the ranges recommended in USEPA (2000) and adjusted during calibration.

Model results were also visually compared to observed data using time series plots, and additional graphical and tabular monthly comparisons were performed. Less credence was placed in the seasonal summer and storm event summer statistics since runoff volumes are low (or non-existent) during the dry seasons, and storms are rare.

Table 2-1. Criteria for the Hydrology Calibration

Category	Recommended Criteria (%)
Error in total volume:	±10
Error in 50% lowest flows:	±10
Error in 10% highest flows:	±15
Seasonal volume error - Summer:	±30
Seasonal volume error - Fall:	±30
Seasonal volume error - Winter:	±30
Seasonal volume error - Spring:	±30
Error in storm volumes:	±20
Error in summer storm volumes:	±50
Nash-Sutcliffe efficiency statistic (NSE):	>0.75

Modified from Lumb et al., 1994 and Donigian et al., 1984

2.1.1.1 Model Calibration Locations

The HRU distribution for prioritized locations summed across soil and slope categorization are given in Figure 2-2 through Figure 2-7.

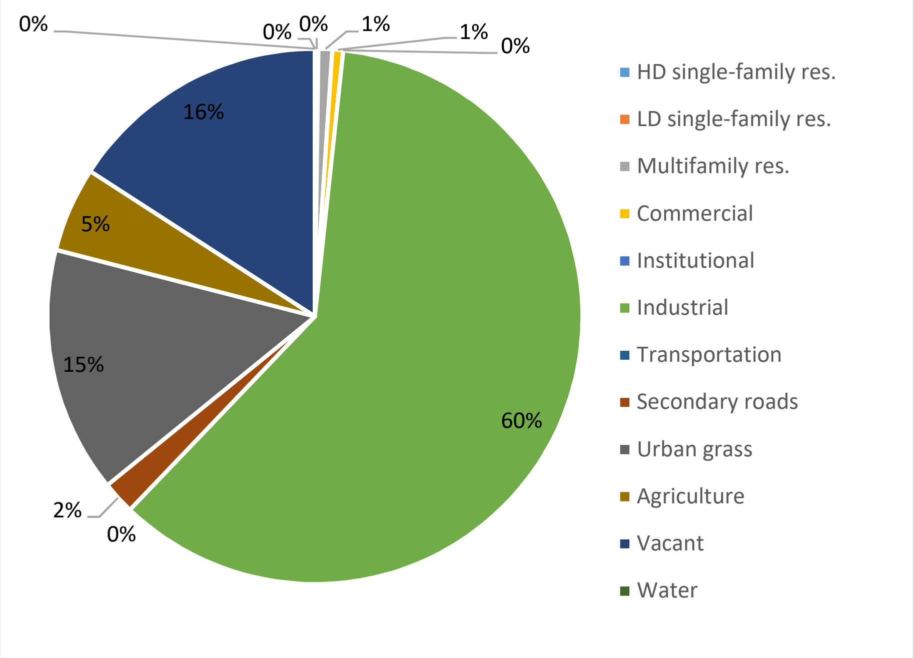


Figure 2-2. HRU Distribution at Flow Gage E326

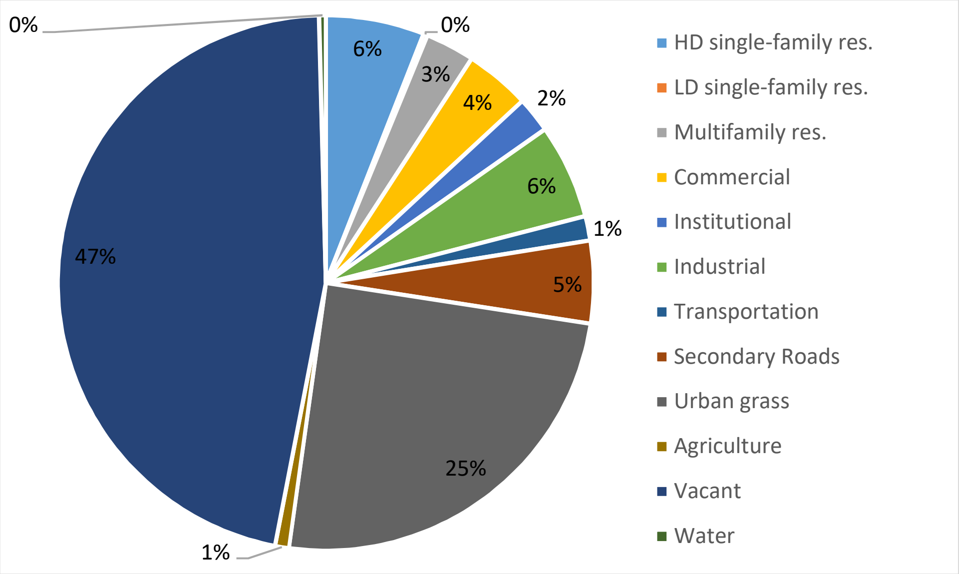


Figure 2-3. HRU Distribution at Flow Gage F194.

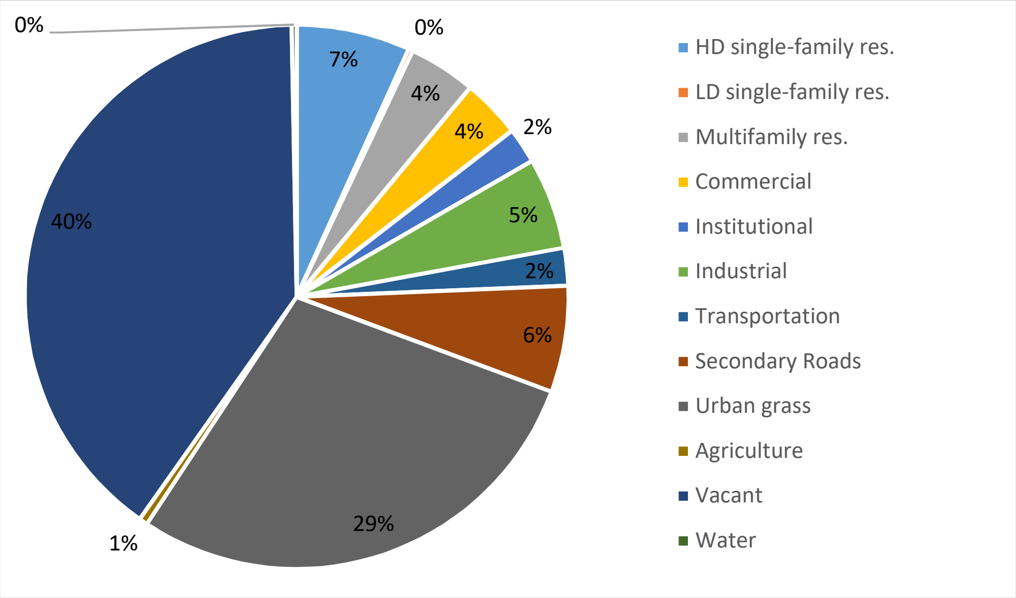


Figure 2-4. HRU Distribution at Flow Gage F319

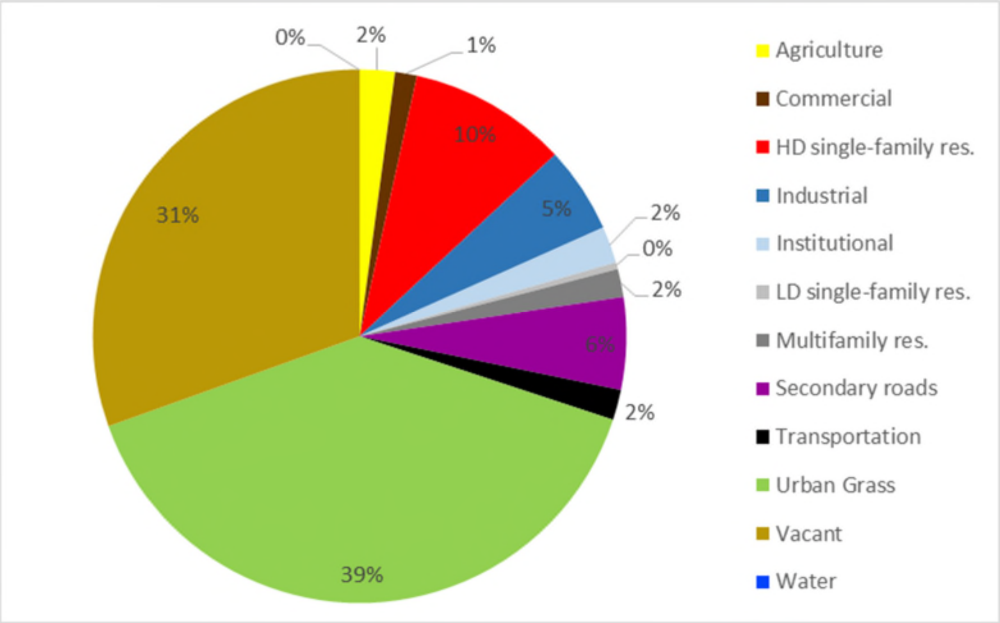


Figure 2-5. HRU Distribution at Flow Gage F329-R.

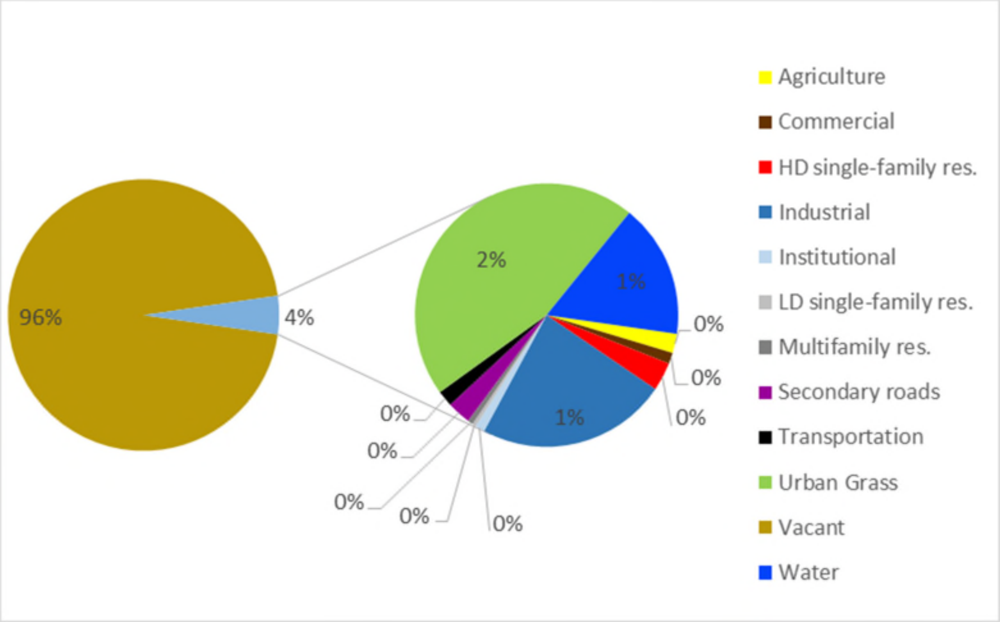


Figure 2-6. HRU Distribution at Flow Gage E281.

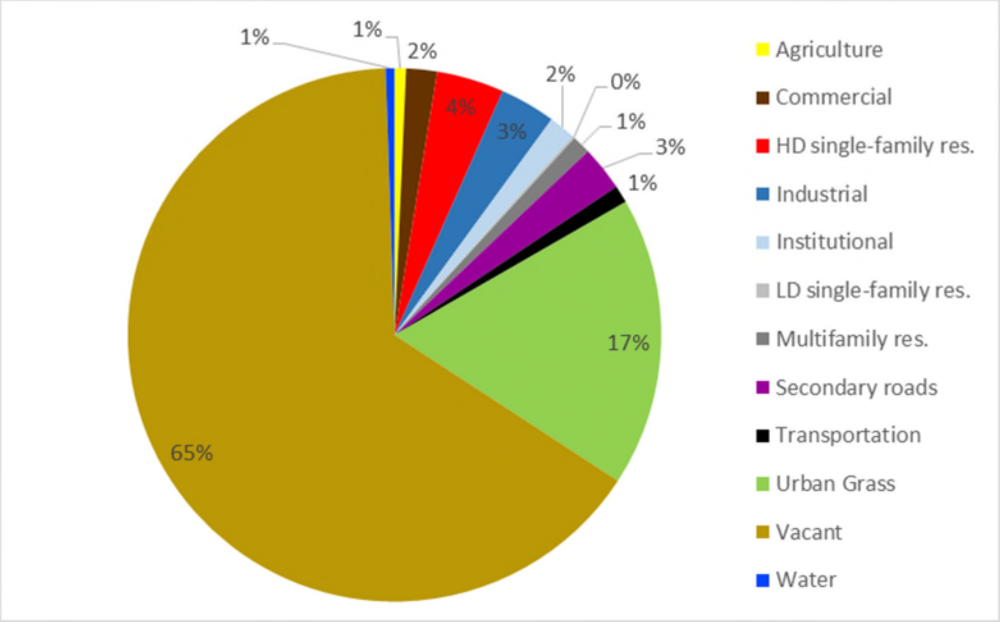


Figure 2-7. HRU Distribution at Flow Gage F263-R.

A review of the available stream monitoring data yielded the following observations:

Rio Hondo

- E326 is a flow monitoring gage located on the Rio Hondo below the confluence with Arcadia Wash. The land use distribution is predominantly Industrial (60%). Larger pervious areas include Vacant (15%), Urban Grass (15%) and Agriculture (5%). Low base flows are observed at this location, with peak flows associated with rainfall events. The largest flow event occurs in January 2005, following a string on rainfall over the previous 14 days. These high flow events appear to primarily be influenced by surface runoff from the impervious areas in the watershed.

- F194 is a flow monitoring gage located on Sawpit Wash above Peck Road Park Lake. A significant portion of the land use distribution is Vacant (47%). The next largest landuse classification is Urban Grass (25%). Impervious areas account for a smaller portion of the area, the largest being High-density Single-family Residential and Industrial at 6% each. Stream flows appear to primarily respond to rainfall runoff, however a small number of events (one large and 3-4 smaller events) in 2003 occur without the initiation of rainfall. Given the large pervious area at this location we expect greater influence of subsurface flows, however events such as this are likely due to manually/controlled releases, for which we do not have the appropriate information to represent in the model. The seasonal summer volume error and summer storm volume error are significantly impacted by these events, which are expected to be low during the dry season, thus indicating model under prediction. However, 2003 is the only year for which this observation is made, thus we do not expect this to be a reoccurring condition.

- F319 is a flow monitoring gage located on the Los Angeles River below Wardlow River Road and is co-located with an available water quality data monitoring dataset. The land use distribution is predominantly Vacant (40%), with additional pervious area classified as Urban Grass (29%). High-density Single-family Residential (7%), Secondary Roads (6%) and Industrial (5%) are the larger impervious areas identified. A sustained, consistent base flow is observed at this location, with peak flows primarily in response to rainfall. Flow rates are significantly higher at this location, further downstream the Los Angeles River, with a large drainage area.

San Gabriel

- F329-R is a flow monitoring gage located on Bradbury channel, an unmanaged watershed located upstream of the Santa Fe Dam. The land use distribution is predominantly Vacant (31%) and Urban Grass (39%) with the largest impervious areas identified as High-density Single-family Residential (10%), Secondary Roads (6%), and Industrial (5%). Stream flow in the channel shows a rainfall runoff response where rainfall events are associated with peak flows that appear to be primarily surface run off exhibiting quick recession with little or no base flow or inter flow. This indicates that the impervious cover in the watershed is the dominant factor affecting hydrologic response.
- E281 is a flow monitoring gage located on the San Gabriel River below the Santa Fe Dam and has been selected as a project compliance location. The land use distribution for this location is almost entirely Vacant (96%), with the remaining area made up of Urban Grass (2%), Water (1%), and Industrial (1%). This location is highly managed with flow being driven by dam releases, which are intermittent and generally below 100 cfs. There are two major rainfall events in the winter of 2005 that showed recorded flows of 14,586 and 10,317 cfs on January 10th and February 21st, respectively. Matching hydrologic response at this location is highly dependent on the proper representation of the Santa Fe Dam.
- F263C-R is a flow monitoring gage located on the San Gabriel River below the Whittier Narrows Dam and is co-located with an available water quality data monitoring dataset. The land use distribution is predominantly Vacant (65%) and Urban Grass (17%) with the largest impervious areas identified as High-density Single-family Residential (4%), Secondary Roads (3%), and Industrial (3%). This location is highly managed with flow being driven by dam releases, which are more frequent and greater than the Santa Fe Dam, typically between 100 and 1000 cfs. Similar to what is observed at gage E281, there are two major rainfall events in the winter of 2005. The events at this downstream location result in significantly smaller flows, however, with stream flow measured at 4,820 and 5,803 cfs on January 14th and February 21st, respectively. That there is a greater contributing watershed area, but smaller flows for the two peak events indicates that the operation of the Whittier Narrows Dam is the dominant factor in hydrologic response at this location. The reservoir is attenuating peak flows to a significant degree by allowing reservoir storage to infiltrate and evaporate, while also maintaining greater and more frequent intermediate flows.

Reservoir Representation

The representation of reservoirs and spreading grounds in the study watersheds was first configured in the WASOP model as detailed in the Los Angeles County Watershed Model Configuration and Calibration Report (Tetra Tech 2010a). Both watersheds have uninhabited mountains in the headwaters, with a number of dams at the edge of the mountains. The user-specified FTables developed in the original WMMS to represent these dams were found to be inaccurate based on more recent monitoring data. An iterative approach was again used to adjust these FTables to improve the simulation relative to the observed flows. For the LAR watershed model adjustments were made to FTables to improve representation of Eaton Wash Dam, Santa Anita Dam, and Sawpit Wash Dam.

The Whittier Narrows Dam on the San Gabriel River was represented to better calibrate the hydrology at the F263 location. The Whittier Narrows Dam is operated by the Army Corps of Engineers Los Angeles District, which provides the following description of the San Gabriel River side of the dam.

Whittier Narrows Dam provides water conservation storage and is also the central element of the Los Angeles County Drainage Area (LACDA) flood control system. The purpose of the project is to collect runoff from the uncontrolled drainage areas upstream along with releases into the San Gabriel River from Santa Fe Dam. If the inflow to the reservoir exceeds the groundwater recharge capacity of the spreading grounds along the Rio Hondo or the bed of the San Gabriel River downstream, this water is stored temporarily in a water conservation pool. The San Gabriel outlet has nine large gates installed on top of a spillway with one gate is normally open about 0.5 feet (0.15 meters) with the remaining gates closed. The reservoir is normally empty and a "crossover weir" within the reservoir keeps the flows from the Rio Hondo and the San Gabriel River separated. If the water conservation pool on either side of the reservoir is exceeded, discharges on the San Gabriel side can be increased to approximately 5000 cfs (142 cms). The San Gabriel outlet has automatic spillway gates. When the pool in the reservoir exceeds flood control storage these gates will begin to open automatically.

The design specifications given for the San Gabriel side Flood Control pool are shown in Table 2-2. These design elements were used to develop an F-table for a trapezoidal representation of the reservoir that included losses representing spreading ground infiltration and overflows of the crossover weir. In addition, two stages of discharge were represented, one at the Water Conservation Pool Depth and a one at the Flood Control Pool Depth to achieve a better model fit.

Table 2-2. San Gabriel River Whittier Narrows Dam Design Specifications

Design Component	Unit	Value
Depth (to top) of Spillway Gate	ft	29
Water Conservation Pool Depth	ft	13.5
Flood Control Pool Depth	ft	28.5
Total Height	ft	39
Water Conservation Pool Area	ac	71
Water Conservation Pool Volume	ac-ft	387
Spillway Gate Dimensions	ft	50 x 29

Santa Fe Flood Control Basin Diversion

The LA River watershed in the original WMMS was notably missing a diversion from the Santa Fe Flood Control Basin. The major inflows to Peck Road Park Lake include Sawpit Wash, Santa Anita Wash, and this diversion from the Santa Fe Flood Control Basin. Flow data was obtained for this diversion from the stream gage in the Santa Fe Diversion Channel and added as a point source to the subbasin containing Peck Road Park Lake in the recalibrated model. From 1991 – 2012 the average volume of water diverted to Peck Road Park Lake from the Santa Fe Diversion was 9,756 acre-ft/yr. This has a considerable influence on the hydrology and water quality in the downstream watershed.

2.1.1.2 Hydrology Results

The model calibration covered the period of record for each monitoring location as shown in Table 2-3 and Table 2-4. The entire modeling time period was selected for calibration as a means of ensuring that the models captured the range of hydrologic conditions in watersheds where wet, dry, and average years are all properly represented.

Table 2-3. Los Angeles River Flow Monitoring Locations

Station ID	Station Description	Data Record	Record Count
E326	Rio Hondo below Garvey	10/1/2001 – 4/30/2012	4,865
F194	Sawpit Wash below Live Oak Avenue	10/1/2000 – 4/30/2004	1,308
F319	Los Angeles River below Wardlow	5/1/2001 – 4/30/2012	4,018

Table 2-4. San Gabriel River Flow Monitoring Locations

Station ID	Station Description	Data Record	Record Count
F329-R	Bradbury Channel Below Central Avenue	10/1/2001–4/30/2012	3,865
E281	San Gabriel River below Santa Fe Dam	12/1/1999–4/30/2012	4,484
F263C-R	San Gabriel River below S. G. River Parkway	10/1/1996–4/30/2012	5,508

An initial review of model simulated hydrology performance showed a need to reduce low flows, increase storm flows, and improve total volume errors. Model parameters adjusted to achieve those performance areas for the SGR watershed included the baseflow evapotranspiration coefficient (BASETP), interflow (INTFW), and upper zone nominal storage (UZSN). The key parameters adjusted for the LAR watershed included those that influence the deep storage (DEEPFR), lower and upper zone storage (LZSN and UZSN), infiltration (INFILT), interflow (INTFW), evaporation (BASETP, and LZETP), and irrigation demand (Irrigation Constant ET Coefficient). After parameter adjustment, an overall assessment of the hydrology calibration was done to give a focused overview of its performance. This assessment used the quantitative metrics presented in Table 2-5 applied to critical hydrologic measures for the Los Angeles County watershed models for the model calibration time period. Those critical measures include: total volume, error in the 10 percent highest flows, and the Nash-Sutcliffe efficiency statistic (NSE). Together these metrics are indicators for the overall water budget, critical wet-periods, and overall monthly fit of the model to observed conditions, respectively. Calibration summaries of the watershed hydrology include, critical hydrology calibration metrics (Table 2-5) and time series and regression plots comparing modeled and observed average monthly flows for the calibration time period are shown in Figure 2-8 through Figure 2-13.

For the model calibration time period all measures at station E326 are within the target criteria, with the exception of the 50% lowest flow volumes. At station F194 the total volume falls just outside the target criteria and a number of the other statistics fall outside the recommended criteria as well. Overall summer volumes are under-predicted, while winter and spring volumes are over-predicted by the model. However, the 10% highest flows volumes and storm volumes fall within the target criteria and there is a reasonable NSE. At station F319 the total volume falls just above the target criteria, whereas the 10% highest flows is further outside the criteria. However, the error in storm volumes is lower and within the criteria, at 15.29 percent error. The error in 10% highest flows could not be further improved without sacrificing the reasonable NSE value at this station. For the San Gabriel River watershed stations, all critical metrics are met except for the NSE at F329-R and F263C-R. All sites show a generally good agreement for both the total volume and error in the 10 percent highest flows metric, where both measures are met for all locations. The model also captures peak stormflows well, with the only notable miss being for storm events in February 2005 at F329-R.

Table 2-5. Overall calibration assessment for critical hydrology metrics (calibration time period)

Station ID	Station Description	Error in total volume	Error in 10% highest flows	NSE
E326	Rio Hondo below Garvey	4.97	-11.11	0.723
F194	Sawpit Wash below Live Oak Avenue	13.71	3.76	0.626
F319	Los Angeles River below Wardlow	11.33	32.90	0.729
F329-R	Bradbury Channel Below Central Avenue	-0.87	1.57	0.587
E281	San Gabriel River below Santa Fe Dam	-9.45	-8.09	0.790
F263C-R	San Gabriel River below S. G. River Parkway	-0.83	1.28	0.548

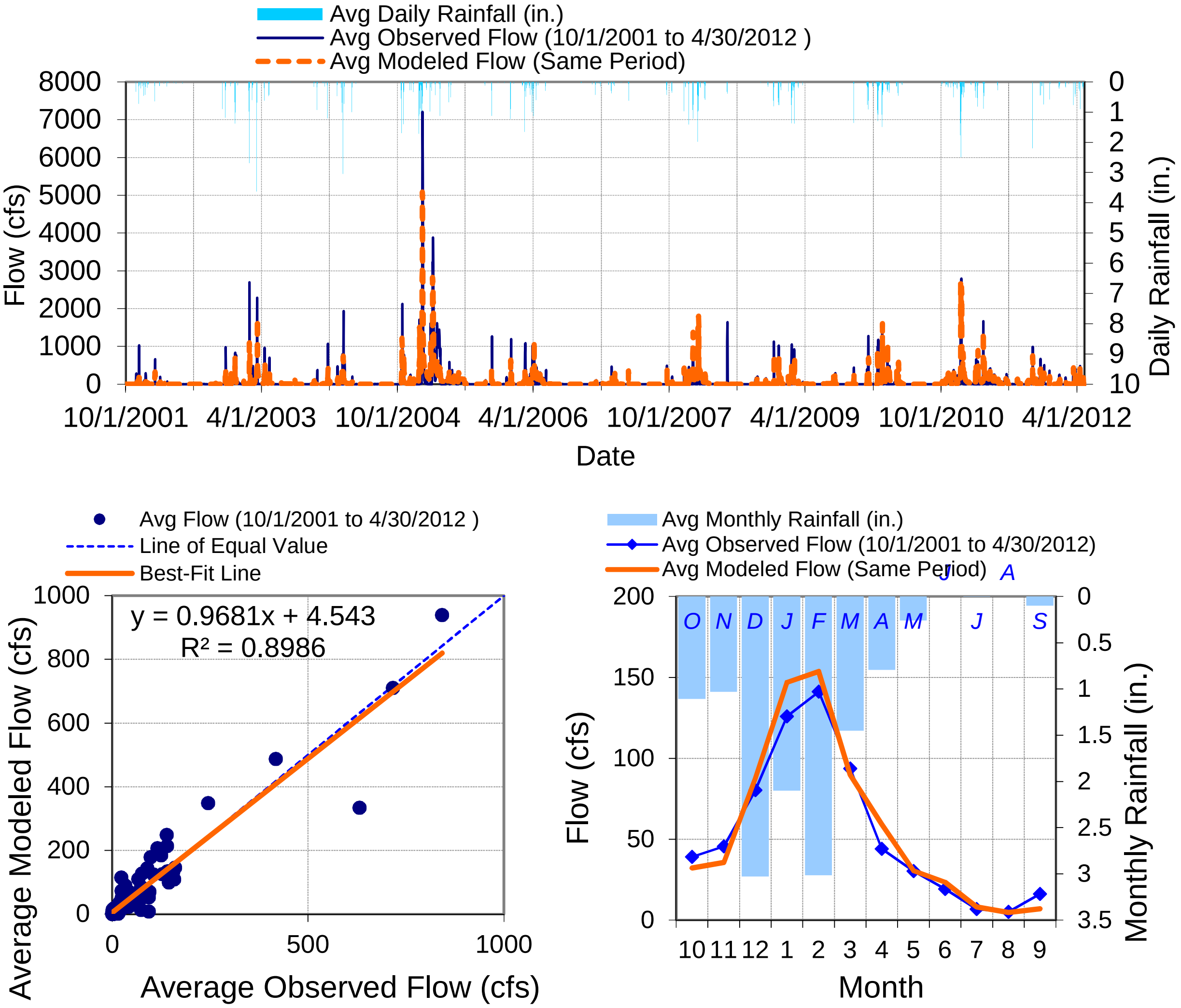


Figure 2-8. Daily flow: Outlet 6137 vs E326 Rio Hondo below Garvey.

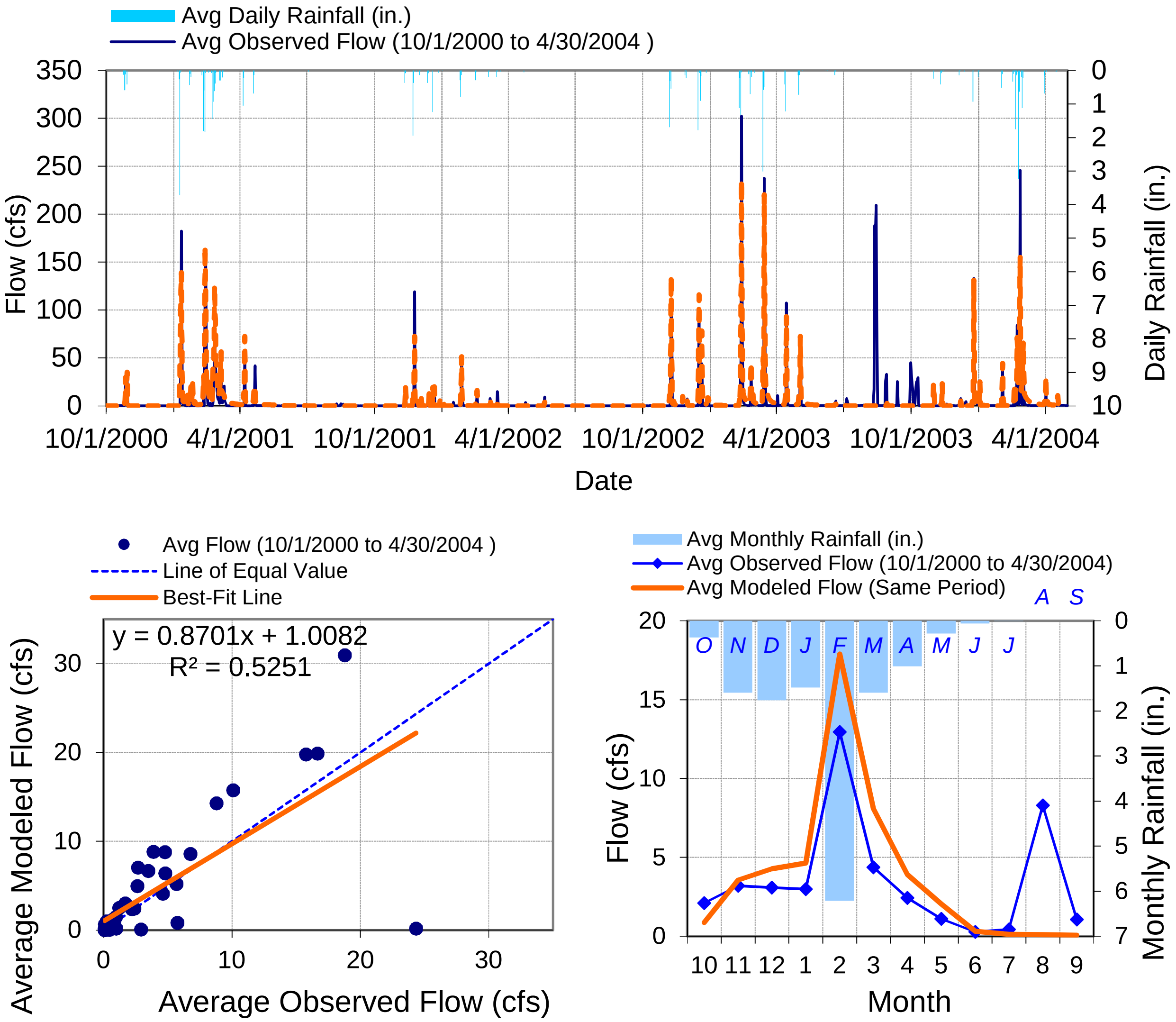


Figure 2-9. Daily flow: Outlet 6302 vs F194 Sawpit Wash below Live Oak Avenue.

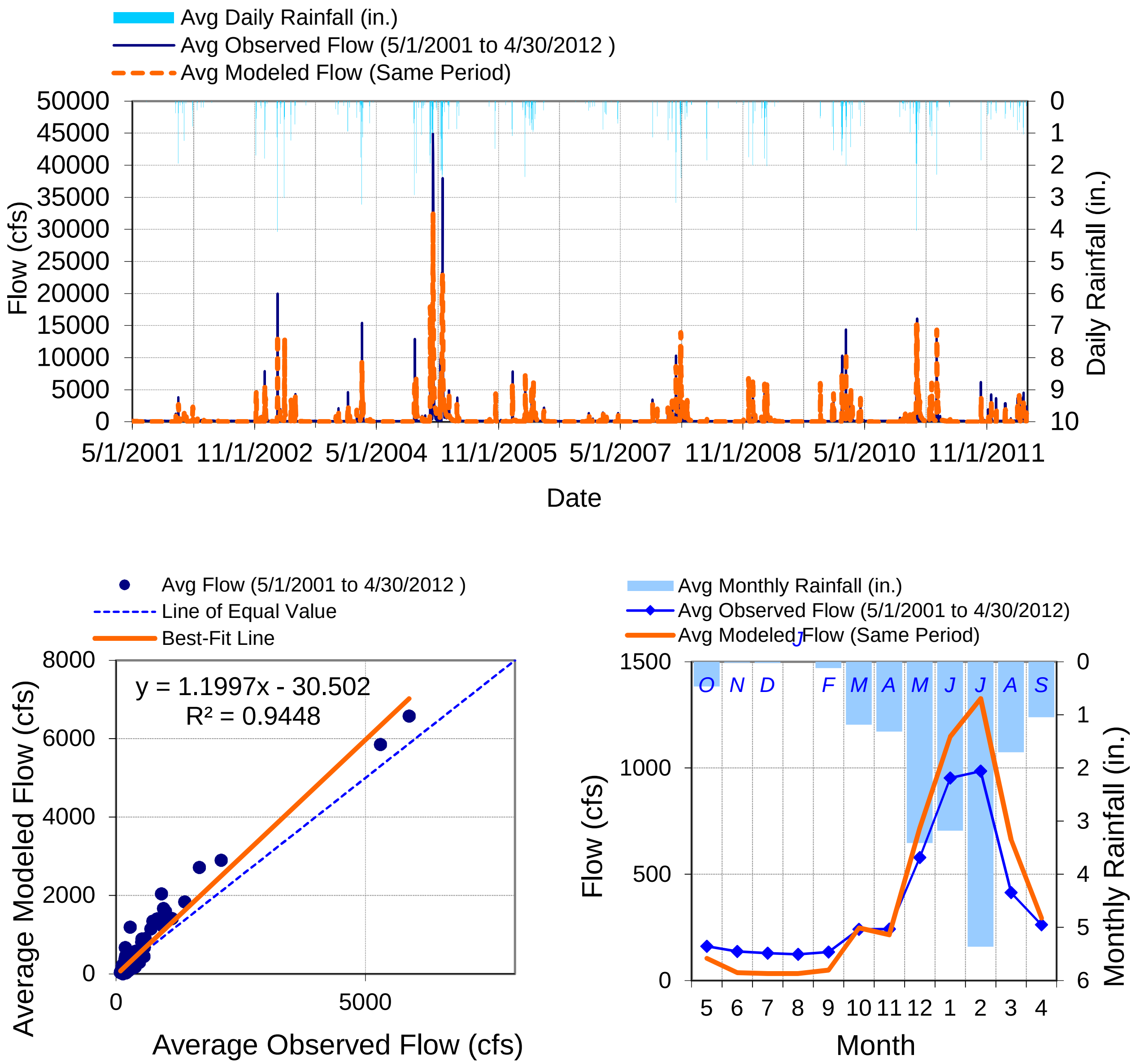


Figure 2-10. Daily flow: Outlet 6006 vs F319 Los Angeles River below Wardlow.

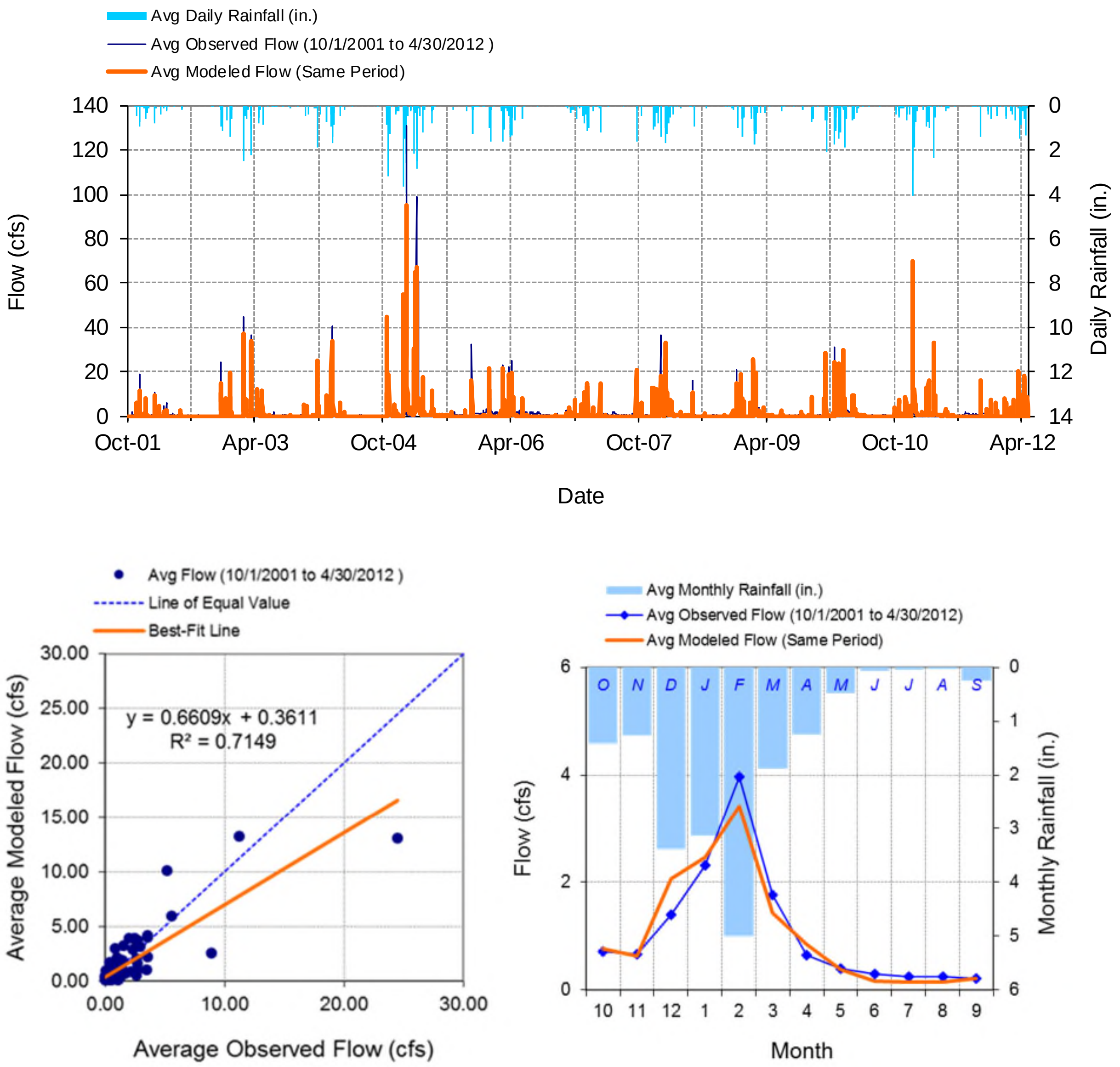


Figure 2-11. Mean daily flow: Outlet 5250 vs F329-R Bradbury Channel below Central Avenue.

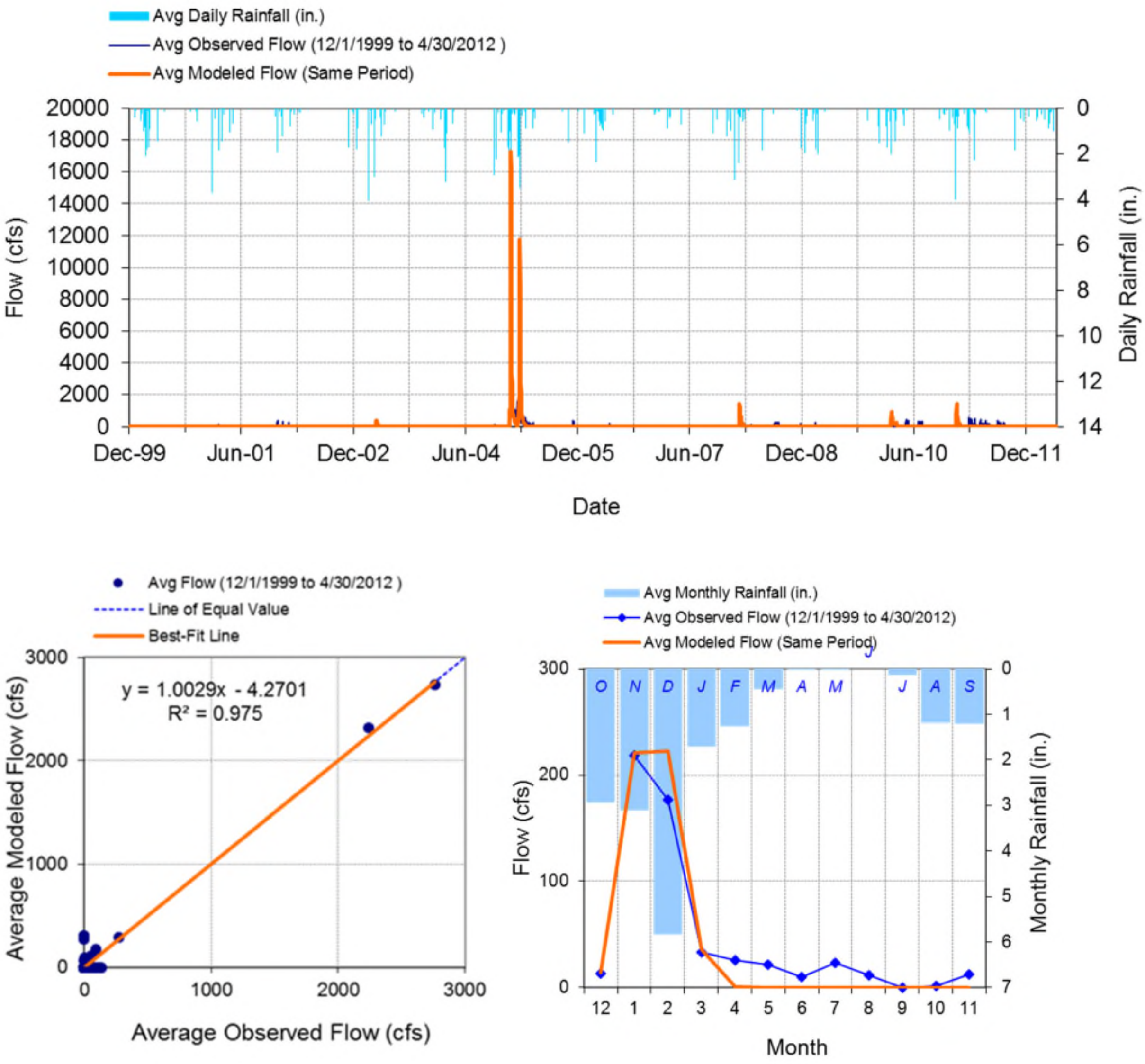


Figure 2-12. Mean daily flow: Outlet 5244 vs E281 San Gabriel River below Santa Fe Dam.

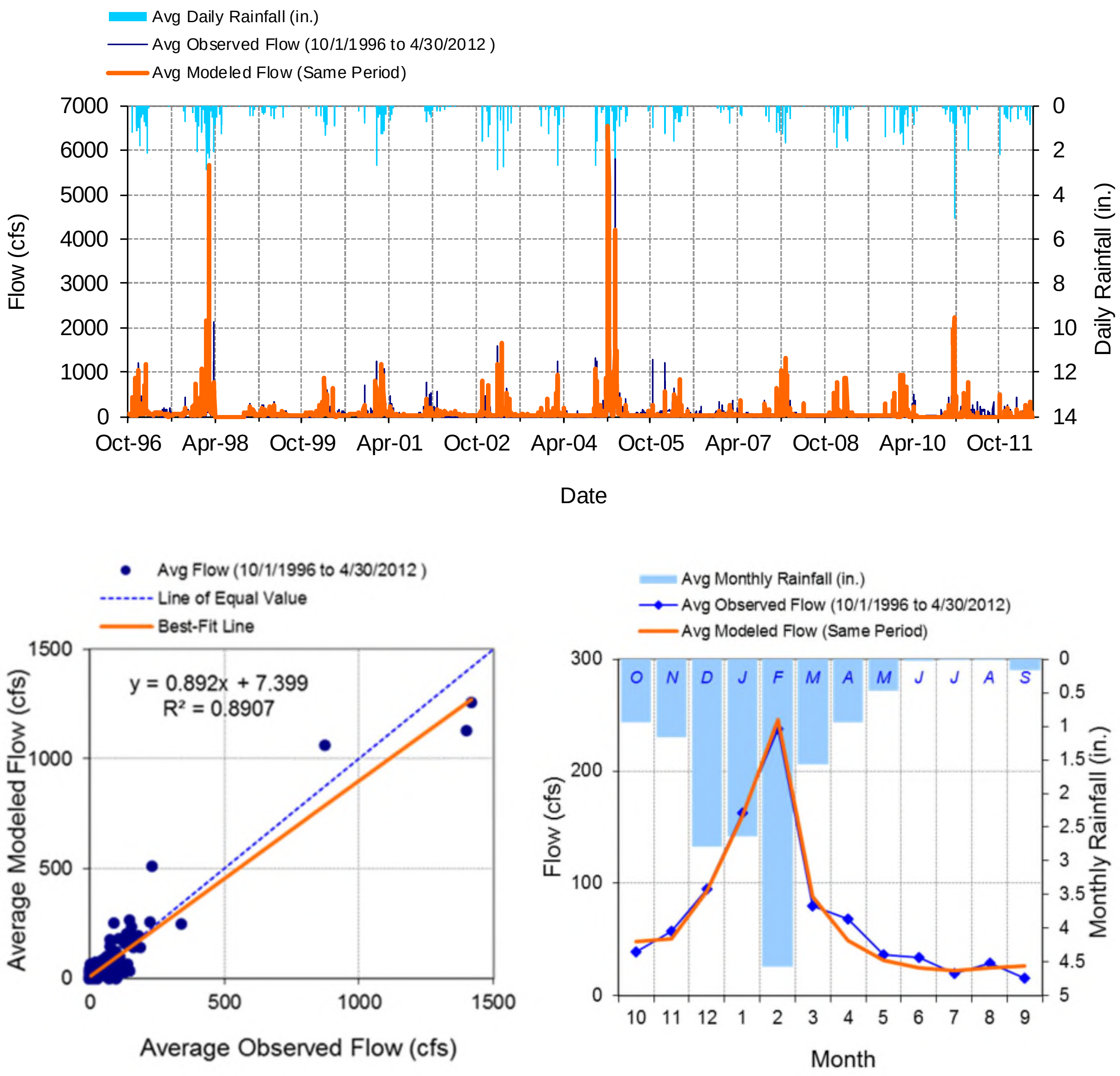


Figure 2-13. Mean daily flow: Outlet 5147 vs F263C-R San Gabriel River below S.G. River Parkway.

2.1.2 Watershed Water Quality Model

Water quality simulations build upon the calibrated model hydrology. Pollutant loads were simulated as sediment associated, where metals loading is simulated as associated with the processes of sediment erosion and transport when runoff due to rainfall events or irrigation water application occurs. The updated LSPC model for this project was set up to simulate the source, transport, and fate of sediment and three metals, copper, lead, and zinc. Delivery of pollutants through subsurface pathways (i.e., interflow and groundwater) was also represented. Initial water quality parameterization built upon the previous regional WASOP watershed modeling (Tetra Tech 2010b).

2.1.2.1 Water Quality Calibration

The F319 monitoring location on the Los Angeles River below Wardlow included available water quality data at Mass Emission Station S10. The F263C-R monitoring location on the San Gabriel River below the Whittier Narrows Dam included available water quality data at Mass Emission Station S14. Table 2-6 and Table 2-7 lists the modeled parameters and the available monitoring data and period of record for collected flow weighted concentrations.

Table 2-6. Water quality data summary for S10.

Model Constituent	Date Range	Sample Count	Avg. Conc.	Conc. Unit
TSS	12/9/2006 – 4/26/2012	61	337.21	mg/L
Copper	12/9/2006 – 3/17/2012	22	81.66	µg/L
Lead	12/9/2006 – 3/17/2012	22	77.20	µg/L
Zinc	12/9/2006 – 3/17/2012	22	507.43	µg/L

Table 2-7. Water quality data summary for S14

Model Constituent	Date Range	Sample Count	Avg. Conc.	Conc. Unit
TSS	12/9/2006–4/26/2012	59	91.71	mg/L
Copper	12/9/2006–3/17/2012	21	22.85	µg/L
Lead	12/9/2006–3/17/2012	21	10.38	µg/L
Zinc	12/9/2006–3/17/2012	21	91.5	µg/L

LSPC parameter values developed for the previous WASOP watershed modeling studies (Tetra Tech 2010b) served as a starting point for the model HRUs in the current effort. The model simulates the erosion and transport of sediment and pollutant generation is considered sediment associated, thus pollutant runoff and delivery is tied to simulated sediment loads. Delivery of pollutants through subsurface pathways (i.e., interflow and groundwater) is also represented. Model output generated using this initial setup were then compared to the available metals monitoring data to determine if the timing and relative magnitude of concentrations were the same. Further model calibration used the following comparisons to support the assessment of model output and performance:

Pairwise comparison of simulated and observed loads with linear regression slope values to show model fit.

Time series plots of simulated and observed concentrations at each calibration location**.** The time series plots are useful for making a general comparison of the order-of-magnitude between observed and simulated values.

Simulated and observed land use load/EMC values. These comparisons ensure that the land based source loading is being represented in a reasonable fashion.

Calibration of the LSPC water quality model involved two major components. The first was comparing simulated and observed instream sediment concentrations and loads at the selected monitoring location. Using an iterative approach, sediment parameters were first adjusted, including those that influence the build-up, detachment, and washoff of sediment (KSER, JSER, ACCSDP, REMSDP), instream sediment transport (KSAND/TAUCD, EXPSND/TAUCS), as well as subsurface background concentrations of sediment (SED_IFWO, SED_AGWO). Pairwise comparison, time series, and load duration curve plots for simulated and observed TSS are shown in Figure 2-14 through Figure 2-19 and a comparison of literature and simulated unit-area loads is presented in Table 2-8 and Table 2-9. Simulated land use sediment load values are notable lower than literature values. However, this difference is due to prioritizing site-specific information on EMCs by land use-based sources of trace metals sampled in Los Angeles sites from 2000 through 2005, discussed further below (SCCWRP, 2007).

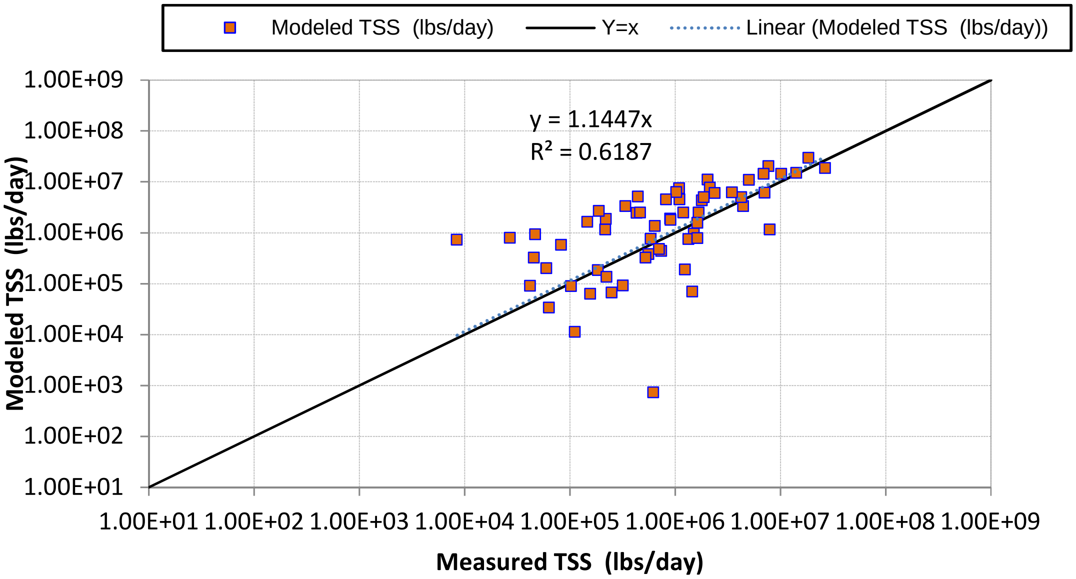


Figure 2-14. Pairwise comparison of simulated and observed TSS loads at S10.

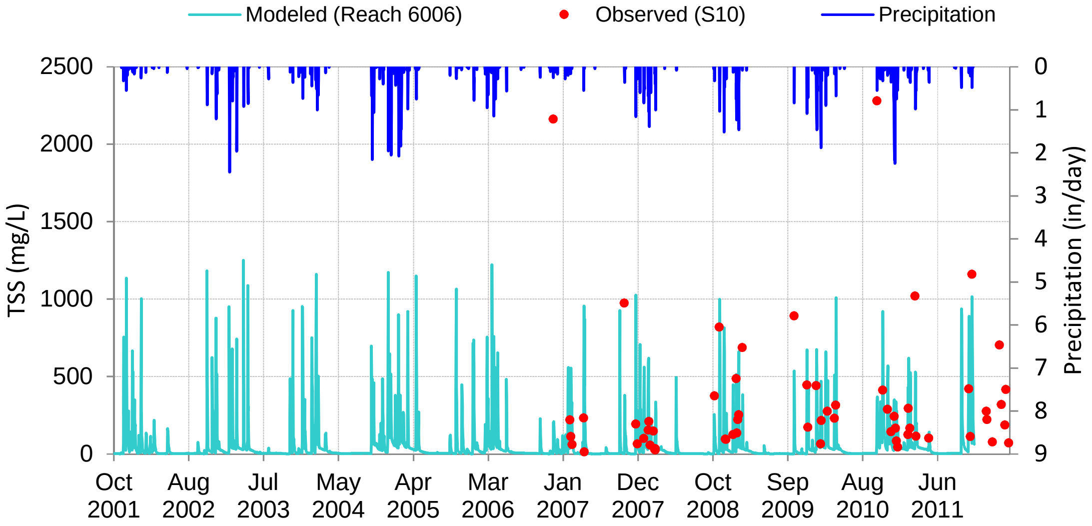


Figure 2-15. Time series comparison of simulated and observed TSS concentrations at S10.

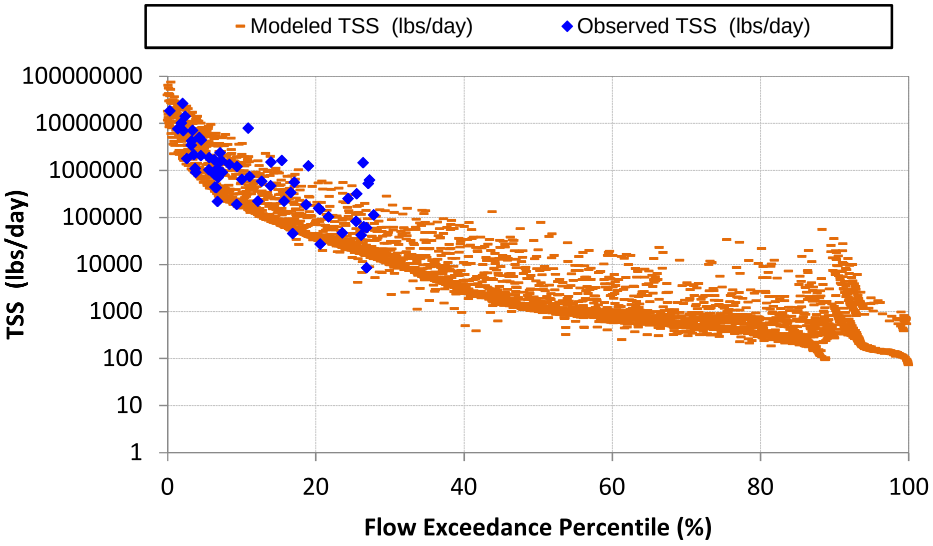


Figure 2-16. Load duration curve comparison of simulated and observed TSS loads at S10.

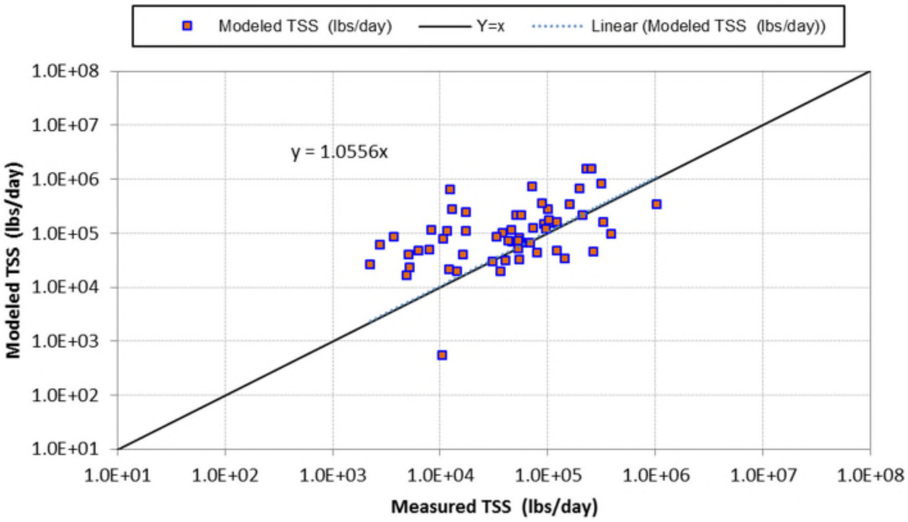


Figure 2-17. Pairwise comparison of simulated and observed TSS loads at S14.

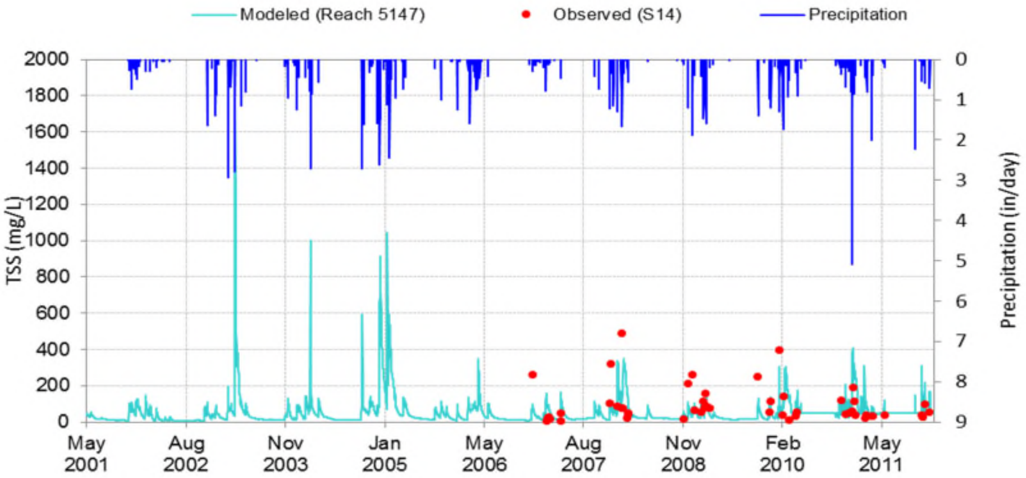


Figure 2-18. Time series comparison of simulated and observed TSS concentrations at S14.

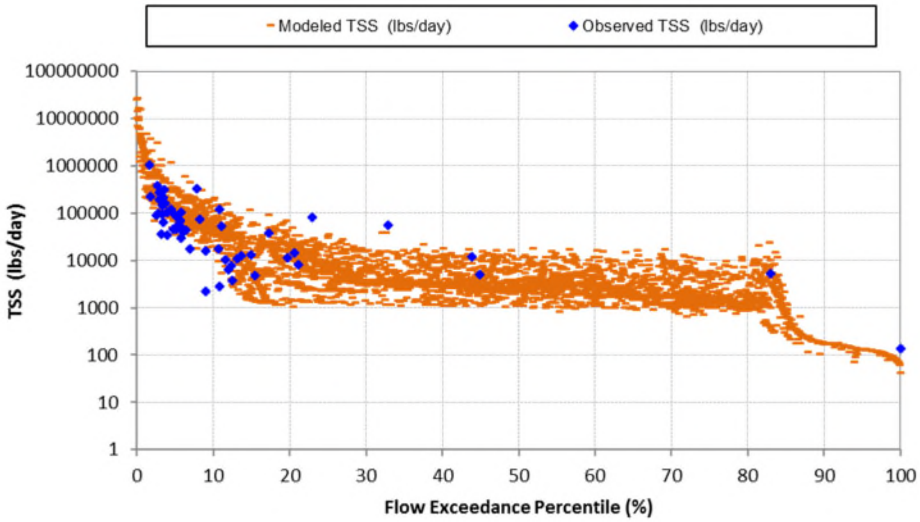


Figure 2-19. Load duration curve comparison of simulated and observed TSS loads at S14.

Table 2-8. Comparison of simulated and literature[1] average annual sediment loads by HRU/land use at S14.

Model HRU	Area (ac)	Reference Land Use	Reference Load (tons/ac)	Simulated Load (tons/ac)
HD single-family residential	35,771	Urban	0.2 –1.0	0.761
LD single-family residential moderate slope	921			0.737
LD single-family residential steep slope	491			0.770
Multifamily residential	21,141			0.704
Commercial	18,622			0.934
Institutional	11,222			0.915
Industrial	28,757			0.882
Transportation	11,789			0.992
Secondary roads	33,456			0.982
Urban grass Irrigated	115,273			0.123
Urban grass Non-irrigated	36,040			0.081
Agriculture moderate slope B	566	Conservation Tillage	0.5 –4.0	0.110
Agriculture moderate slope D	2,165			0.152
Vacant moderate slope B	2,518	N/A	N/A	0.087
Vacant moderate slope D	7,036			0.085
Vacant steep slope A	1,077			0.069
Vacant steep slope B	61,370			0.187
Vacant steep slope C	55,520			0.184
Vacant steep slope D	83,532			0.173

[1] Values taken for BASINS Technical Note 9 (USEPA 2006)

Table 2-9. Comparison of simulated and literature[1] average annual sediment loads by HRU/land use at S14.

Model HRU	Area (ac)	Reference Land Use	Reference Load (tons/ac)	Simulated Load (tons/ac)
HD single-family residential	11,729	Urban	0.2 –1.0	0.238
LD single-family residential moderate slope	251			0.233
LD single-family residential steep slope	189			0.229
Multifamily residential	3,264			0.239
Commercial	5,373			0.266
Institutional	4,610			0.265
Industrial	9,688			0.262
Transportation	3,048			0.27
Secondary roads	7,787			0.275
Urban grass Irrigated	37,650			0.443
Urban grass Non-irrigated	12,649			0.244
Agriculture moderate slope B	75	Conservation Tillage	0.5 –4.0	0.455
Agriculture moderate slope D	1,915			0.796
Vacant moderate slope B	1,205	N/A	N/A	0.412
Vacant moderate slope D	3,894			0.571
Vacant steep slope A	8,946			0.322
Vacant steep slope B	26,249			0.588
Vacant steep slope C	33,253			2.327
Vacant steep slope D	113,799			2.657

[1] Values taken for BASINS Technical Note 9 (USEPA 2006)

Next, select metal parameters were adjusted, including the instream decay rate (Decay), subsurface concentrations (IOQC and AOQC), atmospheric deposition (ADDC and AWDC), surface accumulation and storage (ACQOP and SQOLIM), and rate of removal by surface runoff (WSQOP). Atmospheric deposition parameters were selected based on measured atmospheric deposition dry flux and EMCs at sites in Los Angeles (SCCWRP, 2006). Subsurface concentrations were calibrated to match general dry-weather conditions. Adjustment to the land based metals loads was achieved by increasing or decreasing the sediment potency factor for each HRU, which defines the sediment pollutant concentration as lb/ton. Potency factors for land use pollutant contributions were adjusted based on EMCs by land use-based sources of trace metals sampled in Los Angeles sites from 2000 through 2005 (SCCWRP, 2007). This site-specific information, show in Figure 2-26, was prioritized over the literature values from the RAA Guidelines. Like for sediment the first calibration step was comparing simulated and observed instream sediment concentrations and loads. Pairwise comparison, time series, and load duration curve plots for simulated and observed metals are shown in Figure 2-20 through Figure 2-25, respectively and a comparison of literature and simulated EMCs for select HRUs is presented in Table 2-10 and Table 2-11.

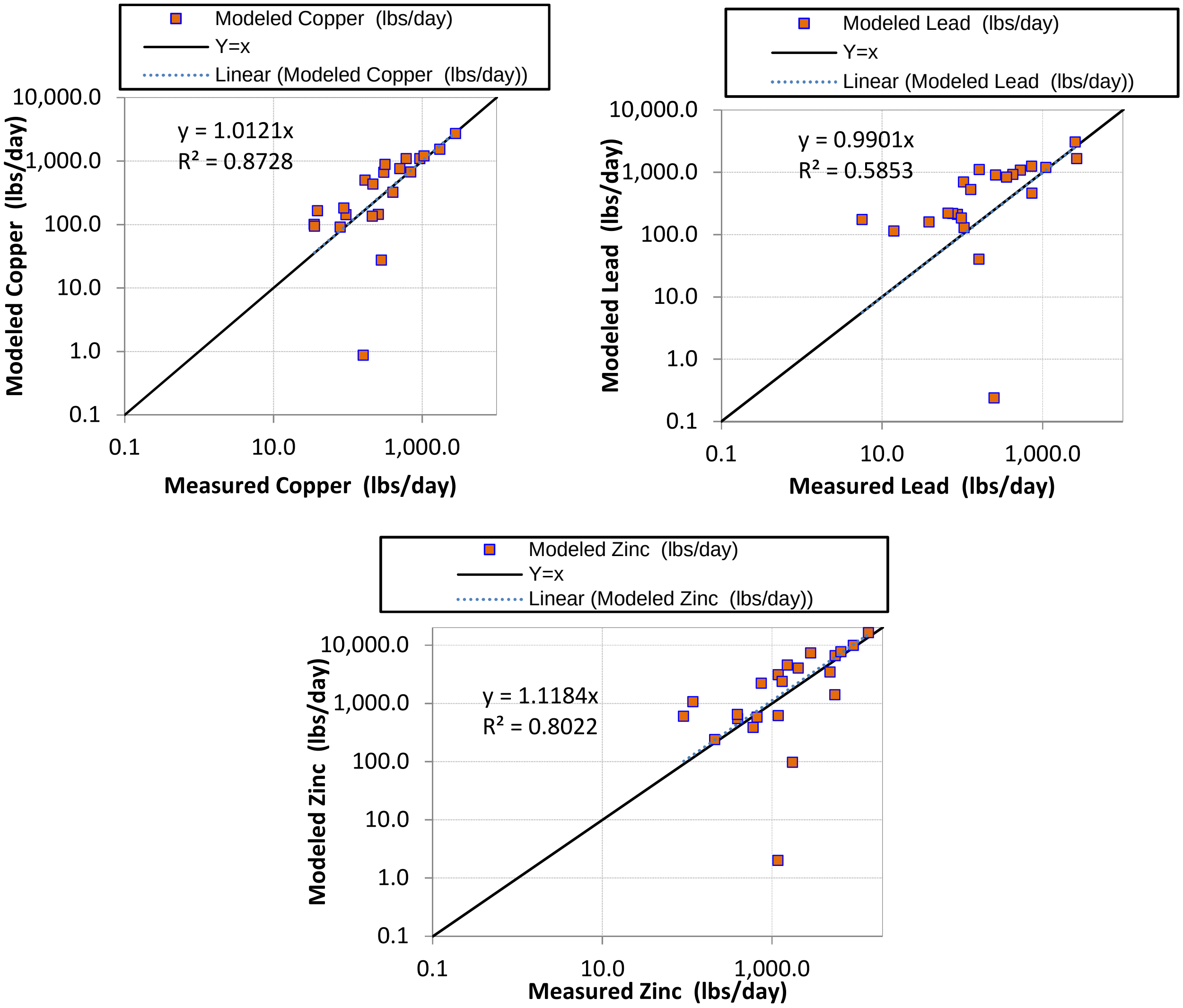


Figure 2-20. Pairwise comparison of simulated and observed metal loads at S10.

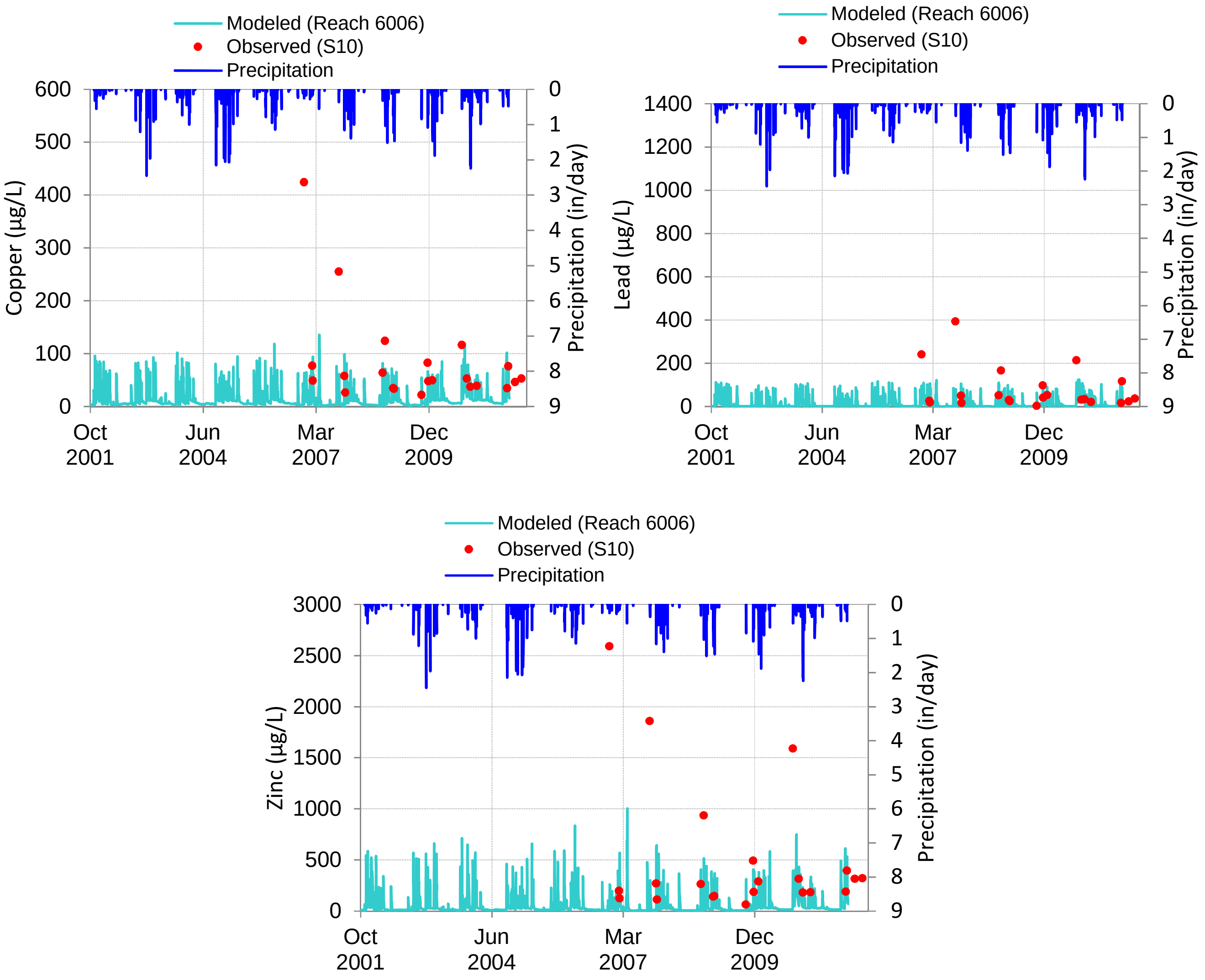


Figure 2-21. Time series comparison of simulated and observed metals concentrations at S10.

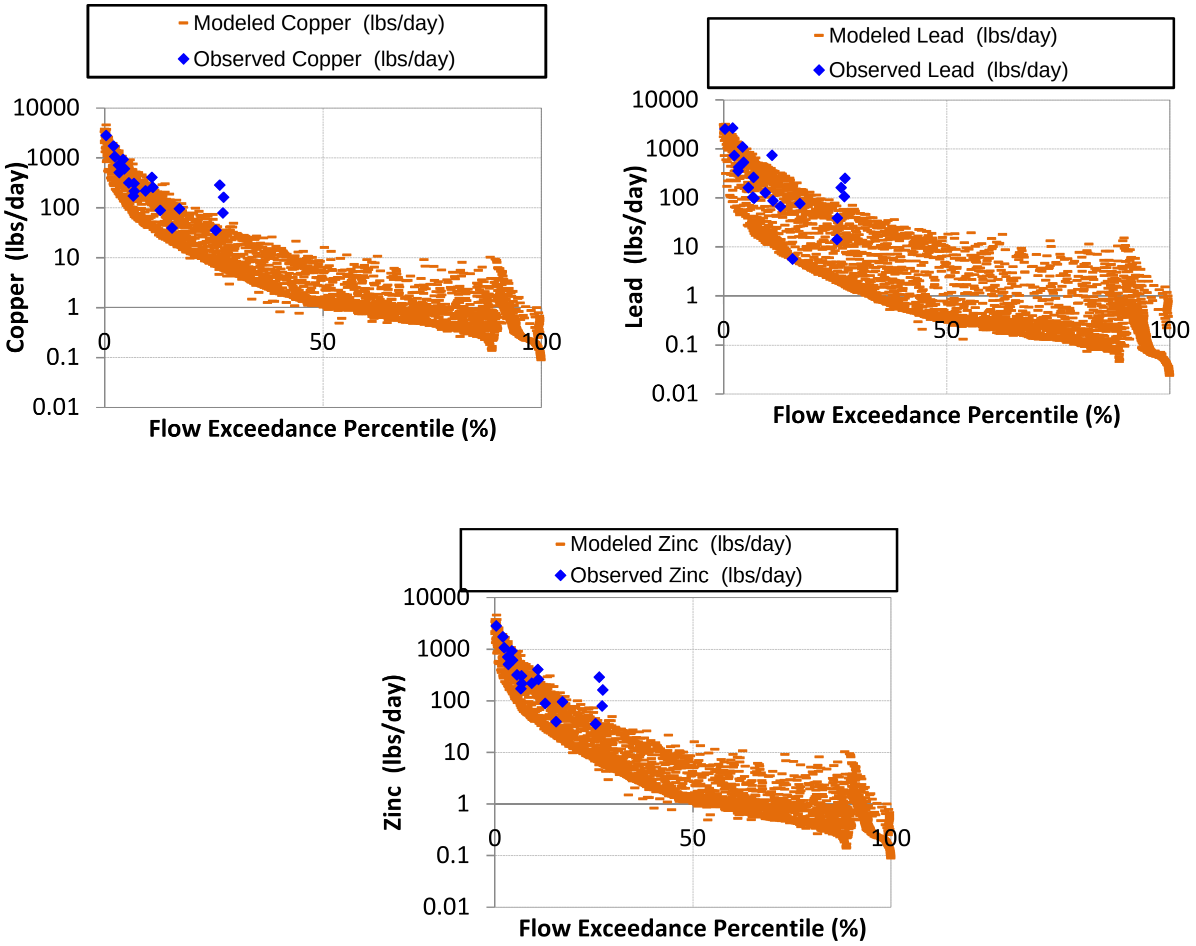


Figure 2-22. Load duration curve comparison of simulated and observed metal loads at S10.

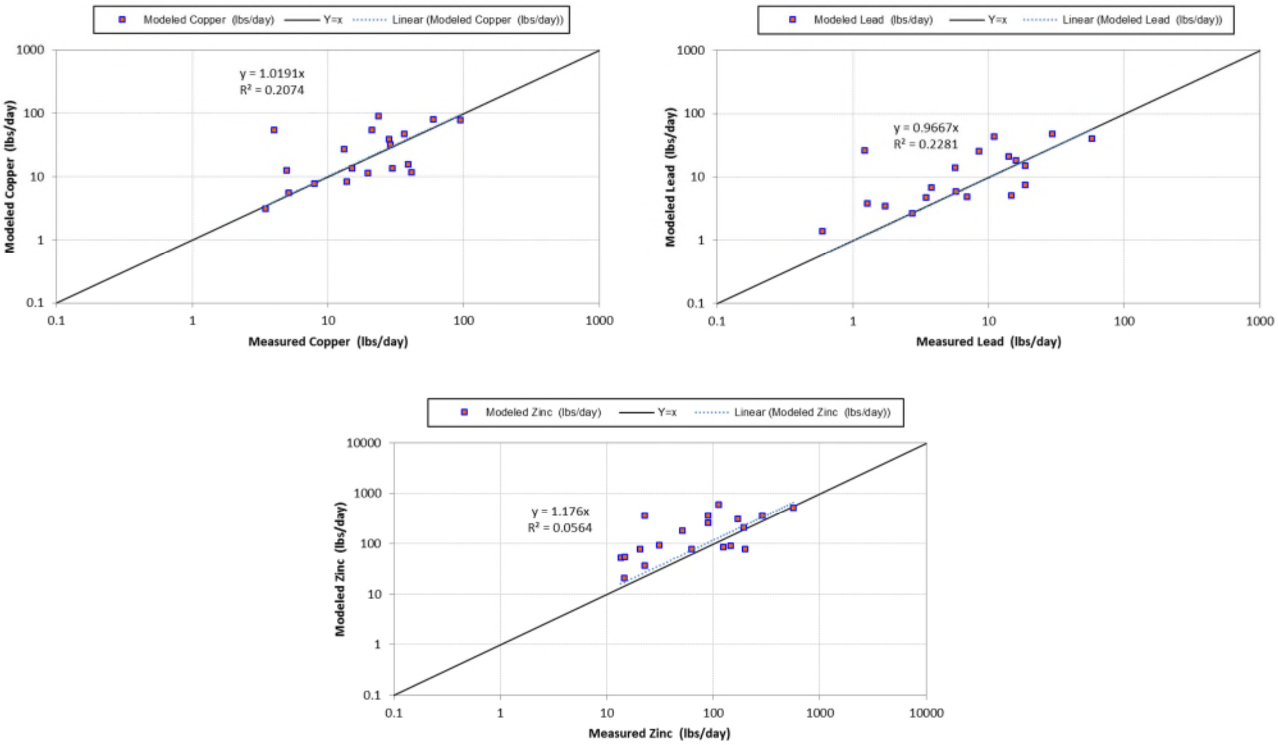


Figure 2-23. Pairwise comparison of simulated and observed metal loads at S14.

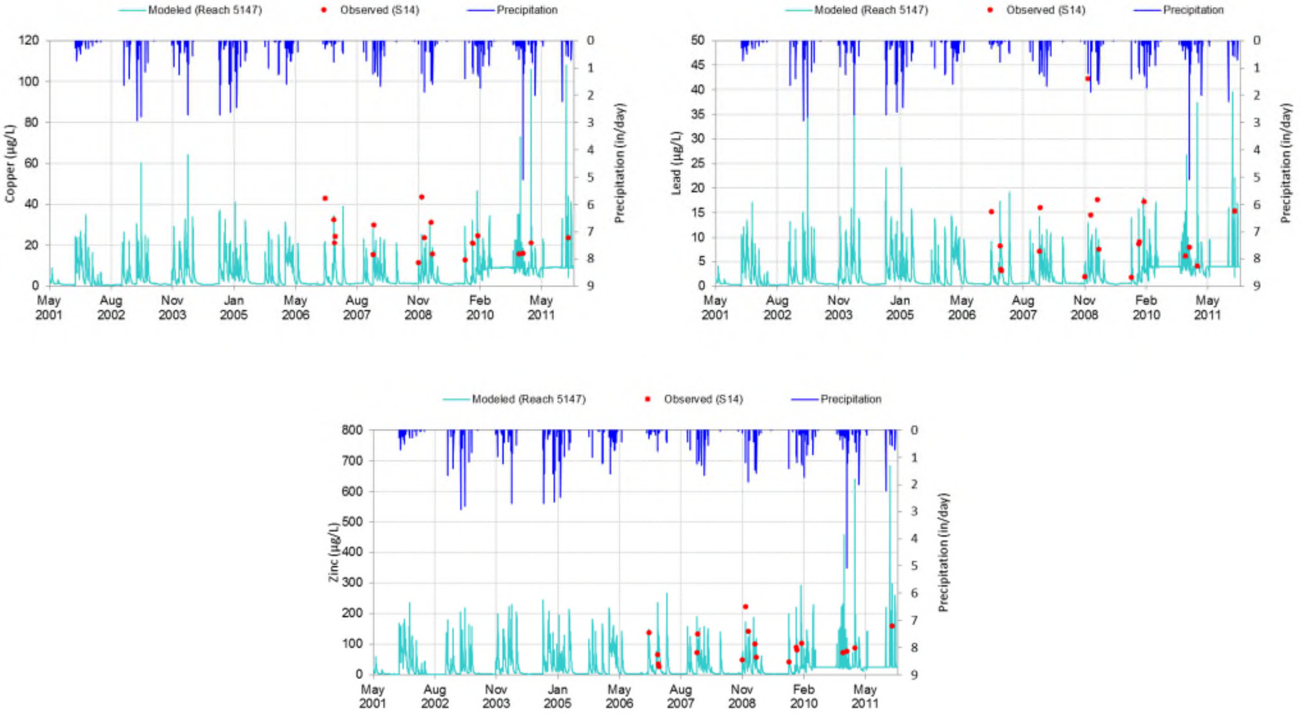


Figure 2-24. Time series comparison of simulated and observed metals concentrations at S14.

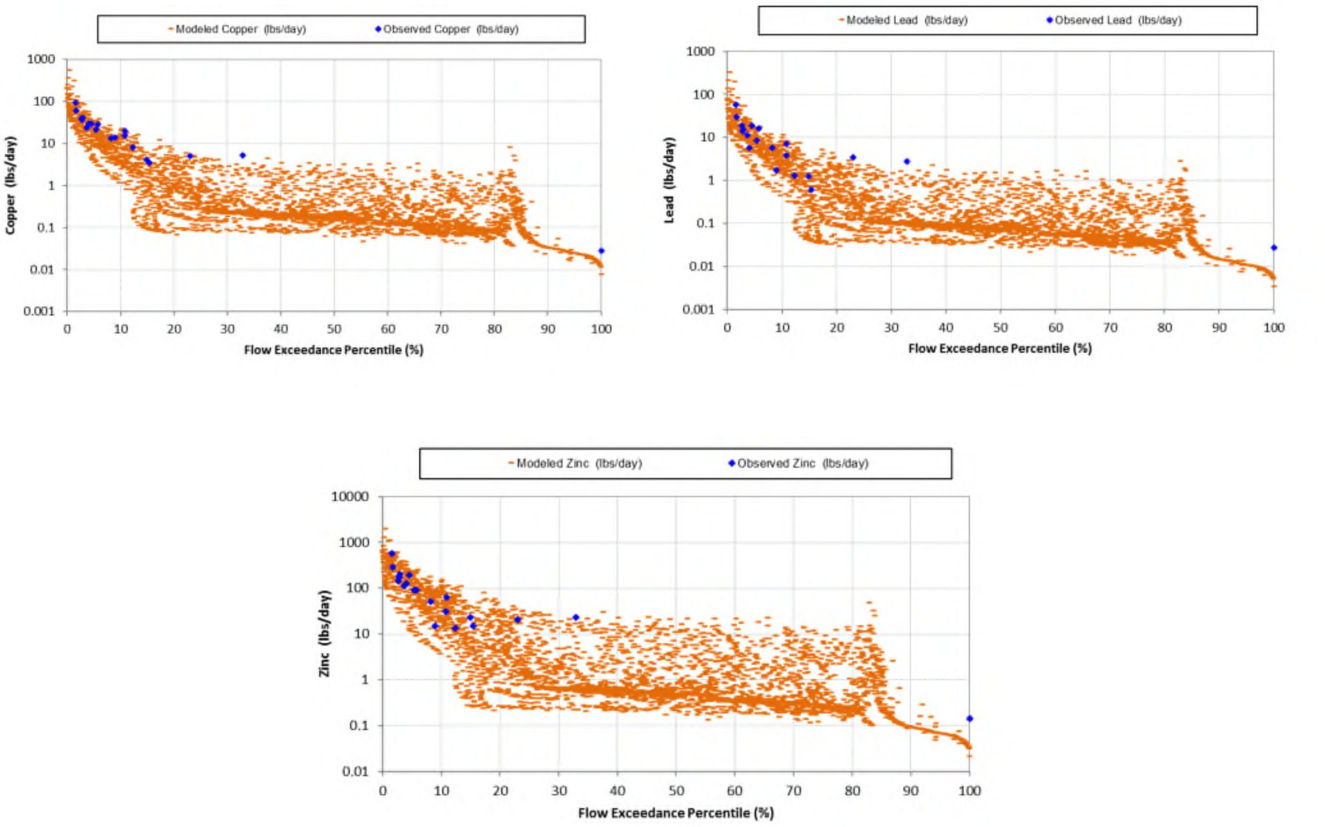


Figure 2-25. Load duration curve comparison of simulated and observed metal loads at S14.

Table 2-10. Simulated and literature[1] average EMCs by HRU/land use at S10.

Model HRU	Simulated Cu (µg/L)	RAA Avg. Cu (µg/L)	Simulated Pb (ug/L)	RAA Avg. Pb (µg/L)	Simulated Zn (µg/L)	RAA Avg. Zn (µg/L)
LD single-family residential moderate slope	42.44	18.70	53.41	11.30	106.16	71.90
Multifamily residential	41.92	12.10	72.34	4.50	204.13	125.10
Commercial	63.23	31.40	64.02	12.40	386.95	237.10
Industrial	88.31	34.50	79.86	16.40	647.24	537.60
Transportation	39.46	52.20	53.39	9.20	116.96	292.90
Agriculture moderate slope B	17.15	100.10	5.03	30.30	49.94	274.80
Vacant moderate slope B	16.40	10.60	5.09	3.00	35.90	26.30

[1] RAA Guideline average EMCs (Nguyen, 2014)

Table 2-11. Simulated and literature[1] average EMCs by HRU/land use at S14

Model HRU	Simulated Cu (µg/L)	RAA Avg. Cu (µg/L)	Simulated Pb (ug/L)	RAA Avg. Pb (µg/L)	Simulated Zn (µg/L)	RAA Avg. Zn (µg/L)
LD single-family residential moderate slope	14.80	18.70	1.87	11.30	35.08	71.90
Multifamily residential	13.73	12.10	14.88	4.50	99.67	125.10
Commercial	22.57	31.40	7.76	12.40	148.53	237.10
Industrial	39.42	34.50	12.54	16.40	207.08	537.60
Transportation	5.34	52.20	2.31	9.20	109.56	292.90
Agriculture moderate slope B	13.81	100.10	5.92	30.30	47.76	274.80
Vacant moderate slope B	9.04	10.60	3.83	3.00	25.22	26.30

[1] RAA Guideline average EMCs (Nguyen, 2014)

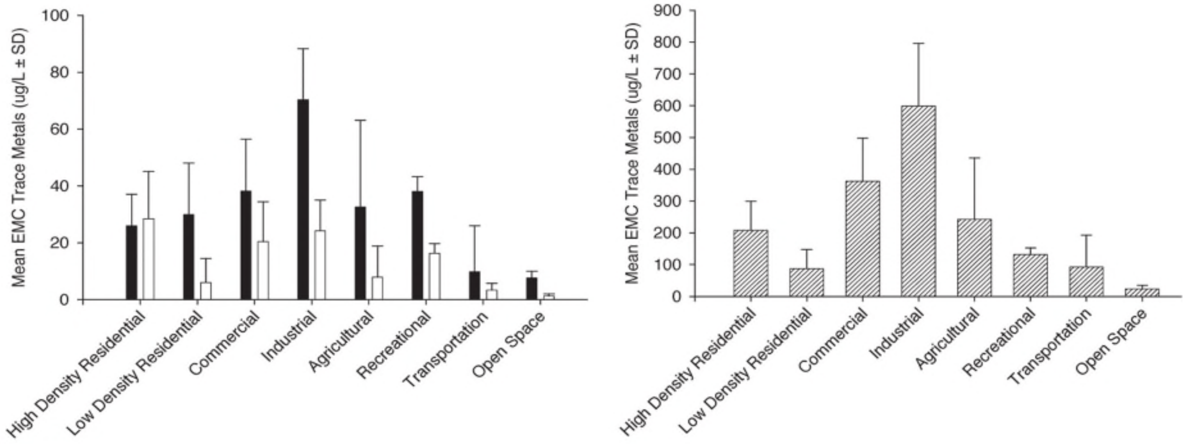


Figure 2-26. EMCs for Copper (left, black), Lead (left, white), and Zinc (right, mixed) by land use-based sources of trace metals sampled in Los Angeles sites from 2000 through 2005 (SCCWRP, 2007).

The overall assessment of the water quality calibration includes a comparison that uses the RAA Guideline average as the observed data source and an assessment of simulated average annual instream load with linear regression slope as an indicator of model fit. Together these measures provide a basis for determining whether the process based watershed simulations are reasonably capturing observed conditions, where:

- EMC comparisons show that the simulated upland flow and metals loads for the assessed land uses are comparable to observed conditions. These can be thought of edge-of-stream EMCs though they are subject to the in-pipe processes/conditions where they were collected.
- Pairwise comparisons of instream loads can show that modeled instream metal loads are comparable to observed conditions.

If both upland and instream comparisons are reasonable then it can be concluded that the model is properly representing source loading and the intervening processes that ultimately determine instream water quality. In general, the modeled EMC summaries are of the same magnitude and cover the range of EMCs in the observed data for each land use. Pairwise comparison linear regression plots show the relationship between measured and simulated constituents, where we want the slope of this regression to be as close to 1 and the R-squared value to be as close to 1 as well, representing the strength of the linear relationship. Pairwise comparison linear regression slope show values close to 1, indicating that the model generally captures the average instream metals load. For the LAR station, S10, the linear regression slopes range from 0.99 to 1.14, and all R-squared values fall between 0.59 and up to 0.87. For the SGR station, S14, the linear regression slopes range from 0.967 to 1.18, however R-squared values were lower at the SGR station. The load duration plots show the model captures the lower range of observed concentrations, but misses a few peak concentrations for each of the constituents. Such observed peaks seem to be random and are likely due to processes that cannot be captured by the model.

2.2 WATER QUALITY OBJECTIVES

Water quality objectives are established to protect beneficial uses. Based on the pollutants of concern and applicable TMDL's, numeric targets are identified for metals based on the California Toxics Rule (CTR). The acute and chronic CTR equations determine concentrations which cannot be exceeded to protect aquatic life health. The acute CTR criteria are used for metal TMDL loading capacities and waste load allocations. Loads are calculated by multiplying the maximum allowable concentration, based on the acute CTR equation (units in µg/l total recoverable metals), by daily volume. Basin Plan Amendment R15-004 established a site-specific water effects ratio (WER) for Copper in the Los Angeles River Watershed of 3.97. The amendment also introduced a recalculated Lead CTR equation. Such updates are used in determining water quality numeric targets, as the objectives still fully protect aquatic life and will not unreasonably affect present and anticipated beneficial uses of the waters.

CTR equations are dependent on hardness values and to convert from dissolved to total recoverable metals are dependent on conversion factors. Hardness values and conversion factors (CF) for Cadmium, Copper, Lead, and Zinc were updated based on more recent monitoring data (1996 – 2017) from Mass Emission Stations S10 (Los Angeles River (LAR) at Wardlow) and S14 (San Gabriel River (SGR)). These are the same stations used in the LAR and SGR metal TMDLs, which base hardness values and conversion factors on data only up to 2002 and 2005 in LAR and SGR, respectively. At S10, the 50th percentile hardness value changed from 80 mg/l to 76 mg/l based on more recent monitoring data. Table 2-12 shows the regression analysis performed, with more recent monitoring data at S10, to determine whether updated conversion factors were allowable. All samples below the reporting limit were removed and outliers were removed according to the formal definition (1.5 times the interquartile range below or above the first and third quartile). At S14, the 50th percentile hardness value changed from 175 mg/l to 155 mg/l. Table 2-13 shows the regression analysis performed at S14, using the same methods as described for S10. The R-squared value for Copper is 0.014, thus following analyses did not use the updated conversion factor for Copper.

To account for uncertainty in the updated conversion factor the 95% confidence interval was calculated. This considers the number of samples and standard deviation in the monitoring data to provide a range of the conversion factor that more confidently contains the true value. The greater the conversion factor, the more stringent the CTR criteria, with a greater fraction of the total recoverable metals attributed to the dissolved component. Therefore, when updating the conversion factors, the upper limits of the 95% confidence intervals were used as the representative conversion factors in the following analyses.

Table 2-12. Regression analysis for updated conversion factors at S10.

Constituent	CF (slope of regression) (1996 – 2017)	95% Confidence Interval	Number of samples	R^2	Default CF	Previous CF (1996 - 2002)
Cadmium	0.800	0.770 – **0.829**	27	0.992	0.940	0.940
Copper	0.480	0.426 – **0.535**	91	0.723	0.960	0.650
Lead	0.386	0.297 – **0.476**	53	0.719	0.824	0.820
Zinc	0.470	0.402 – **0.538**	74	0.468	0.978	0.610

Table 2-13. Regression analysis for updated conversion factors at S14.

Constituent	CF (slope of regression) (1996 – 2017)	95% Confidence Interval	Number of samples	R^2	Default CF	Previous CF (1997 - 2005)
Cadmium	0.919	0.847 – **0.991**	7	0.988	0.94	0.940
Copper	0.374	0.315 – 0.432	63	0.014	0.96	**0.960**
Lead	0.464	0.372 – **0.557**	40	0.494	0.709	0.709
Zinc	0.647	0.573 – **0.722**	52	0.591	0.978	0.978

The updated CTR acute criteria, from the updated hardness and updated conversion factors (bolded in Table 2-12 and Table 2-13), are presented in Table 2-14.

Table 2-14. *Updated CTR acute criteria.*

Watershed	CTR Acute Criteria (µg/L total recoverable metals)			
	Cadmium	Copper	Lead	Zinc
LAR	4	77	152	173
SGR	7	21[a]	186	235

a. Updated CF not used due to poor correlation in regression analysis.

2.3 CRITICAL CONDITIONS

An annual critical condition was selected to determine baseline loading and eventually load reduction requirements (discussed in later sections). The critical water year was determined based on the 90th percentile rainfall intensity. Rainfall intensity was defined as the average rainfall per wet day. Rainfall gages within each watershed were aggregated and area-weighted to determine annual average rainfall per wet day. A total of 99 rainfall gages, with data from 1990 – 2012, were utilized in this effort. The water year, within the most recent 10 years of modeling, closest to the 90th percentile average rainfall per wet day was selected (Table 2-15). In the LAR watershed the critical water year was 2003 and in the SGR watershed the critical water year was 2004. A number of other critical conditions were explored, including the critical water year based on the greatest total rainfall, a representative water year based on average annual rainfall, and daily critical conditions, such as the 90th percentile load. The critical water year based on rainfall intensity was identified as the most robust, and overall protective, condition.

Table 2-15. Selection of Critical Water Year based on Rainfall Intensity (average rainfall per wet day)

Year	Average Rainfall per Wet Day (in)
2007	0.22
2009	0.22
2011	0.22
2010	0.23
2008	0.23
1999	0.25
1990	0.25
2012	0.25
2002	0.26
1989	0.27
1987	0.27
1997	0.29
1994	0.29
1991	0.29
2005	0.29
1986	0.29
1996	0.30

Year	Average Rainfall per Wet Day (in)
2006	0.30
2004	0.32
2000	0.32
2001	0.32
1992	0.34
2003 **(90th Percentile Most Recent 10 Years)**	**0.35**
1995	0.37
1998	0.37
1993	0.39
1988	0.39
90th Percentile (All Years)	**0.37**

2.4 LIMITING PRIORITY POLLUTANT

Section 2.2 of the original EWMP lists the water body-pollutant combinations. Table 2-5 of the original EWMP summarizes the water body-pollutant combination categories as well as the impacted reaches. Specific combinations were deprioritized for the following reasons (generally consistent with justification provided in the original 2016 EWMP):

- Nutrients: Targets are based on existing conditions (anti-degradation). The Los Angeles Area Lakes TMDL for Peck Road Park Lake states “This lake is currently achieving the in-lake chlorophyll *a* target and TMDLs are being established at the existing loads.” (USEPA, 2012) Nitrogen compounds have shown no exceedances in recent years in Rio Hondo Reach 3 and sources of these compounds are likely other than MS4s.
- Trash: Majority of cities are over 90% compliant.
- Bacteria: Implementation of the metals TMDLs, with earlier compliance deadlines, is expected to address much of the bacteria impairment. Also, base flows and dry-weather discharges from the RH/SGR Water Quality Group area are not suspected to be a large contributor to the impairments identified in the LA Bacteria TMDL. Further investigation of the sources of bacteria impairments are required. See section 1.3.2 of the accepted 2016 EWMP on the relevant TMDLS for more detail on this justification.
- Legacy: Constituents are no longer in commercial use. Internal lake dynamics are likely more important than any current loading from the watershed.

In the original 2016 EWMP, refer to Section 2.4 on the prioritization of the water body-pollutant combinations and Section 2.5.1 on the constituent relationships for more detail.

Therefore, metals are the remaining water body-pollutant combination of concern. A limiting priority pollutant can be selected under the RAA guidelines. The limiting pollutant should be the constituent with the highest required reduction or the most difficult to treat. The concept of the limiting pollutant stands if the limiting pollutant reduction requirements are met, necessary reductions to all other constituents should be met as well. Zinc had the greatest reduction requirement at all compliance points (discussed in next section, Table 2-16). However, at the San Gabriel River and Big Dalton Wash compliance point copper had a greater percent reduction requirement. Recall the CTR criteria was not updated for copper in the San Gabriel River watershed given the poor regression, therefore the maximum concentration is significantly stricter. Copper is assumed to be primarily managed through the break pad replacement program, therefore zinc is the limiting priority pollutant in both watersheds. The selection of zinc as the limiting pollutant is further supported as lead reduction requirements were near zero across the compliance points based on a number of critical conditions initially investigated.

2.5 REQUIRED REDUCTION

Three downstream compliance locations were selected to account for the drainage from water bodies located within the EWMP area. Figure 2-27 shows one is located along the Rio Hondo in the LA River Watershed and two in the San Gabriel River Watershed, one along the San Gabriel River and the second along Big Dalton Wash. The jurisdictions are taking on a proportional responsibility for the upstream areas (above the jurisdictional areas) contributing to the compliance locations. For the Rio Hondo and San Gabriel River compliance points the contributing area outside the jurisdictional boundaries is primarily vacant mountainous terrain. Required load reductions are determined by comparing the baseline loading to the target loading, set based on the water quality objectives, on wet days (>0.1 inches rainfall plus the following 3 days). For the critical water year (WY2003 in LAR and WY2004 in SGR), the required load reduction for each wet day exceeding the allowable load were totaled to determine the annual load reduction required. Table 2-16 summarizes the annual load reduction requirements as well as the percent reduction requirements at each compliance location. Table 2-17 through Table 2-19 describe the load reduction analysis required for zinc, the limiting priority pollutant at each compliance location. Figure 2-28 through Figure 2-30 show the required zinc load reductions at each compliance location and where these occur in terms of the percent rank of wet day loads.

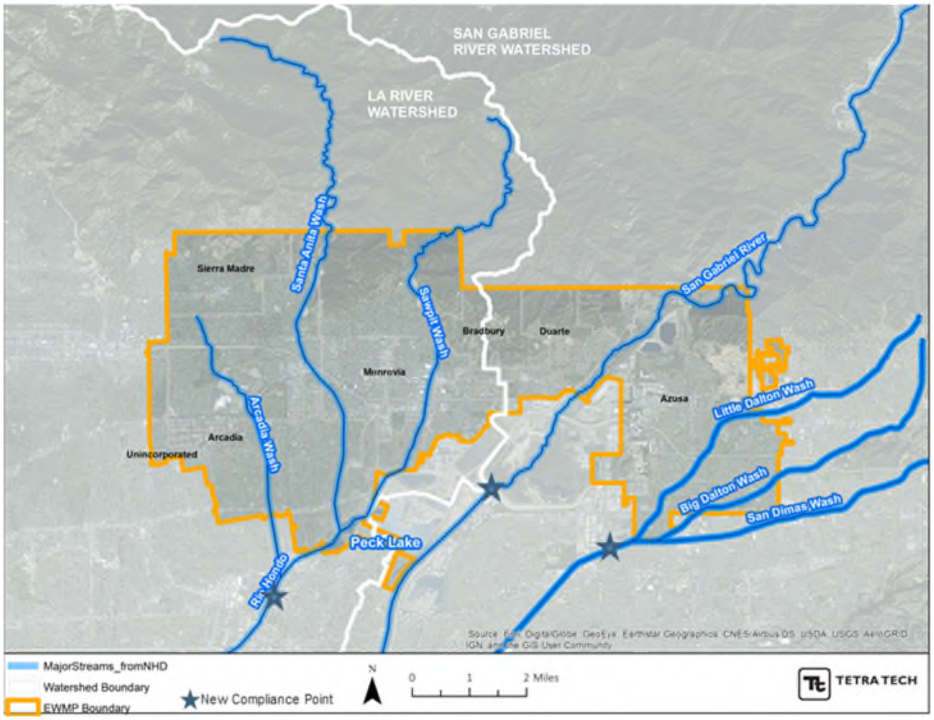


Figure 2-27. Compliance locations, where required load reductions assessed.

Table 2-16. Required load reduction at each compliance location for metals for wet days under the critical condition.

Constituent	Required Reduction	Compliance Location		
		Rio Hondo	San Gabriel River	Big Dalton Wash
Copper	Load (lb/yr)	23	63	80
	Percent (%)	3.0	39.0	31.9
Lead	Load (lb/yr)	0	0	0
	Percent (%)	0	0	0
Zinc	Load (lb/yr)	1163	236	295
	Percent (%)	30.4	27.7	20.0

Table 2-17. Rio Hondo load reduction analysis for zinc

Wet Days Summary	
Total Wet Days (10/1/2002 - 9/30/2003)	46
Total Wet Exceedance Days	13
Total Existing Load (Wet Days) (lbs/yr)	3,822
Total Allowable Load (lbs/yr)	2,659
Required Load Reduction (lbs/yr)	1,163
Required Percent Reduction using 198 µg/L Total Zinc target	30.4%

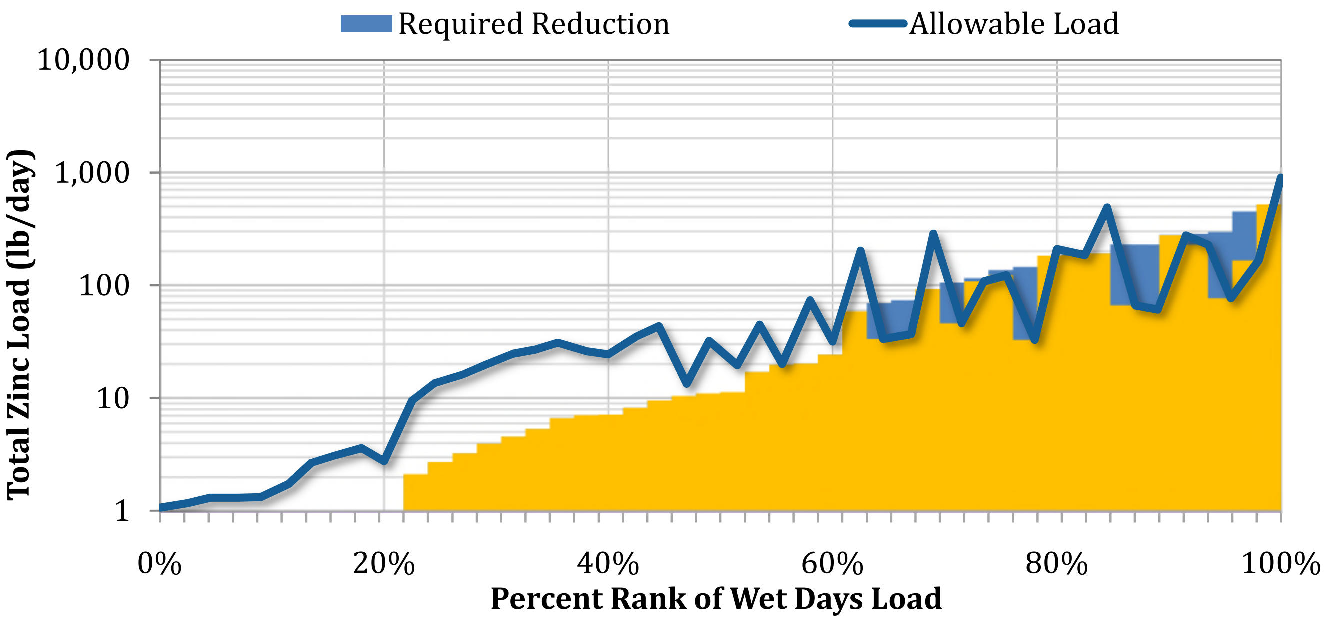


Figure 2-28. Days with required zinc load reductions at the Rio Hondo compliance location, based on the baseline and allowable loads.

Table 2-18. San Gabriel River load reduction analysis for zinc

Wet Days Summary	
Total Wet Days (10/1/2003 - 9/30/2004)	49
Total Wet Exceedance Days	12
Total Existing Load (Wet Days) (lbs/yr)	852
Total Allowable Load (lbs/yr)	616
Required Load Reduction (lbs/yr)	236
Required Percent Reduction using 260 µg/L Total Zinc target	27.7%

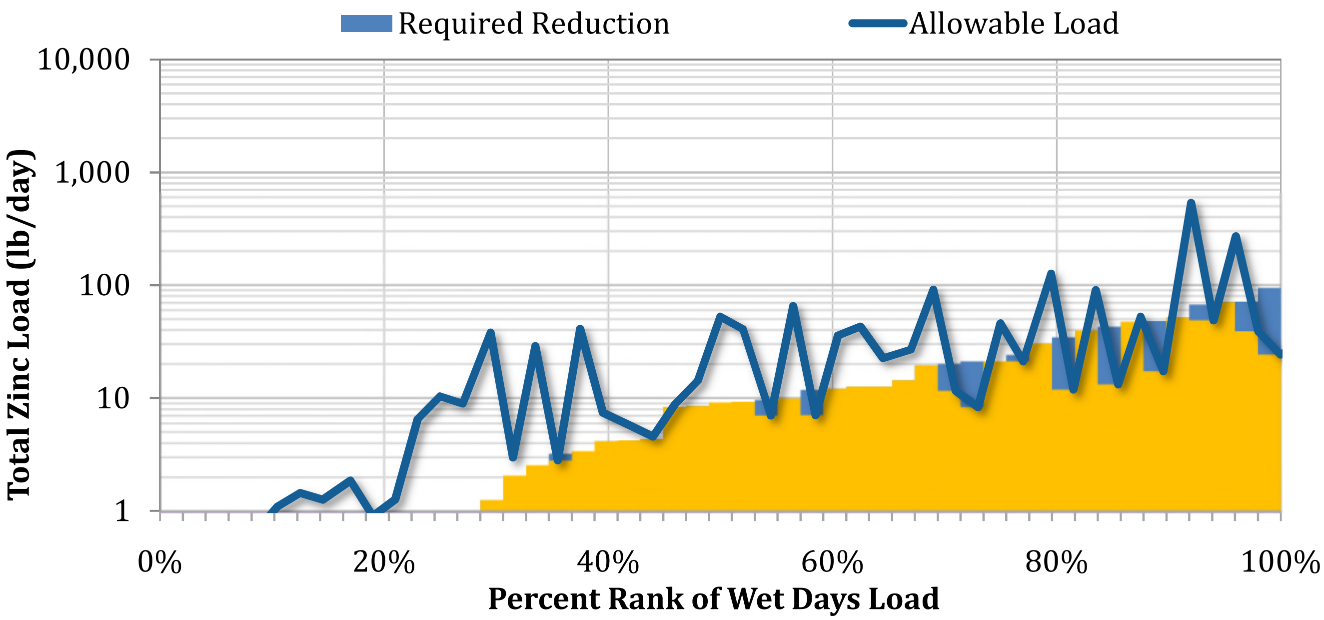


Figure 2-29. Days with required zinc load reductions at the San Gabriel River compliance location, based on the baseline and allowable loads.

Table 2-19. Big Dalton Wash load reduction analysis for zinc

Wet Days Summary	
Total Wet Days (10/1/2003 - 9/30/2004)	48
Total Wet Exceedance Days	19
Total Existing Load (Wet Days) (lbs/yr)	1,478
Total Allowable Load (lbs/yr)	1,182
Required Load Reduction (lbs/yr)	295
Required Percent Reduction using 260 µg/L Total Zinc target	20.0%

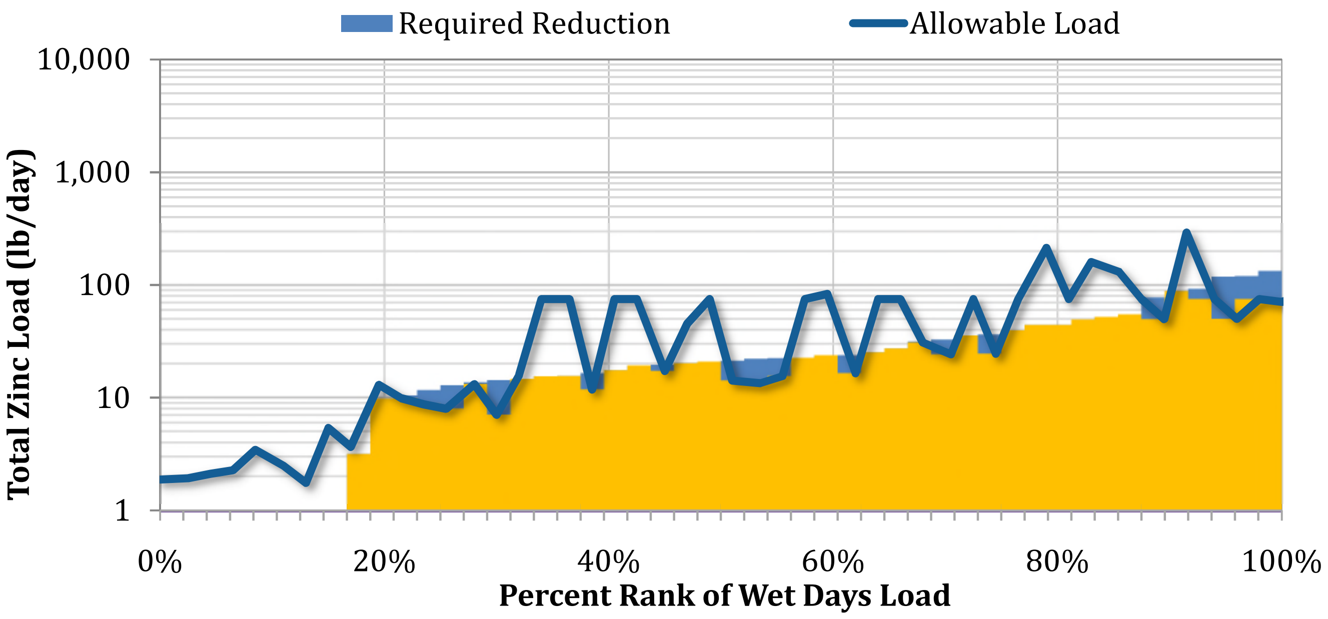


Figure 2-30. Days with required zinc load reductions at the Big Dalton Wash compliance location, based on the baseline and allowable loads.

Independent from the load reduction targets defined above for the established compliance points, a small sliver of the EWMP area eventually outfalls downstream from the Rio Hondo compliance point (via Eaton Wash). To define a load reduction target for this area, the reduction ratio computed at the Rio Hondo compliance point (30.4%) was applied to the baseline loading (to define load reduction target of 98.1 pounds of zinc). The RAA for this portion of the watershed is presented herein separately from the RAA for each compliance point.

3.0 REPRESENTATION OF EWMP CONTROL MEASURES

The next step of the RAA is to determine the optimal BMP combination to achieve required load reductions. SUSTAIN was used to represent potential BMP combinations and evaluate performance. A number of assumptions are factored in to the representation of control measures in the model. BMP assumptions were determined based on the best available data. The following subsections discuss methods and key assumptions of the model.

3.1 BMP OPPORTUNITIES

3.1.1 Enhanced Minimum Control Measures and Redevelopment LID

Non-structural BMPs for the participating jurisdictions include enhanced Minimum Control Measures (MCMs) and redevelopment projects. Refer to Section 3.4.1.1 and Section 3.4.1.3 of the original 2016 EWMP for further details on the non-structural programs and redevelopment projects planned in each jurisdiction.

Enhancements to MCMs are credited a 5% load reduction from the baseline load, as implementation of the required control measures under the 2012 MS4 Permit are expected to reduce pollutant loading as compared to the baseline conditions and calibrated watershed model, the period for which ends on 4/30/2012. Note that the 2016 EWMP applied a weighted average load reduction of 5.2%, but 5% was used in the rEWMP for consistency with other EWMPs throughout the region.

Permittees were required to develop and implement an LID ordinance under the 2012 MS4 Permit which applies thresholds of disturbance to impervious areas to new and redevelopment projects. The original EWMP referenced average annual redevelopment rates released by the City of Los Angeles and assumes all redevelopment projects will include BMPs required by the MS4 Permit that provide a load reduction based on capturing the runoff volume associated with the 85th percentile rainfall.

3.1.2 Multi-Benefit Regional Projects

Four multi-benefit regional projects were proposed by the participating cities and county as a first step to addressing required load reductions. These projects were selected for their significant water quality improvements, practicability, and multi-benefits. The multi-benefit regional projects are shown in Figure 3-1 and include the Arcadia Arboretum Ecosystem Restoration and Groundwater Recharge Project, Rio Hondo Ecosystem Restoration and Arcadia Wash Water Conservation Diversion Project, Basin 3E Enhancements at Santa Fe Spreading Grounds Project, and Encanto Park Stormwater Capture Project.

Additional required load reductions will primarily be addressed through distributed BMPs, such as green streets.

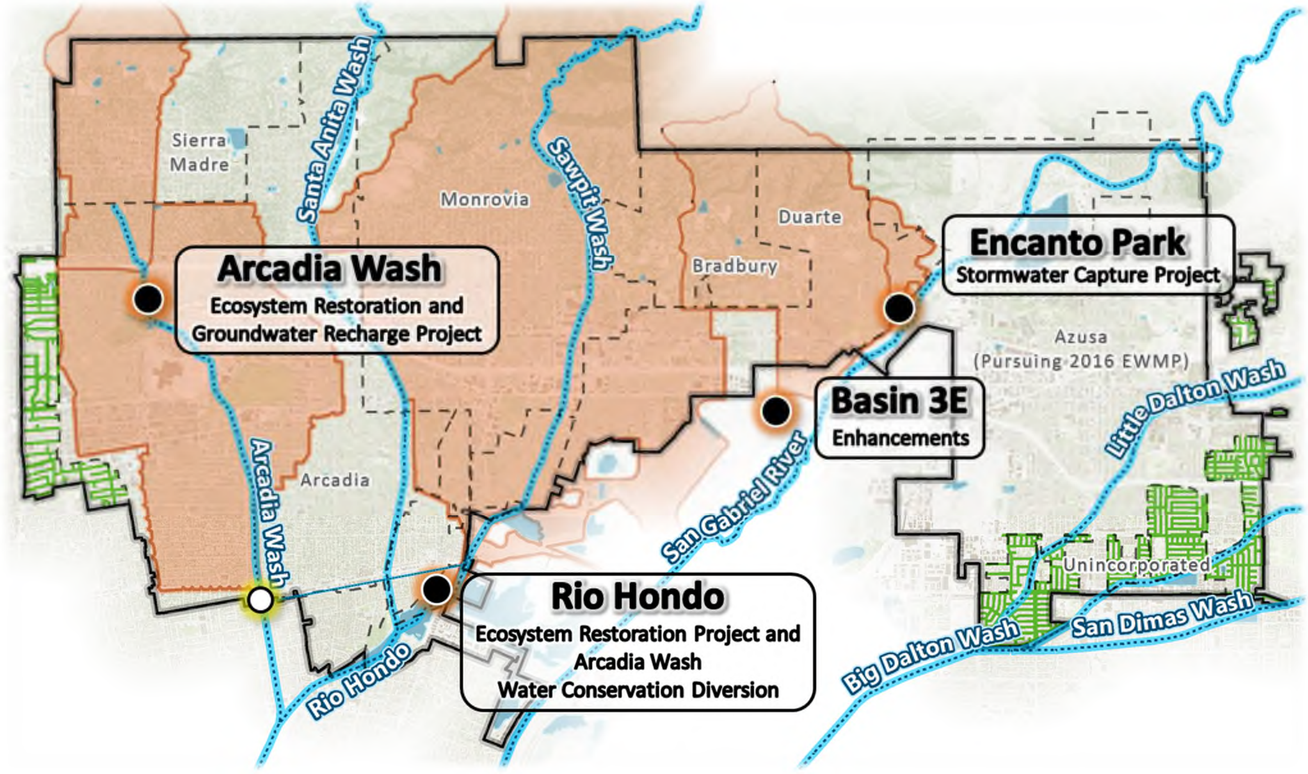


Figure 3-1. Multi-benefit regional project locations and potential green street locations.

3.1.3 Distributed BMPs – Green Streets

Green streets were proposed to address remaining required load reductions not achieved by other control measures. Through a spatial opportunity screening process, potential locations for green streets throughout the EWMP area were identified. The process was consistent with methods used in the Upper Los Angeles River, Ballona Creek, Upper San Gabriel River, and Upper Santa Clara River EWMPs; please refer to the technical appendices of those documents for opportunity screening assumptions. The majority of the Rio Hondo drainage area (excepting the portion draining to Eaton Wash) and the entirety of the San Gabriel River drainage area were excluded from the screening, as analyses demonstrate achievement of the total required load reduction through non-structural and Multi-Benefit Regional Projects (see Section 4). Note that, while this analysis provides recommendations at the subwatershed-scale, the green street implementation strategy will be augmented by the results of Los Angeles County's ongoing green streets projects.

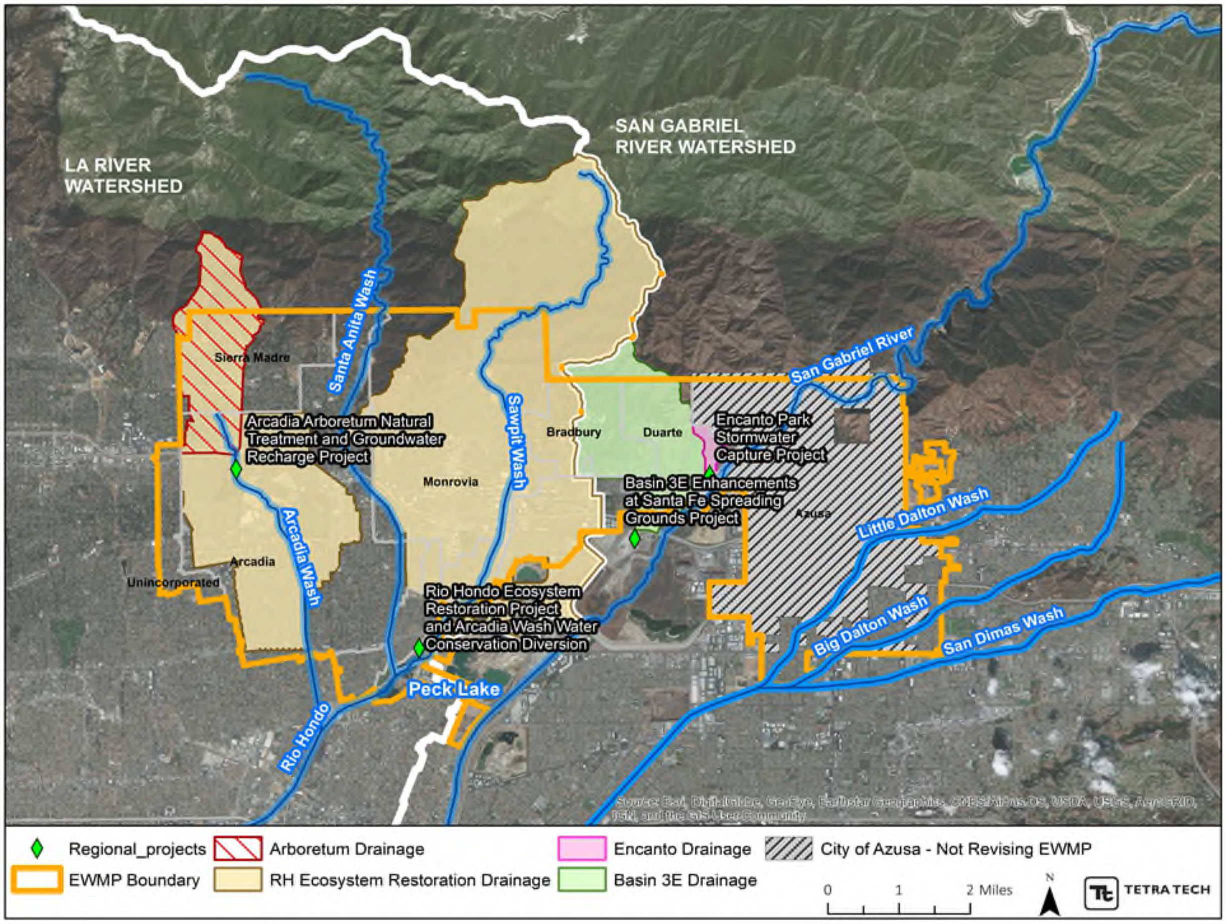
3.2 BMP CONFIGURATION

3.2.1 Enhanced MCMs and Redevelopment LID

To account for load reductions resulting from LID a percentage of the impervious area being redeveloped was adjusted to a pervious land use in the watershed model. The percent area changed was determined based on reducing the runoff volume to capture the 85th percentile rainfall. The identified percent change was applied to the percent area to be redeveloped by 2028 for the identified impervious HRUs (except transportation, to avoid double counting with green streets). See Table 3-20 of the original EWMP for the percent area to be redeveloped by 2028. Next, a 5% load reduction was assumed for MCMs. For best accuracy, the 5% adjustment was made directly to the timeseries used to model downstream structural BMPs (to simulate the upstream reduction of pollutants by source control practices).

3.2.2 Multi-Benefit Regional Projects

Similar to the watershed model, a BMP model was set up for each of the two watersheds within the group's jurisdictions. There are two multi-benefit regional projects within each watershed, see Figure 3-2 for the respective drainage areas.



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 3-2. Drainage areas for the multi-benefit regional projects.

In the LAR watershed the Arcadia Arboretum Ecosystem Restoration and Groundwater Recharge (Arboretum) Project will be a constructed wetland with recharge ponds surrounding. Water is diverted from Arcadia Wash into the wetland pond, then spills into recharge ponds on either side. Outflow water from the wetland pond is routed back to Arcadia Wash through an orifice and any outflow from the recharge ponds is also routed back to Arcadia Wash. Further downstream on Arcadia Wash a diversion structure routes water to the Rio Hondo Ecosystem Restoration (Rio Hondo) Project, which will be a constructed wetland. This project also diverts water from Sawpit Wash into the constructed wetland, indicted by the two distinct drainage areas in Figure 3-2. Outflow from the wetland is routed to Peck Road Park Lake.

In the SGR watershed the Encanto Park Stormwater Capture (Encanto) Project will be an underground storage unit. Water is diverted to the unit from an existing storm drain, note the relatively small drainage area. A portion of the treated water will be used for onsite irrigation at the park. This was represented in the model as an hourly release 4am – 7am. The release flowrate was determined based on the yearly irrigation demand of the park for Fiscal Year 2017, assuming a constant daily rate. The remaining water in the storage unit is routed to the San Gabriel River. The Basin 3E Enhancements at Santa Fe Spreading Grounds (Basin 3E) Project will be an enhancement of the existing detention basin that does not require any diversion, as it is located at the outlet of Bradbury Channel. The outflow is routed to the San Gabriel River. Monthly evaporation rates in the BMP models were calculated in each watershed based on representative cells from the Simplified Surface Energy Balance (SSEBop) model, and checked against local CIMIS stations.

In the Rio Hondo BMP model setup, the Arboretum wetland pond had a set width of 50' and ponding depth of 2.5'. The orifice height was set to 1.5', with a diameter of 4.3" based on an outflow rate of approximately 1 cfs. The Arboretum recharge ponds were represented as a larger single dry pond, with a set width of 60' and depth of 3'. The Rio Hondo wetland had a set width of 150'. The Holton infiltration method was used for all the LAR watershed regional projects. Pollutant removal for the two wetlands was represented with the Kadlec and Knight method, while 1st order decay was assumed for the dry ponds. Background concentrations and removal rates for the Kadlec and Knight method were based on William Mitschs' and James Gosselinks' *Wetlands* (Mitsch, 2007). Soil parameters (porosity, field capacity, wilting point, and infiltration rate) were selected based on the soil type identified at the location, unless additional site-specific information was available. For the Arboretum wetland pond soil depth and infiltration rate were set arbitrarily low, as a main function of the wetland pond is settling and pollutant uptake from ponded water and water overflowing into the dry ponds will infiltrate into the groundwater. For the Rio Hondo wetland the infiltration rate was set to the minimum design infiltration rate by the County Standards of 0.3 in/hr.

In the San Gabriel River BMP model set up the Encanto underground storage unit had a set width of 150' and depth of 10'. The Basin 3E detention basin had a set width of 180' and depth of 5' based on available space. The Holtan infiltration method was again used for all the SGR watershed regional projects. Pollutant removal for both projects was based on 1st order decay. Soil parameters were again selected based on the soil type identified.

In the optimization modeling the following parameters were adjustable and maximums were set based on physical limitations:

Rio Hondo Watershed:

- Arcadia Wash diversion to the Arboretum wetland pond: maximum 40 cfs
- Arboretum wetland pond and dry ponds length: maximum 500 ft
- Arcadia Wash diversion to the Rio Hondo wetland: maximum 50 cfs
- Sawpit Wash diversion to the Rio Hondo wetland: maximum 200 cfs
- Rio Hondo wetland length: maximum 3000 ft
- Rio Hondo wetland ponding depth: maximum 4 ft

San Gabriel River Watershed:

- Strom drain diversion to Encanto storage unit: maximum 50 cfs
- Encanto storage unit length: 500 ft
- Basin 3E detention basin length: 1350 ft

3.2.3 Distributed BMPs – Green Streets

Green street opportunities in the County of Los Angeles within the Big Dalton Wash drainage area and the portion of the Rio Hondo EWMP area draining downstream from the Rio Hondo compliance point (via Eaton Wash) were identified through a spatial screening process (Figure 3-3 and Figure 3-4). The remainder of area in the Rio Hondo compliance point drainage area were left out as non-structural and regional BMPs alone achieved the required load reduction. In the drainage area to the San Gabriel River compliance point, green street opportunities in Bradbury and Duarte were left out, as the Non-structural and Regional BMPs were able to reduce the required percent reduction of the wet days load contributed by these cities. However, for County islands which contribute loads to Eaton Wash and the Big Dalton Wash compliance point (where there are no proposed Regional BMPs) green streets were the predominant load reduction method. Ninety-five unique combinations based on the city, soil type, and subwatershed were identified for green street opportunities in these areas. The identified County green street potential opportunities cover a total footprint of 20.2 acres.

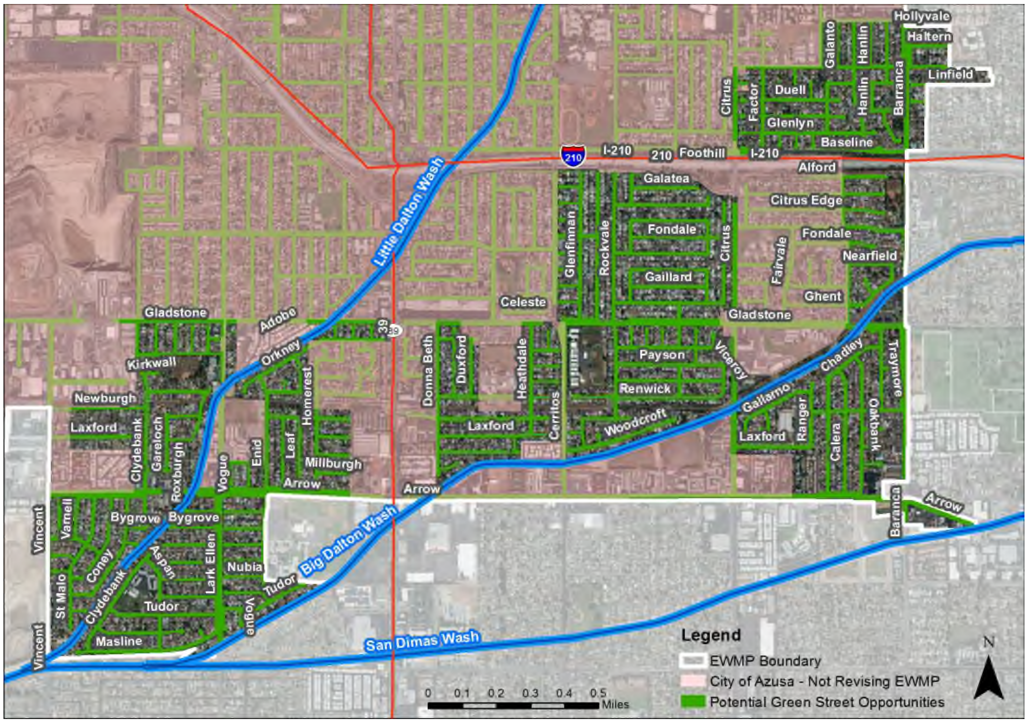


Figure 3-3. Screened Green Street Opportunities in County Islands within the Big Dalton Wash drainage area.

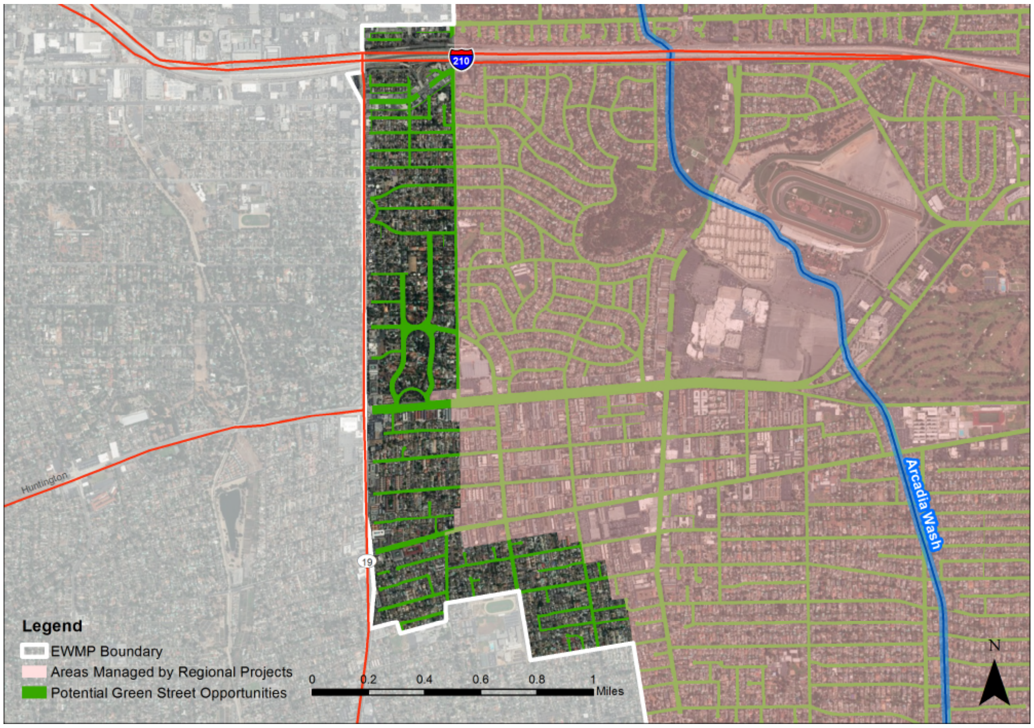


Figure 3-4. Screened green street opportunities in Unincorporated EWMP areas draining downstream from compliance point on Rio Hondo (via Eaton Wash)

Bioretention green streets were assumed and sized based on availability. In the optimization modeling, the length of each green street was adjustable starting from zero to the maximum, set based on the availability. The following parameters were assumed for each of the green streets:

- Ponding depth: 7 in
- Width: 4 ft
- Soil depth: 2 ft
- Media porosity: 0.35

If the underlying soils had an infiltration rate less than 0.3 in/hr an underdrain was included, with a depth of 1.5' and media porosity of 0.4.

3.3 COST FUNCTIONS

The following cost functions were used in the BMP modeling to help evaluate optimum BMP configurations. The costs used to generate the cost functions used data from previous projects, industry and local standards, as well as fill-ins from the International BMP Database. Optimization runs were analyzed to maximize load reduction while minimizing total estimated cost. Note the high Rio Hondo Wetland constant cost due to land acquisition requirements.

Table 3-1. Cost Functions for the Regional BMPs

Multi-Benefit Regional Project	Linear Cost ($)	Area Cost ($)	Total Volume Cost ($)	Media Volume Cost ($)	Underdrain Volume Cost ($)	Constant Cost ($)
Arboretum Wetland Pond	87.34	52.00	2.58	2.87	2.87	87041.90
Arboretum Recharge Ponds	87.34	54.58	2.58	2.87	2.87	87041.90
Rio Hondo Wetland	87.34	41.92	2.58	2.87	2.87	229930094.86
Encanto Underground Storage Unit	21.84	66.90	0.00	0.72	0.72	122961.60
Basin 3E Detention Basin	87.34	44.45	0.00	2.87	2.87	37510.00

Table 3-2. Cost Functions for the diversions to the Regional BMPs

Diversion	Constant Cost ($)
Arcadia Wash to Arboretum Wetland Pond	6122.94
Arcadia Wash to Rio Hondo Wetland	90108.36
Sawpit Wash to Rio Hondo Wetland	6878.22
Storm Drain to Encanto Underground Storage Unit	5903.68

Table 3-3. Cost Functions for Green Streets

Distributed BMP	Area Cost ($)	Total Volume Cost ($)	Media Volume Cost ($)
Green Streets	56.658	2.165	2.64

4.0 SELECTION OF CONTROL MEASURES FOR EWMP IMPLEMENTATION

The RAA recommends the selection of control measures which result in the attainment of water quality objectives, while maintaining cost-effectiveness. The following subsections discuss the recommended Non-structural, Regional, and Distributed BMPs and the expected performance.

4.1 NON-STRUCTURAL BMPS

Table 4-1 shows the load reductions achieved on the critical water years (Rio Hondo: WY2003; San Gabriel River and Big Dalton Wash: WY2004) through redevelopment projects and MCMs. The non-structural BMP load reductions were applied prior to evaluating reductions from regional and distributed BMPs.

Table 4-1. Load reductions resulting from Redevelopment Projects and MCMs in the critical water years.

Compliance Point	Load Reduction (lb/yr)		
	Redevelopment LID	Enhanced MCMs	Combined
Rio Hondo	145	188	333
San Gabriel River	12.3	39.9	52.2
Big Dalton Wash	10.7	69.1	79.8

Independent from the compliance points above, redevelopment LID and enhanced MCMs are predicted to reduce loading from the portion of the EWMP area draining downstream from the Rio Hondo compliance point (via Eaton Wash) by 1.3 lb/yr and 16.1 lb/yr, respectively.

4.2 MULTI-BENEFIT REGIONAL PROJECTS

Following load reductions achieved from Non-structural BMPs, the performance of proposed Multi-Benefit Regional Projects was evaluated. Using Sustain, optimization runs produced many BMP configurations based on the adjustable parameters. Figure 4-1 and Figure 4-2 show the zinc load reduction and associated cost for several configurations of the multi-benefit regional projects in the LAR and SGR, respectively. The curves show the additional load reductions from potential multi-benefit regional project configurations, beyond that already achieved from Redevelopment Projects and MCMs. The cost-effectiveness curves allow for the selection of the optimum configurations which result in achievement of numeric targets. The lower the slope of the curve, the less additional load reduction achieved at the same incremental increase to the cost.

In the LAR, there are many configurations to choose from above the required load reduction target, but the slope of the cost-effectiveness curve above the target demonstrates diminishing returns at the higher costs. In the SGR, a significant decrease in performance is observed beyond a $10 Million-dollar cost. The overall load reduction target for the entire drainage area to the San Gabriel River compliance point cannot be achieved with the Non-structural and Multi-Benefit Regional Projects only. However, a large portion of this area is Azusa, who is not revising the EWMP for their City area. Therefore, the target is adjusted based on the percent of Bradbury, Duarte, and County area from the EWMP boundary that drains to the San Gabriel River compliance point (31.1%), as the

Multi-Benefit Regional Projects are focused in these areas. The total required load reduction is 236 lb/yr at the San Gabriel River compliance point, where 52.2 lb/yr reduction is achieved through the non-structural BMPs. The cities of Bradbury, Duarte, and County are responsible for 31.1% of the remaining 183.8 lb/yr required load reduction. Therefore, the additional required load reduction in Bradbury, Duarte, and County areas draining to the San Gabriel River compliance point, in addition to that achieved through non-structural BMPs, is 57.1 lb/yr. With the adjusted target, there are many configurations to choose from above the required load reduction target and before the slope significantly decreases, though the configurations above the target fall within the higher costs of diminishing returns.

To maximize the cost-effectiveness of the multi-benefit regional projects, configurations resulting in load reductions slightly above the target are recommended, where the returns (i.e. increase load reductions) from increased costs are greatest (of the options that meet the requirements). The recommended configurations are outlined in Table 4-2.

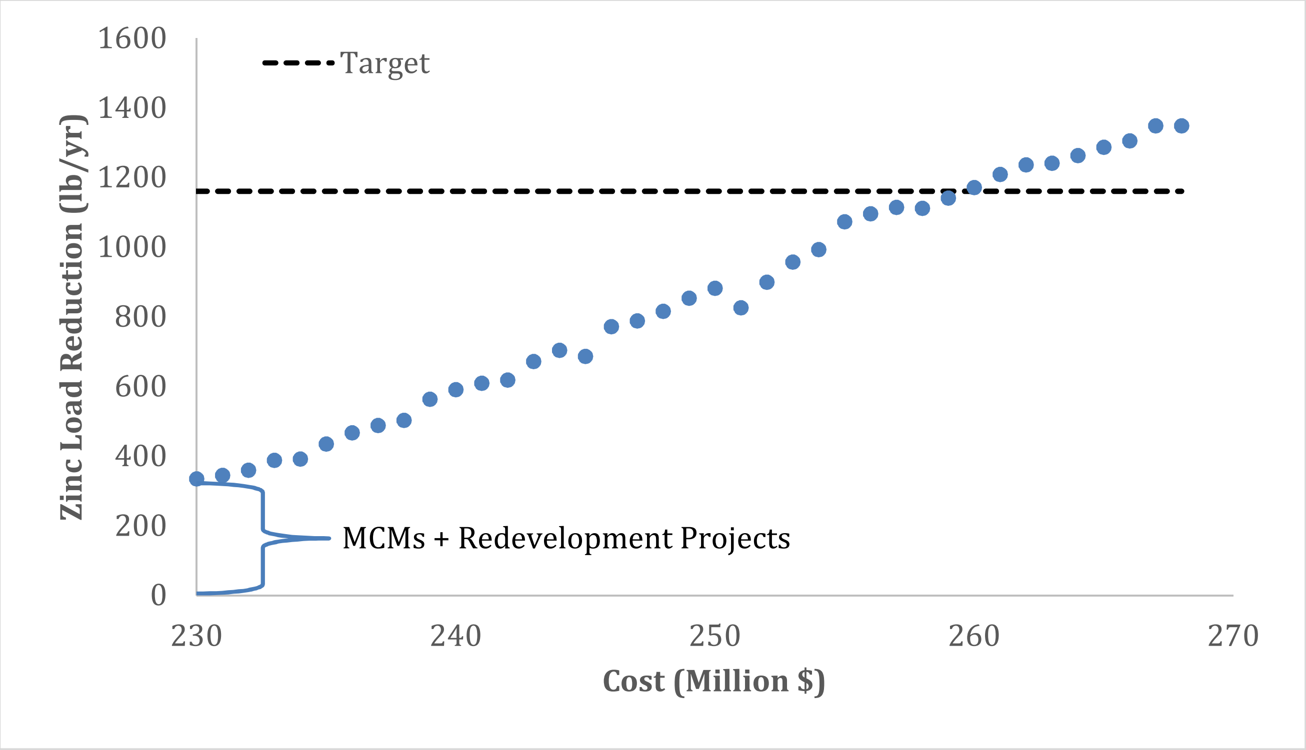


Figure 4-1. Cost-effectiveness curve for Multi-Benefit Regional Projects within the Rio Hondo drainage area (modeled costs are relative – see Attachment B for detailed engineering cost estimates).

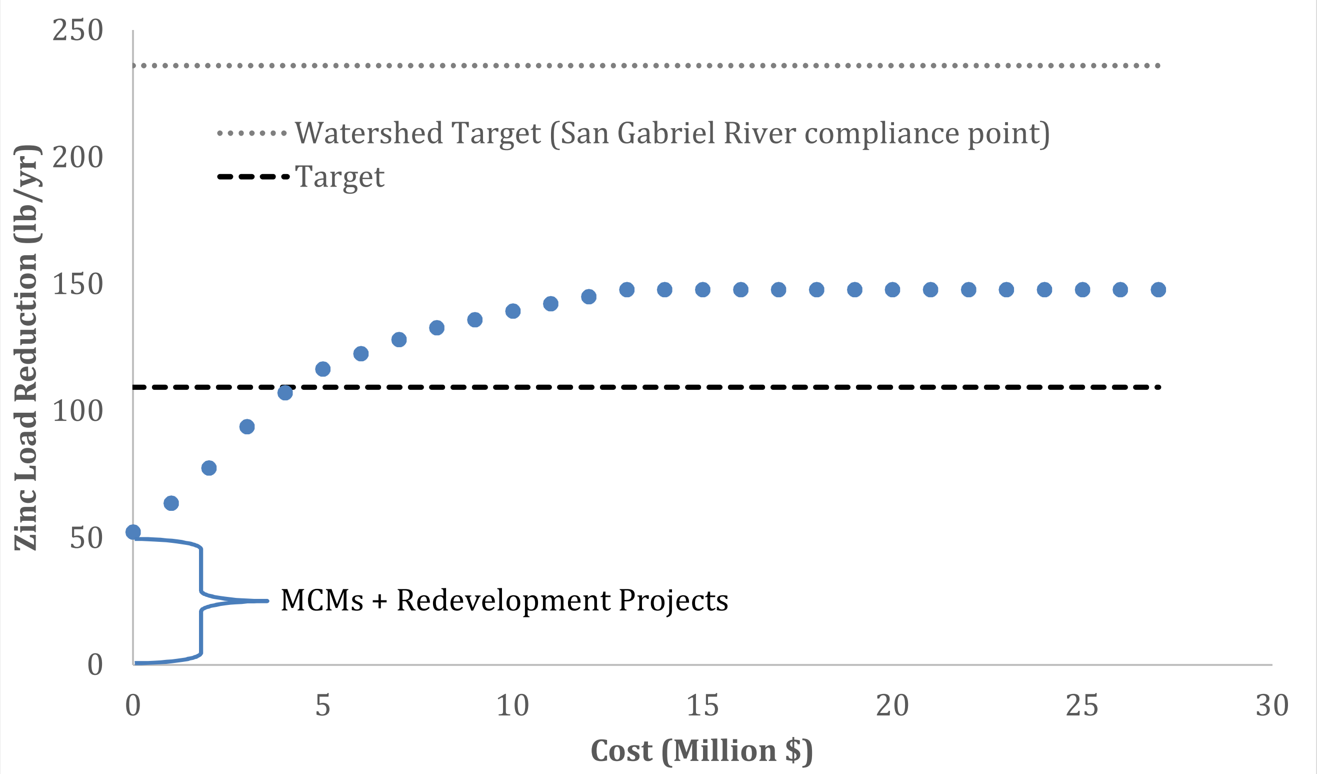


Figure 4-2. Cost-effectiveness curve for Multi-Benefit Regional Projects within the San Gabriel River drainage area. (modeled costs are relative – see Attachment B for detailed engineering cost estimates)

Table 4-2. Recommended Multi-Benefit Regional Project configurations.

Parameter	Rio Hondo Multi-Benefit Regional Project			San Gabriel River Multi-Benefit Regional Project	
	Arboretum Wetland Pond	Arboretum Recharge Pond (each side)	Rio Hondo Wetland	Encanto Underground Storage	Basin 3E Detention Basin
Length (ft)	500	500	2400	75	550
Width (ft)	50	30	150	150	180
Height (ft)	2.5	3	4	5	5
Diversion Rate (cfs)	30	N/A	185 (Sawpit Wash) + 37 (Arcadia Wash)	3	N/A
Load Reduction (lb/yr)	854.0			64.3	

The average annual volume captured by the Multi-Benefit Regional Projects is 1120 ac-ft/yr and 340 ac-ft/yr in the Rio Hondo and San Gabriel River drainage areas, respectively. This is based on a long term (10 year) period and broken up by jurisdiction in Table 4-3, based on the percent area within the EWMP boundary that drains to the respective compliance locations.

Table 4-3. Average Annual Volume Capture Achieved by Multi-Benefit Regional Projects by Jurisdiction.

Jurisdiction	Average Annual Volume Capture by Multi-Benefit Regional Projects (ac-ft/yr)	
	Rio Hondo	San Gabriel River
County	75.1	26.0
Bradbury	34.4	102.7
Sierra Madre	124.1	NA
Monrovia	355.3	NA
Duarte	59.2	211.7
Arcadia	471.4	NA

It is worthwhile to consider alternatives to the current recommendations if additional obstructions or constraints present themselves in the future. A number of additional alternatives were investigated for the RAA:

- Additional Multi-Benefit Regional Projects:
    - A vacant lot is located to the east of Santa Anita Wash, above Like Oak Ave. This presents the opportunity for a storage unit that diverts water from Santa Anita Wash before it reaches Peck Road Park Lake. The potential storage volume at this location is 6.54 acre-ft, with a 12,247 acre drainage area. There is also the opportunity to discharge the stored water to the sanity sewer, located along Live Oak. Discharge to the sanitary sewer would be pending coordination with the Sanitation Districts of Los Angeles County.
    - An additional wetland between the north and south basins of Peck Road Park Lake was investigated. This wetland would intercept Santa Anita Wash before flowing into Peck Road Park Lake. Additionally, the Arcadia Wash Water Conservation Diversion could route to this wetland instead of the Rio Hondo Wetland on the northeast side of the lake. A third option would exclude the diversion from Santa Anita Wash and only treat the Arcadia Wash diversion at this location. The total drainage area ranges from 5,253 acres (if only divert from Arcadia Wash) to 18,096 acres (if divert from Arcadia Wash and Santa Anita Wash). The potential volume of the wetland is 11 acre-ft.
- Adjustments to Existing Multi-Benefit Regional Projects:
    - If infiltration at the Rio Hondo Wetland can reasonably be increased to 0.8 in/hr (currently set to 0.3 in/hr based on County Standards) this would significantly increase the performance of the wetland. Overall a greater load reduction would be achieved with the same size and diversion parameters.
    - The Arboretum Project could exclude the groundwater recharge ponds. All outflow from the wetpond would be routed to Baldwin Lake or back to Arcadia Wash further downstream. In the recommended configuration the recharge ponds account for 16.5 lbs/yr of the load reduction, which is a little under half of the load reduction achieved from the Arboretum project.
    - The Rio Hondo Wetland could add a diversion from Santa Anita Wash, which would treat an additional 12,247 acres.
    - The Rio Hondo Wetland could remove the Arcadia Wash Water Conservation Diversion, which treats an additional 5,242 acres, and only divert water from Sawpit Wash.

No regional projects are proposed within the Big Dalton Wash drainage area. Therefore, the additional required load reductions will be addressed with distributed BMPs.

4.3 DISTRIBUTED BMPS – GREEN STREETS

Following load reductions achieved from Non-structural and Multi-Benefit Regional Projects, the performance of the proposed Distributed BMPs (Green Streets) were evaluated. As the required load reductions are achieved through the Non-structural and Regional BMPs for two of the three compliance points, green streets are only required for the Big Dalton Wash drainage area and the portion of the EWMP area draining downstream from the Rio Hondo compliance point (via Eaton Wash). Using the same optimization modeling, many configurations were identified by varying the length of potential green street opportunities.

For the Big Dalton Wash compliance point drainage area, a large portion is Azusa, who is not revising the EWMP for their City area. Therefore, the target is adjusted to focus on the County area from the EWMP boundary that drains to the Big Dalton Wash compliance point (25.1%), as green streets were focused in the County islands. The total required load reduction is 296 lb/yr at the Big Dalton Wash compliance point, where 79.8 lb/yr reduction is achieved through the non-structural BMPs. The County is responsible for 25.1% of the remaining 216.2 lb/yr required load reduction. Therefore, the additional required load reduction in County islands draining to the Big Dalton Wash compliance point, in addition to that achieved through non-structural BMPs, is 54.3 lb/yr. Figure 4-3 shows the zinc load reduction and associated cost for different combinations of green streets. There are many combinations which achieve a zinc load reduction above the target, before the slope of the curve levels off, where the increased performance diminishes with the increased cost.

The total drainage area and footprint of the combined green streets for the recommended configuration, which is a subsection of the identified potential opportunities from the screening process, is presented in Table 4-4. If an average width of 4 feet is assumed, the recommended green streets would span 7.8 miles. Table 4-4 also includes the total storage capacity of the recommended green streets and the volume captured by the over the critical water year. The average annual volume capture, based on a long term (10 year) period, is 113 ac-ft/yr. The footprint and drainage area for recommended green streets are further broken down by subwatershed in Table 4-5. Recall, two types of green streets were represented in the modeling, infiltrating and filtrating depending on the underlying soils, thus the total storage capacity of both types of recommended green streets within each subwatershed are presented in Table 4-5 as well.

Note that, while this planning-level analysis assumed certain green street cross sections (discussed in Section 3.2), alternative green street configurations of comparable stormwater capture potential may be substituted during implementation.

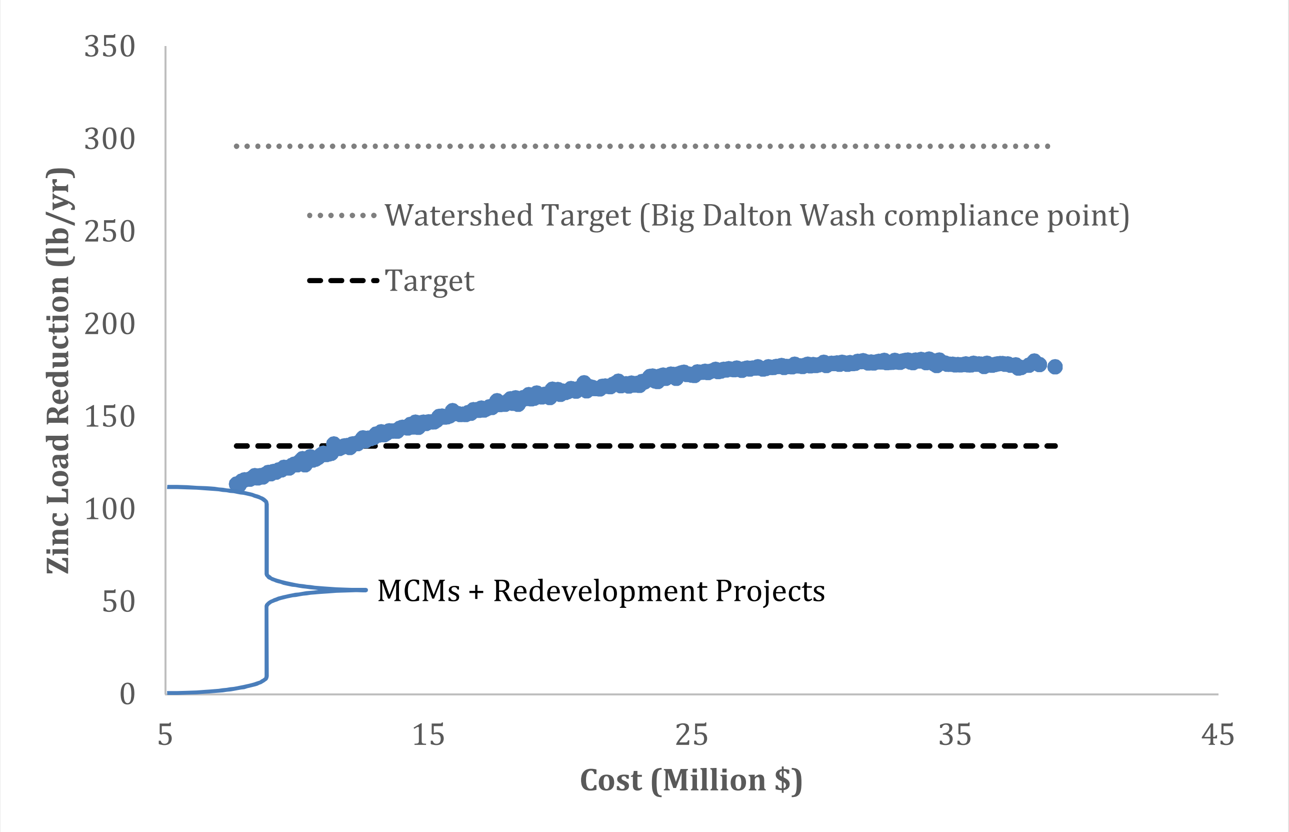


Figure 4-3. Cost-effectiveness curve for Green Streets in the County within the Big Dalton Wash drainage area.

Table 4-4. Recommended Green Street opportunities in County Islands within the Big Dalton Wash drainage area.

Total Drainage Area (ac)	Total Footprint (ac)	Cost, including 20 years O&M (Million $)	Load Reduction (lb/yr)	Storage Capacity (ac-ft)	Volume Capture (ac-ft/yr)
675	3.77	11.4	54.7	8.3	83.7

Table 4-5. Recommended Green Street opportunities in County Islands within the Big Dalton Wash drainage area by Subwatershed.

Subwatershed	Footprint (ac)	Drainage Area (ac)	Storage Capacity of Infiltration Green Streets (ac-ft)	Storage Capacity of Filtration Green Streets (ac-ft)
5431	0.449	45.22	0.865	0.139
5433	0.767	151.76	1.680	0.008
5435	0.118	12.61	0.260	NA
5438	0.522	62.27	NA	NA
5440	0.193	39.58	1.147	NA
5442	0.003	6.27	0.424	NA
5457	0.004	0.11	0.006	NA
5458	0.194	40.00	0.010	NA
5459	0.015	1.91	0.427	NA
5460	0.031	2.18	0.033	NA
5469	0.477	79.41	0.069	NA
5470	0.129	89.45	1.050	NA
5471	0.546	99.74	0.285	NA
5472	0.175	20.91	1.200	NA
5473	0.146	23.29	0.386	NA
Total:	**3.770**	**674.72**	**8.16**	**0.15**

As discussed, green streets were also evaluated for the portion of the EWMP area draining downstream from the Rio Hondo compliance point (via Eaton Wash). The recommended green street implementation is tabulated below in Table 4-6 and broken down by subwatershed in Table 4-7. Note that during future adaptive management--as the RH/SGR Water Quality Group gains more understanding about the projects located in their jurisdictions--the equivalent load and volume reductions provided by these green streets opportunities may be redistributed to multi-benefit regional projects in the Rio Hondo watershed.

Table 4-6. Recommended Green Street opportunities in Unincorporated County area draining downstream from Rio Hondo compliance point (via Eaton Wash).

Total Drainage Area (ac)	Total Footprint (ac)	Cost, including 20 years O&M (Million $)	Load Reduction (lb/yr)	Storage Capacity (ac-ft)	Volume Capture (ac-ft/yr)
327	5.22	15.8	59.5	11.5	83.3

Table 4-7. Recommended Green Street opportunities in Unincorporated County area draining downstream from Rio Hondo compliance point (via Eaton Wash) by Subwatershed.

Subwatershed	Footprint (ac)	Drainage Area (ac)	Storage Capacity of Infiltration Green Streets (ac-ft)
6217	1.114	74.79	2.45
6218	0.029	0.99	0.06
6228	1.456	104.65	3.20
6229	2.618	146.19	5.76
Total:	**5.218**	**326.63**	**11.48**

4.4 RAA VALIDATION

Table 4-8 summarizes the zinc load reductions achieved from the above-mentioned control measures. This demonstrates with reasonable assurance that the total achieved load reductions meet or exceed the required load reduction at each of the compliance points, and that clean water will be achieved by implementing the rEWMP.

Table 4-8. Zinc Load Reductions (lbs/yr) from the recommended control measures compared to the required load reduction at each compliance point.

Control Measure	Compliance Point		
	Rio Hondo	San Gabriel River	Big Dalton Wash
Enhanced MCMs and Redevelopment LID	333	52.2	79.8
Multi-Benefit Regional Projects	854	64.3	--
Distributed BMPs	--	--	54.8
Total	**1187**	**116.5**	**134.6**
Required	**1163**	**109.3**[1]	**134.1**[1]

1. Required reductions adjusted to exclude Azusa

The EWMP area draining downstream from the Rio Hondo Compliance point (via Eaton Wash) was evaluated independently from the established compliance points. Table 4-9 reports the load reductions achieved by projects in this area.

Table 4-9. Zinc Load Reductions (lbs/yr) from the recommended control measures compared to the required load reduction at each compliance point.

Control Measure	EWMP Area Draining Downstream from Rio Hondo Compliance Point
Enhanced MCMs and Redevelopment LID	17.4
Multi-Benefit Regional Projects[1]	24.0
Distributed BMPs	59.5
Total	**100.9**
Required	**98.1**

[1] Excess load reduction achieved by projects draining to the Rio Hondo compliance point (see Table 4-8)

The proposed milestones were aligned with the applicable metal TMDLs. The Los Angeles River Metals TMDL applies to the Rio Hondo compliance point and has one interim milestone (50% of final target), whereas the San Gabriel River Metals TMDL applies to the San Gabriel River and Big Dalton Wash compliance points and has two interim milestones (35% and 65% of final target). Table 4-10 shows the load reduction achieved from each control measure to meet interim milestones and final deadlines. Load reductions from enhanced minimum control measures are expected by the first interim milestone in all watersheds. Load reductions from redevelopment LID were based on average annual redevelopment rates at the interim milestones and by the final deadline. In the Rio Hondo and San Gabriel River drainage areas phases of the planned multi-benefit regional projects were established to meet interim milestones. Although primarily a water conservation project, the incidental water quality benefits from the Arcadia Wash Water Conservation Diversion will contribute towards meeting the 50% milestone in Rio Hondo by 2024. This project will divert flow from Arcadia Wash to Sawpit Wash, upstream of Peck Road Park Lake, and result in a load reduction of 468 lbs/yr, during the critical water year. This project is considered an update to the baseline watershed model rather than a water quality BMP. To meet the 65% milestone in San Gabriel River, the first cell of the Basin 3E Detention Basin (250’ x 180’ x 5’) will be built by 2023, and result in a load reduction of 25 lbs/yr, during the critical water year. In the Big Dalton Wash drainage area, a fraction of the green streets is required to meet the 65% milestone. The two highest performing green streets are recommended to be built by 2023, and result in a load reduction of 13.4 lb/yr, during the critical water year. The green streets are in subwatershed 5438 and 5469, with a drainage area of 62.26 acres with a footprint of 0.511 acres and a drainage area of 77.52 acres with a footprint of 0.454 acres, respectively.

Table 4-10. Zinc Load Reduction (lbs/yr) from Control Measures at each Milestone.

BMP	**Cumulative Load Reduced by Each Milestone**							
	Rio Hondo		**San Gabriel River**			**Big Dalton Wash**		
	50% Milestone (2024)	**Final Deadline (2028)**	**35% Milestone (2020)**	**65% Milestone (2023)**	**Final Deadline (2026)**	**35% Milestone (2020)**	**65% Milestone (2023)**	**Final Deadline (2026)**
Enhanced Minimum Control Measures	188	188	40	40	40	69	69	69
Redevelopment LID	100	145	6	9	12	5	8	11
Multi-Benefit Regional Projects	468	854	--	25	64	N/A	N/A	N/A
Green Streets	N/A	N/A	N/A	N/A	N/A	--	13	55
Total	757	**1187**	45	73	**116**	74	90	**135**
Milestone Target	*582*	***1163***	*38*	*71*	***109***	*47*	*87*	***134***

The EWMP area draining downstream from the Rio Hondo Compliance point (via Eaton Wash) was evaluated independently from the established compliance points. Table 4-11 reports the load reductions achieved at each Milestone. To meet the 50% milestone, a portion of the excess required load reduction achieved by the implementation of the Arcadia Wash Water Conservation Diversion by 2024 was credited to this area. The excess required load reduction achieved by the final deadline at the Rio Hondo compliance point was also credited to this area.

Table 4-11. Zinc Load Reduction (lbs/yr) from Control Measures in EWMP area draining downstream from Rio Hondo compliance point (via Eaton Wash) at each Milestone.

BMP	Cumulative Load Reduced by Each Milestone	
	Rio Hondo (via Eaton Wash)	
	50% Milestone (2024)	Final Deadline (2028)
Enhanced Minimum Control Measures	16.1	16.1
Redevelopment LID	0.90	1.3
Multi-Benefit Regional Projects	32.1[1]	24[2]
Green Streets		59.4
Total	49.1	**100.8**
Milestone Target	49.1	**98.1**

[1] The Arcadia Wash Water Conservation Diversion will support attainment of the 50% milestone in Rio Hondo EWMP area and results in an excess load reduction of 175 lb/yr (see Table 4-10). A portion of this excess load reduction is credited towards meeting the 50% milestone for the EWMP area draining downstream from the Rio Hondo compliance point (via Eaton Wash)

[2] Excess load reduction achieved by projects draining to the Rio Hondo compliance point (see Table 4-8)

To verify required load reductions and WQOs are met under the critical condition the selected control measures were integrated into the watershed model and pollutant loads were reevaluated at the compliance locations. The outputs from the SUSTAIN results for the selected configurations of the multi-benefit regional projects were utilized to evaluate the performance of the BMPs in the watershed model. At the diversion locations, or outlet location along Bradbury Channel into the Basin 3E project, the originally routed flow is removed from the watershed model and the output from the BMPs is included as a point source. This point source includes any non-diverted flows, bypass flows, and flows exiting the BMPs along with the constituent concentrations. The watershed model results show slightly different performance from the selected control measures than the SUSTAIN results, in terms of the annual load reduction on wet days. This is likely due to the more detailed routing and representation of associated environmental factors in the watershed model. Also, the 5% reduction attributed to MCMs had to be applied in post-processing of the watershed model, thus after evaluation of the multi-benefit regional projects (which is in the reverse order of the previous methodology). The difference in this 5% reduction applied pre- versus post-accounting of the multi-benefit regional projects was 55.7 lb/yr in the LAR and 4.5 lb/yr in the SGR, due to the percent reduction applied to a higher initial load in the former method. Load reductions from green streets in the Big Dalton Wash drainage area were not validated through the watershed model, due to the complexity of this integration in the watershed model.

Table 4-12 and Table 4-13 compare the results of the RAA to the baseline load reduction analysis. While the total required load reduction on wet days in achieved, at the LAR compliance point there are still three wet exceedance days. The exceedance days occur on the 10th, 7th, and 4th ranked wet day loads (out of 46 wet days). However, the flow on these days is the three lowest for all wet day loads above the 65th percentile. The required load reductions on each day are 25.7 lbs, 89.2 lbs, and 13.0 lbs and the percent reductions required are 24%, 50%, and 9%. At the SGR compliance point, the annual required load reduction, specific to Bradbury, Duarte, and the County (i.e. excluding Azusa) is achieved by the RAA. There are still three wet exceedance days, however a large portion of the drainage area to this compliance point, Azusa, is not addressed by this RAA.

The concentration curves demonstrate after the control measures are implemented the CTR criteria will be met 96.0% and 94.5% of all wet days at the Rio Hondo and San Gabriel River compliance points, respectively. The curves are based on daily concentrations over a long-term period (10/1/2001 → 9/30/2011). Together with the annual zinc load reduction under the critical condition validated above in Table 4-8, management of concentrations during greater than 90% of wet days (i.e., to 90th percentile conditions) provides an additional layer of reasonable assurance that the strategies outlined in this RAA will achieve clean water goals.

Table 4-12. Watershed model load reduction analysis for the Rio Hondo compliance point, evaluating the RAA versus the baseline.

Wet Days Summary	Baseline	After Implementation
Total Wet Days (10/1/2002 - 9/30/2003)	46	46
Total Wet Exceedance Days	9	3
Total Existing Load (Wet Days) (lbs/yr)	3822	2515
Total Allowable Load (lbs/yr)	2659	2387
Required Load Reduction (lbs/yr)	1163	128
Required Percent Reduction using 198 µg/L Total Zinc target	30%	5%

Table 4-13. Watershed model load reduction analysis for the San Gabriel River compliance point, evaluating the RAA versus the baseline.

Wet Days Summary	Baseline	After Implementation
Total Wet Days (10/1/2003 - 9/30/2004)	49	49
Total Wet Exceedance Days	12	6
Total Existing Load (Wet Days) (lbs/yr)	852	672
Total Allowable Load (lbs/yr)	616	629
Required Load Reduction (lbs/yr)	236	43
Required Percent Reduction using 260 µg/L Total Zinc target	28%	7%

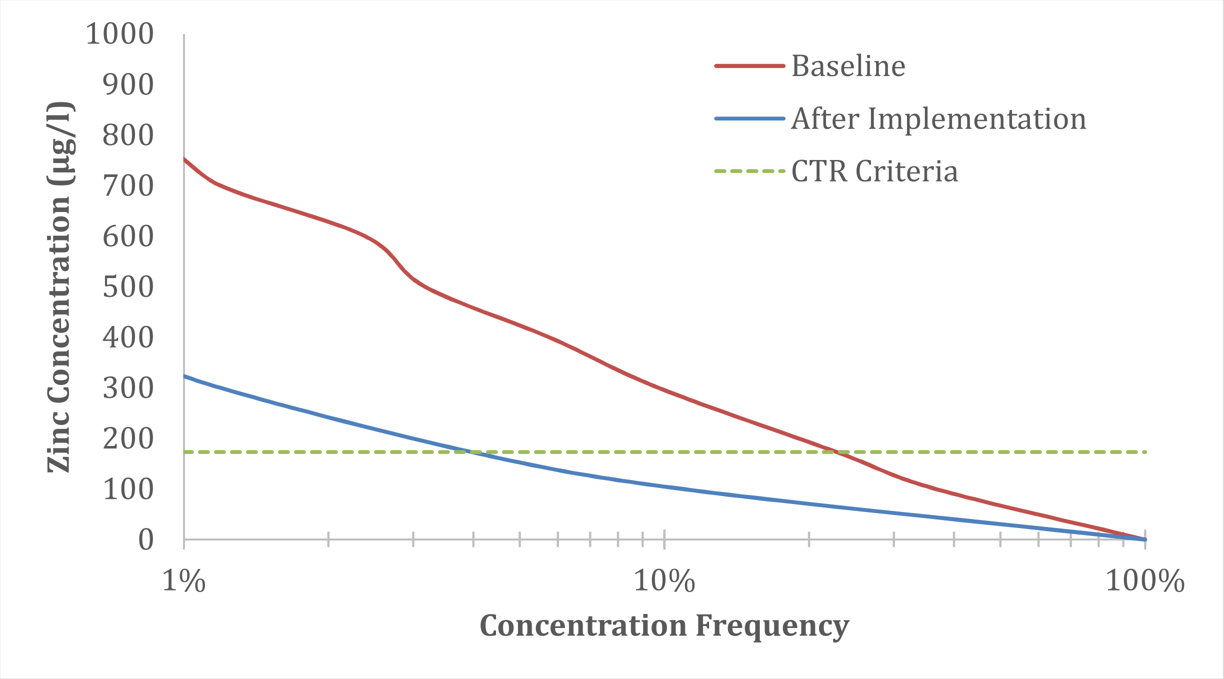


Figure 4-4. Rio Hondo Zinc Concentration Frequency Curves – Log Scale X-Axis.

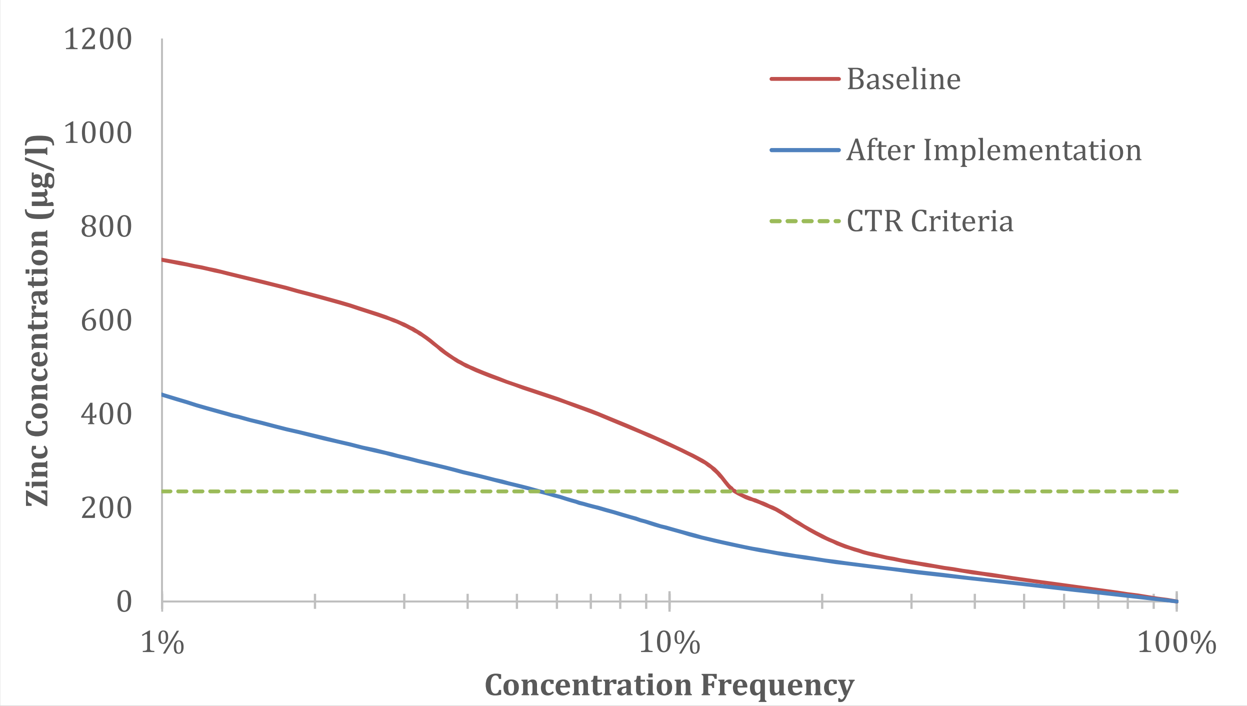


Figure 4-5. San Gabriel River Zinc Concentration Frequency Curves – Log Scale X-Axis.

4.5 DRY WEATHER RAA

Implementation of the above control measures is expected to address dry weather compliance, as dry weather flows are captured by the multi-benefit regional projects and green streets. All dry weather flow from Arcadia Wash upstream from Live Oak Ave and all dry weather flow from Sawpit Wash are diverted to a multi-benefit regional project. Dry weather flows from Santa Anita Wash are currently implicitly managed by Peck Road Park Lake. The San Gabriel River is a soft bottom channel, therefore issues with dry weather flows are minimal. Green streets in the small Unincorporated County Islands in the Big Dalton Wash drainage area are expected to manage nuisance flows. As previously stated in the accepted 2016 EWMP, base flows and dry-weather discharges from the EWMP area are not suspected to be a large contributor to the impairments identified in the LA River Bacteria TMDL, which present the most pressing dry weather issues.

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