LOS ANGELES RIVER & TRIBUTARIES

Total Maximum Daily Loads for Metals

FINAL IMPLEMENTATION PLAN FOR REACH 2 PARTICIPATING JURISDICTIONS

OCTOBER 11, 2010

This Implementation Plan is being submitted by the following jurisdictions:

• Alhambra • Arcadia • Bell • Bell Gardens • Bradbury • Commerce • Downey • Duarte • El Monte
• Huntington Park • Irwindale • La Canada Flintridge • Long Beach • Lynwood • Maywood • Monrovia
• Montebello • Monterey Park • Paramount • Pasadena • Pico Rivera • Rosemead • San Gabriel
• Sierra Madre • South Gate • South Pasadena • Temple City • Vernon • California Department of Transportation (Caltrans)




Prepared By:

CDM

Contents

Section 4 Structural BMP Runoff Capture Evaluation

Section 5 Implementation Plan

Section 6 Compliance Analysis

Figures

Tables

Acronyms

BMPs	Best Management Practices
BPP	Brake Pad Partnership
CAMP	Central Arroyo Master Plan
CARB	California Air Resources Board
CEH	Center for Environmental Health
CMP	Coordinated Monitoring Plan
CPI	Catchment Prioritization Index
CWA	Clean Water Act
CWP	Center for Watershed Protection
DD	*Dry Days**
EPA	Environmental Protection Agency
GIS	Geographic Information System
HWP	Hahamongna Watershed Park Master Plan
k_b	*Buildup*
k_w	*Wash-off*
LAMP	Lower Arroyo Master Plan
LAR	Los Angeles River
LARWQCB	Los Angeles Regional Water Quality Control Board
MS4	Municipal Separate Storm Sewer
NPDES	National Pollutant Discharge Elimination System
LACDPW	Los Angeles County Department of Public Works
NCDC	National Climatic Data Center
O&M	Operation and Maintenance
P_{max}	*Maximum Carrying Capacity*
P_t	*Prior To a Storm Event*
R	*Runoff Depth*
Reach 2	Los Angeles River Reach 2
Regional Boards	California Regional Water Quality Control Boards
RHSG	Rio Hondo Spreading Grounds
RHWMP	Rio Hondo Watershed Management Plan
SCAG	Southern California Area Governments
SCAQMD	South Coast Air Quality Management District
SUSMP	Standard Urban Stormwater Mitigation Plan
SWMP	Caltrans Stormwater Management Plan
SWRCB	California State Water Resources Control Board
TMDL	Total Maximum Daily Loads
VKmT	Vehicular Kilometers Traveled
W	*Watershed Surface*
WERF	Water Environment Research Federation

*Italicized acronyms are for the Quantification Methodology Equation (Section 3).

Executive Summary

Introduction

This Total Maximum Daily Loads (TMDL) Implementation Plan was prepared by the participating jurisdictions in the Los Angeles River Reach 2 (Reach 2) watershed of the Los Angeles River (LAR). The Plan defines the approach for meeting the requirements of the TMDL, as established in *Total Maximum Daily Loads for Metals, Los Angeles River and Tributaries* (Metals TMDL) *(*LARWQCB 2005).

The participating jurisdictions include the following, and are shown in Figure ES-1:

- Alhambra
- Arcadia
- Bell
- Bell Gardens
- Bradbury
- Commerce
- Downey
- Duarte
- El Monte
- Huntington Park
- Irwindale
- La Canada Flintridge
- Long Beach
- Lynwood
- Maywood
- Monrovia
- Montebello
- Monterey Park
- Paramount
- Pasadena
- Pico Rivera
- Rosemead
- San Gabriel
- Sierra Madre
- South Gate
- South Pasadena
- Temple City
- Vernon
- California Department of Transportation (Caltrans)

This Implementation Plan applies to the portion of these jurisdictions within the Reach 2 watershed of the LAR. In addition, this plan also applies to the small portion of the City of Pasadena that lies within Los Angeles River Reach 3 (Reach 3).

Regulatory and Permitting Requirements

The LAR Metals TMDL was first drafted by the LARWQCB in 2004. On June 2, 2005, the LARWQCB adopted the LAR Metals TMDL. Following State Board and State Office of Administrative Law approvals, EPA Region 9 approved the TMDL on December 22, 2005. The TMDL originally became effective on January 11, 2006.

Legal challenges to TMDL provisions arose and were subsequently resolved. Following resolution of these challenges, the TMDL was approved by the LARWQCB on September 6, 2007, by the SWRCB on June 17, 2008, by the Office of Administrative Law on October 14, 2008, and by EPA Region 9 on October 29, 2008. The TMDL became effective on October 29, 2008.

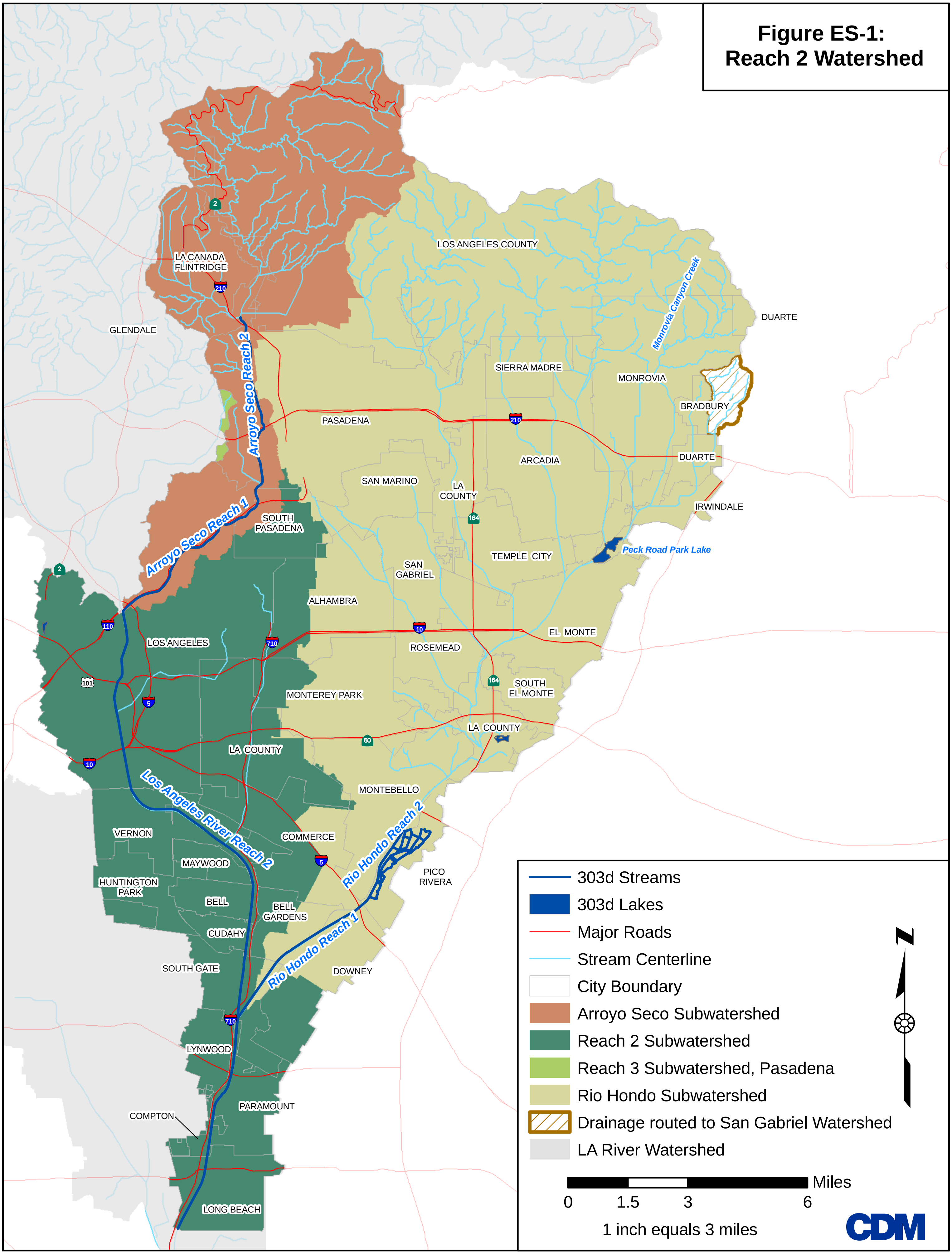


Figure ES-1:
Reach 2 Watershed
LOS ANGELES COUNTY
LA CANADA FLINTRIDGE
GLENDALE
DUARTE
Monrovia Canyon Creek
SIERRA MADRE
MONROVIA
BRADBURY
PASADENA
Arroyo Seco Reach 2
ARCADIA
DUARTE
SAN MARINO
LA COUNTY
IRWINDALE
SOUTH PASADENA
Arroyo Seco Reach 1
Peck Road Park Lake
TEMPLE CITY
SAN GABRIEL
ALHAMBRA
EL MONTE
LOS ANGELES
ROSEMEAD
SOUTH EL MONTE
MONTEREY PARK
LA COUNTY
LA COUNTY
Los Angeles River Reach 2
MONTEBELLO
VERNON
COMMERCE
Rio Hondo Reach 2
MAYWOOD
PICO RIVERA
HUNTINGTON PARK
BELL
BELL GARDENS
CUDAHY
Rio Hondo Reach 1
SOUTH GATE
DOWNEY
LYNWOOD
PARAMOUNT
COMPTON
LONG BEACH
2
210
110
710
101
5
10
164
60
303d Streams
303d Lakes
Major Roads
Stream Centerline
City Boundary
Arroyo Seco Subwatershed
Reach 2 Subwatershed
Reach 3 Subwatershed, Pasadena
Rio Hondo Subwatershed
Drainage routed to San Gabriel Watershed
LA River Watershed
N
0 1.5 3 6 Miles
1 inch equals 3 miles
CDM

The TMDL requires that Municipal Separate Storm Sewer System (MS4) permittees and Caltrans submit plans that are sufficient to address the following (LARWQCB 2005):

> "Each municipality and permittee will be required to meet the stormwater wasteload allocations shared by the…permittees at the designated TMDL effectiveness monitoring points. A phased implementation approach, using a combination of non-structural and structural BMPs, may be used to achieve compliance with the wasteload allocations. The administrative record and the fact sheets… must provide reasonable assurance that the BMPs selected will be sufficient to implement the waste load allocations."

Table ES-1 lists the interim and final TMDL compliance target dates defined by the LARWQCB (LARWQCB 2005):

Table ES-1 Interim and Final TMDL Compliance Target Dates

MS4 Drainage Area[1]	Compliance Target Date	
	Dry Weather Flow	Wet Weather Flow
25%	No Target	2012
50%	2012	2024
75%	2020	No Target
100%	2024	2028

[1]Percent of the MS4 drainage area that must be in compliance with the numeric limits of the TMDL by the compliance target date.

Watershed Description

Local, county, state, and federal resources, regulations, and guidelines in conjunction with geographic information system (GIS) data maintained by the Southern California Area Governments (SCAG) have been used to evaluate hydrologic and water quality characteristics in the Reach 2 watershed that will impact BMP siting.

The Reach 2 watershed consists of approximately 167,130 acres (or 31-percent) of the of the LAR watershed drainage area, and is contained wholly within Los Angeles County. This analysis also includes approximately 200 acres of the Reach 3 watershed located within the jurisdictional limits of the City of Pasadena, bringing the total analyzed drainage area to approximately 167,330 acres. The watershed consists of a varied topography, including undeveloped areas in the San Gabriel Mountains, as well as large urban centers generally northeast of the City of Los Angeles.

The Reach 2 watershed is comprised of approximately 320 stream miles in the Arroyo Seco subwatershed, Rio Hondo subwatershed, and the Reach 2 subwatershed. This area is defined from the LAR's confluence with the Arroyo Seco for the upstream limits to its intersection with West Market Street for the downstream limits, as shown in Figure ES-1. The main reach through the study area is the LAR, with the Arroyo Seco and Rio Hondo reaches as major tributaries.

Rainfall Characteristics

Historical rainfall records from three existing rain gauges located in or adjacent to the Reach 2 watershed were obtained and utilized in this analysis. The meteorological stations and resulting rain gauge data are maintained by National Climatic Data Center (NCDC). The San Gabriel Mountains create an orographic effect within the coastal plain, as shown by a 15-percent variability in the average annual rainfall monitored for the historical record, with the mean annual precipitation ranging from 13.53 inches to 14.51 inches. Generally, rainfall increases with proximity to the mountains. This variability reduces to 8-percent for the 85^{th} percentile storm, with rainfall depths ranging from 0.85 to 1.4 inches.

Flow Characteristics

The Los Angeles County Department of Public Works maintains eight stream gauge stations in the LAR watershed, two within the Reach 2 watershed. Daily mean stream flows were analyzed. Measured flows at these stations were compared to one another to assess the fraction of runoff in the LAR watershed that can be attributed to the Reach 2 watershed. The comparisons revealed that such an estimate cannot be made using data from these stations, as measured flow is not increasing in order of magnitude with increasing drainage area.

TMDL targets are set based on the definition of dry and wet weather, which can be determined using the stream flow data. For the LAR and its tributaries, a dry weather day is defined as a day where the maximum daily flow at station F319-R is less than 500 cubic feet per second. Therefore, it is critical to have a complete data set of flow rates for station F319-R. Preliminary analysis of station F319-R data did reveal some missing flow data due to unknown circumstances. To provide an approximation of the maximum daily flows for the missing days, flows from the nearest upstream station (F34D-R) were utilized. This provided the needed information to designate a wet or dry day, and proceed with evaluating water quality in the watershed.

Surface Water Quality

The Reach 2 watershed currently has metal TMDL limits defined for eight constituents. Water quality sampling for the study area was evaluated for these constituents using data at the Wardlow site recorded by the City of Los Angeles Status and Trends from July 2000 through August 2008. A water quality monitoring site is located at Del Amo Road within the Reach 2 watershed; however, flow data was not available for this site. For the compliance analysis (Section 6) it is necessary to use stream flow data to calculate the baseline copper load for Reach 2. This information is available at Wardlow, the next site downstream. Therefore, Wardlow data was used in this Implementation Plan.

A summary of grab sample exceedances over the sampling period for dry weather is provided in Table ES-2.

Table ES-2 Reach 2 Watershed Summary of Exceedances - Dry Weather

Constituent	Number of Exceedances by Location (Total Dry Samples)				
	Arroyo Seco @ San Fernando	**LAR @ Rosecrans**	**LAR @ Washington Blvd.**	**Rio Hondo @ Garfield Ave.**	**LAR @ Figueroa**
Copper, Dissolved	0 (34)	2 (73)	1 (69)	13 (34)	2 (73)
Copper, Total	1 (38)	7 (76)	9 (73)	20 (35)	7 (77)
Lead, Dissolved	2 (16)	2 (24)	1 (26)	3 (22)	3 (29)
Lead, Total	8 (26)	6 (34)	4 (41)	5 (32)	5 (40)
Zinc, Dissolved				0 (34)	
Zinc, Total				1 (35)	

(1) Based on TMDL limits from *Total Maximum Daily Loads for Metals Los Angeles River and Tributaries*, U.S. Environmental Protection Agency Region 9 and the California Regional Water Quality Control Board Los Angeles Region, June 2, 2005.

The LAR Reach 3 (Reach 3) watershed, upstream of the study area (LAR at Figueroa sample location), was included in the evaluation to identify possible concentration trends that may be impacting concentration levels in Reach 2 watershed. While the Reach 3 watershed is reporting similar results as the Reach 2 watershed, detailed sampling of smaller drainage areas would be required to confirm this correlation.

Table ES-3 provides a summary of exceedances for wet weather composite samples at Wardlow Road. The Wardlow Road station provides automated monitoring of the LAR. Historical data for the watershed at Wardlow showed non-compliance with several TMDL targets, most notably copper.

Table ES-3 Summary of Wardlow Road Station Composite Wet Weather Exceedances in the LAR Watershed

Constituent	Wet Weather TMDL Numeric Target (ug/l)	Number of Exceedances (Total Samples)
Total Cadmium	3	4 (31)
Total Copper	17	21 (31)
Total Lead	61	5 (31)
Total Zinc	159	10 (31)

Best Management Practices (BMPs)

There are several available BMP types that can reduce metals loading in the watershed. Generally, they are defined here as either non-structural or structural BMPs.

Non-structural BMPs

Non-structural BMPs can provide cost-effective water quality benefits by reducing or eliminating pollutants at their source. Effective implementation of these BMPs reduces the need for more costly structural BMPs. Non-structural BMPs include public education and outreach programs to change behavior, development policies that reduce impervious areas, ordinances that conserve water and minimize sources of dry weather flows, and product replacement efforts that eliminate sources of pollutants in the environment.

Non-structural BMPs are typically implemented at the municipal, county, or agency level of government, but may also be implemented statewide, where sufficient interest exists to regulate products identified as significant pollutant sources. For example, product replacement efforts are typically most successful when applied statewide (or even nationally) rather than locally. Non-structural BMPs also may include business incentives to reduce stormwater runoff from commercial and industrial areas to storm drains. Benefits of a comprehensive, effective non-structural BMP program include:

- *Flexibility* – The level of effort applied to program elements may be increased or decreased based on need. For example, if a particular program is found to be especially beneficial, resources may be increased (or diverted from less effective BMPs) to enhance the program.

- *Cost effective* – Structural BMPs are not only costly to build, but have continuing operation and maintenance (O & M) costs associated with them. In contrast, non-structural BMPs often have minimal capital costs and O&M associated with them. Because these programs may be applied to large areas to reach large numbers of people at the same time, these programs can be very cost effective in terms of water quality benefits.

- *Urban retrofit potential* – Much of the Reach 2 watershed is highly urbanized. The potential to retrofit infrastructure to capture and treat urban runoff is somewhat limited unless extremely costly land use conversion activities are implemented. Accordingly, the use of effective non-structural BMPs provides a much less costly approach to reducing pollutants in urban runoff.

- *Target specific sources* – Non-structural programs often can be designed to target not only specific pollutant sources, but also target to areas where pollutant loads are known to be particularly high.

Structural BMPs

Structural BMPs are engineered systems that can provide benefits for both water quantity and quality. The purpose is to provide water quality benefits to the watershed by removing metals from urban runoff through structural BMP implementation. To implement the most effective structural BMP on a site, many factors about the BMP itself should be evaluated including construction and maintenance costs as well as overall effectiveness. A tiered system based on cost and effectiveness assists in prioritizing structural BMPs for implementation.

Structural BMPs considered for the Reach 2 watershed were classified as having a regional, neighborhood, or lot level application. A regional or neighborhood BMP application is capable of accepting drainage from larger areas, typically spanning multiple land uses as well as owners. Lot level BMPs are better suited for accepting smaller drainage areas and are more appropriate for treating stormwater runoff from individual parcels of land. All structural BMPs evaluated as part of this Plan are effective in removing metals from stormwater runoff.

Common categories of regional, neighborhood, and lot level structural BMPs considered for implementation include:

- **Infiltration Systems.** Infiltration systems are constructed to infiltrate a calculated volume of water into the ground. Examples of infiltration systems include infiltration trench, infiltration basin, and porous or permeable pavement.

- **Detention Systems.** Detention systems are designed to temporarily detain a volume of water, allowing solids to settle out, before release to a downstream system. A detention system can be designed with a permanent pool (wet detention), where storage is provided above a defined permanent pool elevation.

- **Constructed Wetland Systems.** A constructed wetland is similar to a detention system, with the general exception of a shallower footprint that retains water to support wetland vegetation growth. Examples of constructed wetland systems include subsurface wetlands with detention and constructed wetlands/wet ponds.

- **Filtration Systems.** Filtration systems consist of a granular filtration media or separation process that removes constituents found in stormwater runoff. Examples of these systems include catch basin inserts, media filters, gross solids removal devices, and hydrodynamic devices. These are typically manufactured devices.

- **Biofiltration and Vegetated Systems.** Biofiltration and vegetated systems are designed to utilize vegetation to accept and treat stormwater runoff through infiltration into layers of plant roots and the growing medium. These systems can be as simple as a filter strip, a swale, a rain garden, or as complex as a bioretention cell.

Implementation Plan

The Reach 2 Watershed Metals TMDL Implementation Plan categorizes BMP implementation into three key areas:

- *New Development and Significant Redevelopment* – Water quality benefits to be obtained through ongoing implementation of new development and significant redevelopment activities;
- *Non-structural BMPs* – This area identifies new or enhanced existing non-structural BMP activities that will result in reductions of metals in urban runoff; and
- *Structural BMPs* – Emphasis of this area is identifying and implementing the necessary structural BMPs to fill expected water quality gaps not addressed by any of the above.

A fourth category would be to consider structural BMPs that have been implemented by developers or public agencies and demonstrate pollutant removal benefits. Since these projects provide water quality benefits not previously accounted for in the development of the TMDL, credit may be taken for their implementation as part of this Plan. At this time, these projects have not yet been identified for the Reach 2 watershed. However, during Phase 1 of the Implementation Schedule, these BMPs can be considered as part of the process to identify locations for structural BMP implementation.

The following sections describe the key implementation elements associated with the three BMP implementation categories listed previously.

New Development/Redevelopment

Developers are required to prepare a Standard Urban Stormwater Mitigation Plan (SUSMP) for new development or significant redevelopment projects if they fall within a prioritized category (as defined by the MS4 permit). Similarly, Caltrans has adopted a Stormwater Management Plan (SWMP) that specifies requirements for the implementation of BMPs in state transportation projects. Under this Plan the Reach 2 participating jurisdictions will continue to implement the approved SUSMP and SWMP requirements and will update them as required by future MS4 permits.

Non-structural BMPs

Table ES-4 provides an overview of recommended non-structural BMPs, the basis for prioritization as high, medium or low, and potential implementation activities. Each jurisdiction will select from the phased non-structural BMP program as outlined in Table ES-4 to determine the most beneficial non-structural BMPs to implement for their city.

Table ES-4 Prioritization and Potential Implementation Approach for Non-Structural BMPs

BMP Category	BMP Type	Priority	Basis for Prioritization	Proposed Implementation Approach
Direct Source Control	Vehicle Brake Pad Replacement	High	Removes a primary source of anthropogenic copper in the environment. Considered one of the primary keys to compliance with copper TMDL targets, which is shown by the compliance analysis to be the primary metal of concern (see Section 6). This BMP should also be a high priority for all stormwater dischargers in the Los Angeles River watershed. Accordingly, if implemented jointly benefits will accrue at relatively low cost.	• Consider participating in BPP activities to stay informed of implementation status, e.g., through California Stormwater Quality Association (CASQA) • Consider developing educational materials as needed to highlight impacts from brake pads • Where appropriate, consider coordinating with transportation agencies to promote water quality benefits of using public transportation which will enhance BPP benefits
	Tire Wheel Weight Replacement	Medium	Removes an important source of anthropogenic lead in the environment. Similar to vehicle brake pad replacement, the cost of implementation is low per the benefits gained. However, lead is not as important of a water quality of concern as copper (see Section 6); therefore, implementation of this BMP has a lower priority than brake pad replacement	• Consider providing funding to support passage of Senate Bill 757 in state legislature • Consider participating in relevant activities, as needed, to stay informed on implementation status, e.g., through CASQA • Consider developing educational materials as needed to highlight impacts from lead tire weights and need to support implementation of legislation • Where appropriate, consider coordinating with transportation agencies to promote water quality benefits of using public transportation
	Pesticide Use	Low	Studies have shown that copper-based pesticides are commonly used in the San Francisco Bay Area and can be an important source of anthropogenic copper. It is assumed that these findings are applicable to the Reach 2 area as well. Use of replacement products may provide benefits as long as the replacement does not cause its own water quality concern. Implementation of this BMP is of lower priority than the brake pad replacement BMP and may be best handled through hazardous waste use practices/ordinances.	• Consider conducting study to evaluate opportunities to reduce metals in pesticides: o Identify commonly used/sold pesticides that are potential metals sources in region o Identify safer alternative products, if any o Evaluate effectiveness of existing pesticide management policies/ordinances o Develop recommendations to reduce metals-based pesticides with implementation schedule • Consider implementing recommendations of any completed study activities, as appropriate

Table ES-4 (Continued)

BMP Category	BMP Type	Priority	Basis for Prioritization	Proposed Implementation Approach
Direct Source Control	Vehicle Tire Wear Reduction	Low	Tread wear is a significant source of particulate pollutants which contain metals; however, the means to reduce this source is limited at this time to programs that reduce vehicle usage, e.g., through increased use of public transportation. Because of limited expectation for significant reduction through this type of BMP, implementation priority is low.	• Consider evaluating the effectiveness of public transportation education campaigns and incentive programs, and develop recommendations for modifications to enhance programs • Consider developing new or revise existing educational materials as needed to highlight impacts of driving on water quality • Consider coordinating where appropriate with transportation agencies to promote water quality benefits of using public transportation
	Roof Materials Control	High	Roofing materials contain numerous metals, including copper, which readily leach during wet weather runoff. There may be opportunities to work with the building industry to identify alternative roofing materials that have reduced metals content. In addition, control of roof-based metals can be enhanced through a strong downspout disconnect program that is coupled with other BMPs that discourage runoff, e.g., development practices that reduce offsite runoff through appropriate post-construction treatment controls. Implementation of this program not only reduces metals, but other pollutants of concern including bacteria. Long term benefits are significant if linked up with the downspout disconnection BMP; accordingly, this BMP was given a high priority.	• Consider coordinating with California Building Industry Association and other relevant stakeholders to support use of alternative materials with reduced metals content • Consider working with planning agencies and regulators to encourage incorporation of alternative materials into building guidelines • If sufficient need and alternative materials available, consider developing an ordinance to require use of specified materials for building • Consider coordinating implementation of this BMP program with downspout disconnection BMP.
	Street Sweeping	Medium	Program already provides significant water quality benefits and such efforts should continue. It may be appropriate to conduct pilot study to evaluate if program can be enhanced to provide additional water quality benefits. However, because any improvements represent an incremental benefit that may be somewhat costly vs. the benefit, the priority is listed as medium.	• Consider conducting study to evaluate opportunities to enhance/modify street sweeping programs: o Collect data to identify hot spot or target areas to focus street sweeping o Evaluate potential benefits from changes in sweeper type, frequency of sweeping, targeted vs. general sweeping, etc. • Consider implementing recommendations from any completed study activities, as appropriate

Table ES-4 (Continued)

BMP Category	BMP Type	Priority	Basis for Prioritization	Proposed Implementation Approach
Direct Source Control	Catch Basin Cleaning	Medium	Program already provides significant water quality benefits and such efforts should continue. It may be appropriate to conduct pilot study to evaluate if program can be enhanced to provide additional water quality benefits. However, because any improvements represent an incremental benefit that may be somewhat costly vs. the benefit, the priority is listed as medium.	• Consider conducting study to evaluate opportunities to enhance/modify catch-basin cleaning program: o Collect data to identify hot spot or target areas to focus catch-basin cleaning o Evaluate effectiveness of existing program and develop recommendations to enhance program to increase water quality benefits • Consider implementing recommendations from any completed study activities, as appropriate
Public Education and Outreach	Used Oil Recycling Individual Car Washing Vehicle Maintenance	Medium	Education BMPs are low cost and easily implemented; accordingly, all existing education programs would be reviewed under this BMP to evaluate how materials need to be changed or updated (if at all) to improve the message and better target metals. Although a low cost BMP, because this BMP already exists any additional water quality benefits from enhanced of modified education materials are expected to be relatively small. Accordingly this BMP was given a medium priority.	• Consider evaluating effectiveness of existing public education materials to target metals sources; similarly, evaluate targeted audience for public outreach to ensure education message is targeted appropriately • Consider modifing material/outreach venues as needed to increase opportunities to target message
Policies and Ordinances	Water Conservation	Medium	Encouraging and even enforcing water conservation provides multiple community benefits that go far beyond water quality benefits. A strong program will significantly reduce dry weather flows in the MS4 that not only greatly reduces metals reaching storm drains but other pollutants as well. Implementation of this BMP, which is best supported through the adoption and implementation of an ordinance, will greatly increase the likelihood of consistent compliance with the 2024 dry weather TMDL target. This BMP was given only a medium priority because the primary water quality concerns in Reach 2 exist during wet weather. Focus on wet weather controls will likely address any remaining dry weather runoff concerns.	• Consider evaluating existing water conservation programs, policies and ordinances to (1) determine where improvements are needed in areas such as coverage, implementation method, and enforcement; (2) consolidate and coordinate water conservation efforts; (3) develop recommendations for development of an ordinance • Consider developing model ordinance for optional use by Reach 2 participating jurisdictions (Note: existing ordinances already in use in the area could be used as template). • Consider establishing and implementing water conservation ordinance

Table ES-4 (Continued)

BMP Category	BMP Type	Priority	Basis for Prioritization	Proposed Implementation Approach
Policies and Ordinances	Development Practices	High	Where physically possible, increased emphasis on the use of BMPs that reduce or eliminate urban runoff from a new development or significant redevelopment (e.g., infiltration), will over a long period of time not only support compliance with the metals TMDL but future TMDLs as well, e.g., bacteria. This BMP should be a high priority, not only because of the potential water quality benefits, but because the next Phase I MS4 permit is expected to contain more stringent development requirements. Developing this BMP now will ultimately support MS4 permit requirements.	• Consider evaluating existing BMP requirements applicable to new development or redevelopment projects • Consider taking into account local/physical limitations, identify alternative practices that promote reduction of urban runoff to storm drains • Consider developing model new development and redevelopment requirements that would result in reduced runoff from development projects (requirements already in use by Reach 2 cities could be used as a template) • Consider developing necessary policies or ordinances, as needed, to support implementation • Consider developing specifications or guidelines, as needed, to support implementation, e.g., specifications for use of porous pavement or construction of green streets
	Downspout Disconnection Program	High	Where roof downspouts can be retrofitted to direct runoff onsite rather than to a storm drain (or stored for future use in a cistern or rain barrel), reductions in pollutant loads during wet weather can be significant. This program can be relatively expensive to implement, but the long-term benefits of increased water conservation and reduced loads of all pollutants, especially bacteria, are significant. Program should be a high priority for implementation, but phased to spread out the cost.	• Consider developing and implementing downspout disconnection program. Activities may include: o Developing specifications for downspout disconnect program, including redirection of downspouts to pervious areas, use of rain gardens, rain barrels and cisterns (Information can be developed from existing programs in other areas) o Identifying areas for prioritized targeting of downspout disconnect program o Developing model pilot program for targeted implementation within participating jurisdictions, including development of incentive programs to encourage implementation on private land o Implementing pilot program in targeted areas o Developing and implementing phased area-wide program based on findings from pilot program

Table ES-4 (Continued)

BMP Category	BMP Type	Priority	Basis for Prioritization	Proposed Implementation Approach
Planning & Coordination	General Plan Update	Low	Incorporation of urban runoff management principles into city planning decisions provides the foundation needed to drive ordinances and policies regarding how water is managed and the city is developed. Modifications of General Plans can be time intensive processes and involve agencies or departments outside of those tasked with managing stormwater; therefore, this BMP was given a low priority.	• Consider coordinating with City planning department (or department tasked with maintaining City's General Plan) on opportunities to revise the General Plan to incorporate urban runoff management elements • Consider developing recommendations and schedule for modifications to City's General Plan, including zoning, transportation, and land use development, to promote better urban runoff management • Consider working with appropriate departments to implement recommendations
	Watershed Coordination Activities	High	Given the significant budget concerns of all governmental jurisdictions, opportunities need to be actively sought to collaborate on project implementation - regardless of whether the BMPs are structural or non-structural. This BMP is intended to provide a mechanism for each participating jurisdiction to stay aware of where opportunities exist for joint implementation of BMPs that provide benefits to multiple jurisdictions.	• Consider reviewing the following: o Existing practices to ensure that an appropriate level of coordination among legal entities (e.g., cities, agencies and NGOs) is occurring o Methods to simplify/improve cost-sharing among potential watershed partners to achieve needed water quality improvements, e.g., through development of MOAs or MOUs o Existing approach for taking advantage of state and federal grant opportunities • Consider developing recommendations based on the findings from the review of existing practices and methods for coordination • Consider implementing recommendations, as appropriate

Structural BMPs

Identification of structural BMPs for implementation in the Reach 2 watershed requires execution of the following process:

- **Identification of high priority areas** within the Reach 2 drainage area based on an analysis of areas expected to generate high levels of metals relative to the rest of the watershed. By targeting high priority areas, higher amounts of pollutants would be removed if BMPs were to be implemented in these areas.
- **Identification of opportunity sites** within the previously identified high priority areas. These sites would have sufficient space available to site a BMP (with size requirements varying for lot level, neighborhood level and regional BMPs).
- **Selection of appropriate BMPs** for implementation at opportunity sites (from the list of BMPs described in Best Management Practices (BMPs) previously).

Final structural BMP type and site selection will require extensive coordination among multiple jurisdictions for design, construction, and operation and maintenance. This activity will occur during Phase 1 implementation (See Implementation Schedule). To support this effort, the Implementation Plan includes the use of hypothetical scenarios to develop information on the potential benefits that may be obtained from selected structural BMPs. This information provides a baseline for evaluating what types of structural BMPs would be most beneficial to participating jurisdictions, in terms of construction cost and overall water quality benefit.

The effects of implementing a structural BMP on a given site were approximated using hydrology modeling software. This hypothetical model evaluated impacts of BMP installation in the watershed, assuming optimal use of a given site. The results of the percent stormwater runoff capture determined as part of this analysis were then extrapolated over the Reach 2 watershed. The goal of the model was to find when optimal treatment of a respective structural BMP is achieved for constituent reduction in the hypothetical drainage area. For evaluation, optimal parameters were established by finding when the hypothetical site's treatment capacity would need to be increased in order to achieve needed pollutant removal.

The hypothetical structural BMP site evaluation considered the BMP size categories discussed previously: regional, neighborhood and lot level. Typical BMPs associated with each of these categories were evaluated to approximate optimal treatment capabilities. The categories and structural BMP types evaluated include:

- **Regional Structural BMPs.** Hypothetical models were developed for an infiltration basin, detention basin, and wetland facility.
- **Neighborhood Structural BMPs.** A hypothetical model was developed for a bioretention cell application.
- **Lot Level Structural BMPs.** A hypothetical model was developed for a porous pavement application.

The results of the hydrologic simulations were used to estimate metals load removal from different size storm events as a function of influent concentration and effluent concentration:

$$M_{removed} = V_{capture} * (C_{influent} - C_{effleunt})$$

The runoff volume captured ($V_{capture}$) is the portion of runoff captured by a given BMP, with the total volume determined based on the 85th percentile storm, runoff coefficients for each land use, and the tributary area of each BMP (the volume captured would be equal to the total volume if the BMP were sized accordingly). The influent concentration ($C_{influent}$) is also based on land use, using known event mean concentrations (EMCs) for each land use type. The effluent concentration ($C_{effluent}$) is estimated for each of the possible BMPs being considered. The resulting amount of metal removed ($M_{removed}$) was ultimately used in the compliance analysis to estimate the effects of implementing each structural BMP.

Implementation Schedule

The TMDL dry and wet weather targets are based on the percent of the MS4 drainage compliant at interim and final TMDL compliance dates (see Table ES-1). The basis for evaluating compliance with these targets is the Coordinated Monitoring Plan (CMP) developed and implemented jointly by the LAR watershed MS4 permittees. The CMP was implemented in October 2008.

Implementation activities will be phased over the period of TMDL implementation, 2010 to the date when full compliance is to be achieved in 2028. Results from the first year of CMP sampling indicate that the 2012 and 2020 dry weather targets are currently being met. In addition, based on analyses of the Reach 2 watershed, which includes the Rio Hondo Spreading Grounds (RHSG), the 2012 wet weather target is currently being met and the 2024 is largely met. Given these findings, the Implementation Plan schedule (Table ES-5) is a four-phased approach. The participating jurisdictions will begin implementation by (1) focusing on non-structural BMP activities; and (2) finalizing the siting of structural BMPs. In the latter phases of implementation, the need for structural BMPs will likely increase, in particular to meet the 2028 wet weather compliance target. As long as engineering processes are implemented by early Phase 2, there is sufficient time in the schedule for the needed planning, design and construction activities to take place before these BMPs need to be in place and functioning.

Tables ES-6 and ES-7 provide more detailed information regarding phased implementation of non-structural and structural BMP activities, respectively. The emphasis during Phase 1 will be (1) implementation of selected non-structural BMP programs; and (2) identification of prioritized locations for structural BMP implementation. The planning, design and construction activities of these structural BMPs will begin in Phase 2 and continue through Phase 4. Deferring implementation of structural BMP projects until Phase 2 is warranted given that the Reach 2 watershed is currently in compliance with the 2012 dry and wet weather targets.

Table ES-5 Phased Implementation in Reach 2 Watershed

Phase	Period of Implementation[1]	Applicable Compliance Target	Key Implementation Activities[2]
Phase 1	2010 – 2011	2012 – dry (50%) wet (25%)	Non-Structural • Implement non-structural BMPs according to phased schedule in Table 5-4 Structural • Finalize identification of structural BMP locations and develop prioritization (high, medium, low) and implementation approach for selected BMPs
Phase 2	2012 – 2019	2020 – dry (75%)	Non-Structural • Implement non-structural BMPs according to phased schedule in Table 5-4 Structural • Complete planning and design phases for medium and high priority structural BMPs • Construct highest priority structural BMPs Other • Periodically evaluate compliance status; revise BMP requirements, as needed
Phase 3	2020 – 2023	2024 – wet (50%)	Non-Structural • Implement non-structural BMPs according to phased schedule in Table 5-4 Structural • Construct medium priority structural BMPs • Implement planning and design phases for low priority structural BMPs Other • Periodically evaluate compliance status; revise BMP requirements, as needed
Phase 4	2024 - 2028	2028 – wet (100%)	Non-Structural • Implement non-structural BMPs according to phased schedule in Table 5-4 Structural • Construct low priority structural BMPs

Table ES-6 Phased Implementation of Non-Structural BMP Program

BMP	Phase 1 (2010 – 2011)	Phase 2 (2012 – 2019)	Phase 3 (2020 – 2023)	Phase 4 (2024 – 2028)
Vehicle Brake Pad Replacement	Senate Bill 346 signed into law September 27, 2010	Support implementation activities		
Tire Wheel Weight Replacement	Support legislative efforts for passage of Senate Bill 757	No new activity (assumes legislative success by 2012)		
Pesticide Use	No activity	Evaluate potential for action and implement as needed by end of Phase 3		No new activity
Vehicle Tire Wear Reduction	No activity	Evaluate potential for action and implement as needed by end of Phase 3		No new activity
Roof Materials Control	Implement building and planning agency coordination activities; evaluate need for ordinance/revised specifications	Establish and implement as needed ordinance and/or revised specifications; implement downspout disconnect program	No new activity	
Street Sweeping	No new activity – continue implementation at current levels	Evaluate existing program to identify opportunities to increase efficiency		No new activity
Catch Basin Cleaning	No new activity – continue implementation at current levels	Evaluate existing program to identify opportunities to increase efficiency		No new activity
Public Education & Outreach	Evaluate and revise public education and outreach materials/programs as needed to focus on metals	Continue to review and revise as needed		
Water Conservation	Develop water conservation model ordinance	Establish ordinance by end of Phase 3		No new activity
Development Practices	Establish model requirements that reduce offsite runoff consistent with future MS4 permit expectations	Revise MS4 program as needed and implement new practices; update as needed over long term to incorporate new concepts or methods		
Downspout Disconnect Program[1]	Establish program for implementation	Implement downspout disconnects at rate determined by Phase 1 structural BMP selection	Implement downspout disconnects at rate determined by Phase 1 structural BMP selection	Implement downspout disconnects at rate determined by Phase 1 structural BMP selection
General Plan Update	Identify areas for revision and establish schedule for implementation	Revise General Plan by end of Phase 3		No new activity
Watershed Coordination	Review existing coordination; identify improved mechanisms and implement	Continue high level of coordination		

1 – The number of downspout disconnections implemented in the Reach 2 watershed is dependent on the number of structural BMPs implemented. The rate of implementation needed will be determined during Phase 1.

Note: Each jurisdiction will select from the phased non-structural BMP program as outlined in Table ES-4 to determine the most beneficial non-structural BMPs to implement for their city.

Table ES-7 Phased Structural BMP Implementation Activities

Activity	Phase 1[1] (2010 – 2011)	Phase 2[1, 2] (2012 – 2019)			Phase 3[1, 2] (2020 – 2023)			Phase 4[1, 2] (2024 – 2028)		
		High	Medium	Low	High	Medium	Low	High	Medium	Low
BMP Selection	Establish prioritized BMP list and mechanisms for implementation	Review/revise prioritized list (as needed)			Review/revise prioritized list (as needed)			Review/revise prioritized list (as needed)		
Planning	No activity	Complete	Complete	No activity	No activity	No activity	Complete	No activity	No activity	No activity
Design	No activity	Complete	Complete	No activity	No activity	No activity	Complete	No activity	No activity	No activity
Construction	No activity	Complete	Initiate	No activity	No activity	Complete	Initiate	No activity	No activity	Complete
O & M	No activity	Initiate	No activity	No activity	Ongoing	Initiate	No activity	Ongoing	Ongoing	Initiate

1 – Terms "complete", "initiate" or "no activity" are relevant to the end of the phase. For example, for Phase 2, planning, design, and construction activities for all high priority structural BMPs will be complete by end of 2019.

2 - High, medium or low priority designation based on analysis completed under BMP Selection activity to be completed under Phase 1.

Note: Each jurisdiction will select from the phased non-structural BMP program as outlined in Table ES-4 to determine the most beneficial non-structural BMPs to implement for their city.

The phased structural BMP approach established by this Plan also recognizes that the Reach 2 watershed is comprised of many legal jurisdictions. Implementing BMP projects in areas where the sources of urban runoff may be derived from a number of jurisdictions requires that the Plan factor in the time needed to develop and implement mechanisms for potential cost-sharing of implementation.

Compliance Analysis

Using the quantifications of pollutant load removal for non-structural BMPs (Section 3) and structural BMPs (Section 4), the level of implementation effort needed to reduce baseline metals loads from the jurisdictions participating in this TMDL Implementation Plan to meet the total treatment area for compliance can be approximated.

Pollutant Load Quantification

To quantify the load reduction needed in Reach 2, the following general calculations were evaluated for total copper:

- **Runoff Event = 0.1 inch.** Runoff from this event over the entire LAR watershed MS4 area (~301,600 acres) is approximately 2,500 acre-feet or 3.1 x 10^9 liters.

$$LAR\ Watershed\ Runoff = \mathbf{3.1\ x\ 10^9\ Liters}$$

- **Baseline Load of Total Copper, LAR Watershed.** The product of concentration and runoff volume approximate the baseline load of total copper as summarized in Table ES-8 by runoff event monitored at the Wardlow station.

Table ES-8 Baseline Copper Loads from Wardlow Monitoring Data

Date	Daily Runoff Volume (ac-ft)	Approximate Runoff Depth (in)[1]	Total Copper Concentration (ug/L)[2]	Baseline Copper Load (kg/day)[3]
10/28/2000	2,300	0.09	11	30
1/11/2001	25,200	1.00	9	294
1/25/2001	1,400	0.06	18	32
3/6/2001	10,100	0.40	8	103
11/24/2001	9,500	0.38	30	351
12/20/2001	1,000	0.04	16	19
1/28/2002	3,300	0.13	15	61
11/8/2002	12,200	0.49	26	390
12/16/2002	16,300	0.65	19	382
2/11/2003	45,000	1.79	13	716
3/15/2003	36,800	1.46	10	434
10/28/2003	24,800	0.99	20	608
10/31/2003	6,200	0.41	295	2,255
12/25/2003	23,600	0.94	21	602
1/1/2004	9,200	0.37	16	184
10/17/2004	4,500	0.18	42	230
10/26/2004	17,300	0.69	51	1,079
12/6/2004	2,500	0.10	35	108
1/7/2005	23,400	0.93	31	897
10/18/2005	2,900	0.12	51	183
12/31/2005	5,200	0.21	12	77
1/14/2006	1,000	0.04	16	20
2/18/2006	2,400	0.10	44	130
12/9/2006	2,900	0.19	424	1,516
2/19/2007	1,400	0.06	77	133
2/22/2007	2,200	0.09	49	132
9/22/2007	7,100	0.47	123	1,077
10/13/2007	3,300	0.22	255	1,037
07-08 Event 29	4,400	0.18	58	312
07-08 Event 31	2,600	0.10	26	83
07-08 Event 32	6,700	0.27	44	362

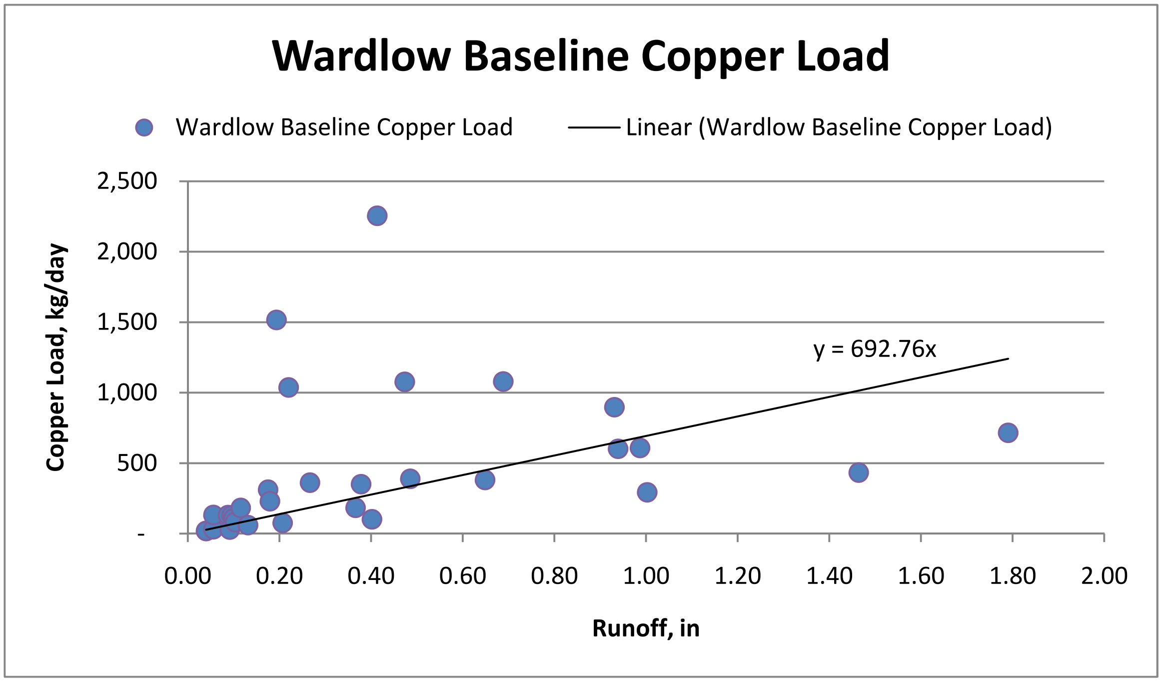
[1]Runoff Depth (in) = Daily Runoff Volume (ac-ft) * 301,600 acre * 12 in / 1 ft

[2] Numeric target is 17 µg/l

[3]*Baseline Copper Load (kg) = Total Copper Concentration (µg/L) * Runoff Volume (ac-ft) * (1 kg / $1(10)^9$ µg)* (28.3 ft^3/1 ac-ft)*

Figure ES-2 shows the baseline copper loads plotted against runoff depths as calculated in Table ES-8. A linear regression was performed on the data to approximate an average baseline copper load, as represented by "Linear (Wardlow Baseline Copper Load)."

Figure ES-2 Baseline Copper Load versus Runoff Depth at Wardlow



For a 0.1 inch runoff event, the baseline copper load can be calculated using the equation of the linear relationship shown in Figure ES-2

$$0.1\ inches * 692.7\ = \mathbf{69\ kg}$$

- **Total Allowable Copper, LAR Watershed.** The allowable total copper load for the 0.1 inch runoff event is determined by the wasteload allocation from the TMDL, which is a direct function of runoff volume converted to liters (Table 6-12, TMDL Staff Report). Therefore, the baseline load of 106 kg must be reduced to 42 kg by all stormwater permittees.

$$1.7\ x\ 10^{-8} * 3.1\ x\ 10^{9}\ Liters - 10 = \mathbf{42\ kg}$$

- **Required Load Reduction.** Per the TMDL, the proportion of the MS4 drainage area within the Reach 2 watershed contributing to the overall load determines the fraction of the total load reduction to be achieved. This MS4 drainage area for Reach 2 was calculated as 37,900 acres (this does not include the Rio Hondo drainage area upstream of the RHSG), which accounts for approximately 15-percent of the total LAR watershed MS4 area at Wardlow (301,600 acres). Therefore, this Implementation Plan should provide approximately 15-percent of the load reduction needed over the entire LAR watershed. Based on the preceding example for total copper during a 0.1-inch runoff event, the load reduction to be achieved by this Implementation Plan is 4.0 kg.

$$15\% * (69\ kg - 42\ kg) = \mathbf{4.0\ kg}$$

Using the quantifications of pollutant load removal for new development and redevelopment projects, non-structural BMPs (Section 3) and structural BMPs (Section 4), the level of implementation effort needed to reduce baseline metals loads from the jurisdictions participating in this TMDL Implementation Plan to meet the total treatment area for compliance can be approximated. It is estimated that development projects and non-structural BMPs would provide approximately 45-percent of the estimated total copper load reduction, and that structural BMPs would provide approximately 55-percent of the estimated total copper load reductions.

Redevelopment and New Development

Load reductions are expected to occur from redevelopment and new development projects that must comply with stormwater permits. Using the assumed redevelopment rate of 2-percent from SCAG, approximately 500 acres of MS4 drainage area within the participating jurisdictions (outside of the RHSG watershed), will be routed to a structural BMP to control metals, other pollutants, and address downstream effects of increasing imperviousness. An approximate metals load removal expected from BMPs implemented to meet stormwater permit requirements provides some credit toward the reductions goals for the participating jurisdictions within the Reach 2 watershed. This mass removal is estimated by taking modeled load reductions for a hypothetical infiltration BMP and applying per acre removal rates to the 500 acres of redevelopment. The total copper load reduction per acre of MS4 tributary area estimated for a hypothetical infiltration basin during a 0.1-inch runoff depth is 0.00023 kg. Using this approach, it is estimated that load reduction for total copper could be achieved:

$$500\ acres * 0.00023 \frac{kg}{acre} = \mathbf{0.1\ kg}$$

Some jurisdictions may opt to take a more stringent approach to managing stormwater runoff through their existing stormwater program. This could provide removals in excess of the estimated 500 acres of larger-scale redevelopment, which could potentially offset the level of implementation for other non-structural and regional structural BMPs included in this Implementation Plan.

Non-Structural BMPs

Brake pad replacement legislation (Senate Bill 346) was signed into law on September 27, 2010. Implementation of this legislation will provide significant metals removal effectiveness, as described in Section 3, relative to cost of implementation. Assuming the average copper content in brake pads could be reduced to approximately 5-percent by the 2028 compliance milestone, brake pad replacement could achieve a load reduction of 1.7 kg, or 43-percent of the total copper load reduction needed.

Benefits are expected from other non-structural programs over time, but these benefits are very difficult to quantify. However, non-quantified programs provide a measure of conservatism or margin of safety to the overall implementation program. As implementation proceeds, it is important to periodically re-evaluate water quality in the impaired waters to determine if water quality is better than expected. If so, then the number of structural programs potentially can be reduced, as appropriate.

Structural BMPs

The portion of load reduction that is planned for control using structural BMPs is 55-percent, or 2.2 kg of total copper. The total copper load reduction per acre of MS4 tributary area estimated for a hypothetical infiltration basin during a 0.1-inch runoff depth is 0.00023 kg. Therefore, an implementation plan that included infiltration BMPs to capture approximately 10,000 acres of MS4 area would provide sufficient load reduction to achieve the 2.2 kg of total copper load reduction that would be needed during this size event.

$$\frac{2.2\ kg}{0.00023\ kg/acre} = \mathbf{10,000\ acres}$$

However, this is not a technically feasible alternative due to the limited set of large, publically owned properties and various infiltration constraints at potential sites. Consequently, implementation of a mix of structural BMP projects that take advantage of existing land use and available publically-owned open space will be needed. Taking into account differences in structural BMP size and the load reduction expected from different types of projects, the total MS4 area that may be directed to a structural BMP will range from 10,000 acres to 22,000 acres. Although classified as a non-structural BMP because of the need to establish a BMP program, for the purposes of the compliance analysis downspout disconnections will be considered as a structural BMP option that would provide treatment to a portion of this MS4 tributary acre target.

Using this information, Reach 2 jurisdictions will identify during Phase 1 specific structural BMPs for construction that provide treatment of at least 10,000 acres. As noted elsewhere, this acreage will be increased or even decreased based on the findings from ongoing water quality monitoring and will be re-evaluated at the major milestones defined in Section 5.

Program Costs

Implementation Plan program estimated cost ranges were developed at a planning level for structural and non-structural BMP implementation (Table ES-9). Structural BMP capital and O & M planning level cost ranges were developed for the representative BMP applications of regional, neighborhood, and lot level (Section 4.4.1) using the Water Environment Research Federation (WERF) and LID Whole Life Cost Models, Version 2.0. Non-structural BMP planning level cost considerations were identified (Section 7.3).

Structural BMP implementation costs were calculated by extrapolating the estimated cost per acre developed for each type of application (Section 7.2.1) over the estimated area needed for treatment (10,000 – 22,000 acres) as defined in Section 6. A treatment area of 15,000 acres was used to estimate program costs. These cost ranges may increase if actual treatment acreage increases beyond the projected 15,000 acres. This cost range assumes that only one type of structural BMP is chosen for implementation. In reality, a combination of regional, neighborhood, and lot level solutions will be implemented to treat the projected 15,000 acres. Clearly, regional solutions are the most cost effective. However, given the high level of urbanization, regional BMP projects will have to be greatly supplemented by neighborhood and lot level projects. The result will be higher costs for compliance.

For planning level non-structural BMP implementation cost ranges, a conservative assumption of 15-percent of total capital costs of regional BMP facility costs was assumed for budgeting purposes. Exact non-structural BMP costs are difficult to approximate without specific plans in place.

As these are planning level cost ranges, both structural and non-structural implementation plan cost estimate ranges should be re-evaluated during all phases of the Implementation Plan, as specific details on the both of these programs are evaluated and coordinated between the participating jurisdictions.

Table ES-9 Implementation Plan Los Angeles River Reach 2 Metals TMDL – Planning Level Cost Ranges

				Implementation Plan Planning Level Costs	
Planning Level Costs	**MS4 Treated Area (acres)(2)**	**Facility Capital Cost Range per Acre**	**Annual O&M Cost Range per Acre**	**Range of Capital Cost**	**Range of Annual O&M Cost**
Structural BMPs					
Regional	15,000	$3,800 to $24,000	$19 to $360	$57,000,000 to $360,000,000	$285,000 to $5,400,000
Neighborhood	15,000	$31,000 to $80,000	$360 to $5,500	$465,000,000 to $1,200,000,000	$5,400,000 to $82,500,000
Lot Level	15,000	$58,000 to $240,000	$1,100 to $8,400	$870,000,000 to $3,600,000,000	$16,500,000 to $126,000,000
Non-Structural BMPs(1)				$8,550,000 to $54,000,000	*NA* to *NA*

(1) As a placeholder, planning level cost estimated as 15-percent of the total regional BMP capital cost, includes cost of downspout disconnection program.
(2) Based on projected treatment of 10,000 – 22,000 acres. Actual treatment acreage may be higher.

Implementation Challenges

The participating jurisdictions have identified three significant challenges associated with implementation of this Metals TMDL in the Reach 2 watershed:

Control of Indirect Sources – Air Deposition

A common source of metals and other potentially toxic pollutants is dry deposition of particulates from urban sources, e.g., highways and industry (e.g., Sabin et al. 2005; Sabin et al. 2006a, b; Lim et al. 2006). The LARWQCB addressed metals loadings from air deposition by including them in the MS4 wasteload allocations (LARWQCB 2005). Much of this load is not derived from the MS4, but from other sources over which the MS4 permittees have no control. The transference of responsibility of air deposition sources to the MS4 creates a significant challenge for achieving compliance with final wet weather targets. In its resolution to adopt the Los Angeles River Metals TMDL into the Basin Plan for the Los Angeles Region the State Water Resources Control Board (SWRCB) acknowledged the need to address this issue at the state level (SWRCB Resolution #2008-0046).

This TMDL Implementation Plan includes a number of non-structural BMPs that support reduction of metals loadings that are derived from particulate sources such as industrial activity or re-suspension of particulates from roadways. However, regardless of progress made by Plan participants towards reducing pollutant loads from these indirect sources, the participating jurisdictions expect the LARWQCB and SWRCB to fulfill its commitments to addressing this issue as stated in Findings #10 and #11 of SWRCB Resolution #2008-0046.

Implementation Costs

Implementation costs will be very high given the highly urbanized nature of the Reach 2 watershed. Given the many participating jurisdictions in this watershed, opportunities exist for cost-sharing. However, even with cost-sharing, budget limitations may affect BMP implementation, in particular structural BMP implementation. While participating jurisdictions are committed to the principles of this Plan, the ability to implement required BMPs will depend on the availability of sufficient funds. Without significant state and/or federal sources of funding, it will be difficult to implement significant BMPs. Action by the state to address indirect sources, over which participating jurisdictions have no ability to control, will increase the likelihood of achieving compliance with all TMDL targets.

Multi-Jurisdictional Coordination

Many jurisdictions make up the Reach 2 watershed. This fact creates significant challenges for the siting, design and implementation of BMPs, especially structural BMPs. Successful implementation requires that significant coordination occurs among jurisdictions. During Phase 1 of implementation, the participating jurisdictions in this Plan will identify prioritized locations for the implementation of structural BMPs. Issues regarding how to share implementation responsibilities including costs will need to be addressed prior to moving into design and construction. In addition, issues regarding long-term operation and maintenance responsibilities will also need to be addressed. These issues will not only involve the participants of this Plan, but may also involve other jurisdictions, e.g., City of Los Angeles or Los Angeles County, if the planned BMP includes drainage from any of their jurisdictions

Section 1 Background

This Total Maximum Daily Loads (TMDL) Implementation Plan describes activities planned for implementation primarily in the Los Angeles River Reach 2 (Reach 2) watershed to comply with requirements established in *Total Maximum Daily Loads for Metals, Los Angeles River and Tributaries (*Los Angeles Regional Water Quality Control Board [LARWQCB] 2005) (Metals TMDL). As required by the TMDL, a draft Implementation Plan was submitted to the LARWQCB on January 11, 2010. On June 14, 2010, the LARWQCB provided comments on the draft Plan and a request for submittal of a final Implementation Plan by October 11, 2010. This submittal fulfills that request.

1.1 Participating Jurisdictions

This Implementation Plan was prepared on behalf of the following participating jurisdictions:

- Alhambra
- Arcadia
- Bell
- Bell Gardens
- Bradbury
- Commerce
- Downey
- Duarte
- El Monte
- Huntington Park
- Irwindale
- La Canada Flintridge
- Long Beach
- Lynwood
- Maywood
- Monrovia
- Montebello
- Monterey Park
- Paramount
- Pasadena
- Pico Rivera
- Rosemead
- San Gabriel
- Sierra Madre
- South Gate
- South Pasadena
- Temple City
- Vernon
- California Department of Transportation (Caltrans)

It applies to the portion of these jurisdictions within the Reach 2 watershed of the Los Angeles River (LAR). In addition, this Plan also applies to the small portion of the City of Pasadena that lies within Reach 3.

1.2 Regulatory and Permitting Requirements

To follow is the regulatory background and an overview of the regulatory requirements associated with the Metals TMDL.

1.2.1 Federal and State Law

The Clean Water Act (CWA) provides the basis for the protection of all inland surface waters, estuaries, and coastal waters. The federal Environmental Protection Agency (EPA) is ultimately responsible for implementation of the CWA and its associated regulations. However, many of these responsibilities have been delegated to the states and in some cases tribal governments.

California, like other states, implements the CWA by promulgating its own water quality protection laws and regulations. As long as this authority provides equivalent protections as the federal CWA, EPA can delegate CWA responsibilities to the state. In some cases, California has established requirements that are more stringent than federal requirements.

The 1970 Porter-Cologne Water Quality Control Act grants the California State Water Resources Control Board (SWRCB) and nine California Regional Water Quality Control Boards (Regional Boards) broad powers to protect water quality. This Act and its governing regulations provide the basis for California's implementation of CWA responsibilities. In the LAR watershed, the LARWQCB is the governing regulatory agency.

1.2.2 Water Quality Requirements

The LARWQCB designates "beneficial uses" for waterbodies in the watersheds that it governs (Table 1-1) and adopts water quality objectives to protect these uses (see LARWQCB 1994, as amended). In some cases, EPA may also promulgate objectives where it makes a finding that the state's objectives are not protective enough to protect the beneficial use. The nature of the objectives is directly related to the type of beneficial use. For example, the freshwater warm habitat beneficial use protects aquatic organisms resident in warm-water streams. The associated water quality objectives are for those constituents known to affect both the growth and reproduction of aquatic life. These objectives range from physical characteristics such as temperature, dissolved oxygen, and pH to potential toxic constituents including metals and organics. In California, the objectives for metals and a number of organic compounds have been established by the federal EPA rather than the state (CTR 2000).

A TMDL establishes the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. Depending on the nature of the pollutant, TMDL implementation requires limits on the contributions of pollutant from point sources (wasteload allocation), nonpoint sources (load allocation), or both.

The LARWQCB is responsible for TMDL development in the LAR watershed. Adoption of a TMDL requires an amendment to Water Quality Control Plan for the Los Angeles Region Basin Plan, which identifies the beneficial uses and objectives to protect waters in this watershed (LARWQCB 1994, as amended). After the LARWQCB adopts the TMDL, it is submitted to the State Board for approval. After State Board approval, the TMDL must be approved by the State Office of Administrative Law and EPA Region 9 before it can become effective.

CWA Section 303(d) requires states to "regularly" identify waterbodies not meeting water quality objectives even after all required effluent limitations have been implemented (e.g., through a wastewater or stormwater discharge permit). These waters are often referred to as "303(d) listed" or "impaired" waters. Waterbodies that are listed on the 303(d) list typically require development of a TMDL for the pollutant(s) impairing the use of the water. Development and approval of the 303(d) list is a lengthy state and federal process. A list is not effective until EPA (Region 9) approves the list. The current EPA-approved 303(d) list for California is the 2006 list.

Table 1-1 Beneficial Uses Identified for the Reach 2 Watershed

Waterbody	Municipal & Domestic Supply	Industrial Process Supply	Industrial Service Supply	Groundwater Recharge	Water Contact Recreation	Limited Contact Water Recreation	Non-Contact Water Recreation	Warm Freshwater Habitat	Cold Freshwater Habitat	Wetland Habitat	Marine Habitat	Wildlife Habitat	Rare, Threatened, or Endangered Species	Migration of Aquatic Organisms	Spawning, Reproduction, and/or Early Development	Shellfish Harvesting
Reach 2 (Figueroa St. to Carson St.)	X			X	X		X	X				X				
Reach 1 (Carson St. to Estuary)	X	X	X	X	X		X	X			X	X	X	X	X	X
Rio Hondo Reach 1 (Los Angeles River upstream to Santa Ana Freeway)	X			X	X		X	X				X				
Rio Hondo Reach 2 (above spreading grounds)	X			X	X		X	X				X				
Arroyo Seco Reach 1 (Los Angeles River to West Holly Avenue)	X			X	X		X	X				X				
Arroyo Seco Reach 2 (Figueroa St. to Riverside Ave.)	X	X	X	X	X	X		X	X	X		X				

The impaired waters listing process identified the following impairments for metals in the Reach 2 watershed: Reach 2 – copper and lead; Rio Hondo Reach 1 – copper, lead, and zinc; and Peck Road Park Lake - lead. In addition, downstream of Reach 2 and the Rio Hondo, Reach 1 is impaired for copper, lead, zinc, and cadmium. These findings contributed to the development of the Metals TMDL.

1.2.3 Metals TMDL Development History

The LAR Metals TMDL was first drafted by the LARWQCB in 2004, and on June 2, 2005, the LARWQCB adopted the LAR Metals TMDL. Following State Board and State Office of Administrative Law approvals, EPA Region 9 approved the TMDL on December 22, 2005. The TMDL originally became effective on January 11, 2006.

Legal challenges to TMDL provisions arose and were subsequently resolved. Following resolution of these challenges, the TMDL was approved by the LARWQCB on September 6, 2007, by the SWRCB on June 17, 2008, by the Office of Administrative Law on October 14, 2008, and by the US Environmental Protection Agency on October 29, 2008. The TMDL became effective on October 29, 2008.

This Implementation Plan is written in response to the TMDL's requirements to submit a final Implementation Plan by October 11, 2010.

1.2.4 Metals TMDL Numeric Limits

The Metals TMDL divides point source implementation responsibilities among the following discharge permit holders:

- Non-stormwater National Pollutant Discharge Elimination System (NPDES) permits, e.g., wastewater facilities
- General industrial stormwater permits
- General construction stormwater permits
- Municipal Separate Storm Sewer (MS4) and Caltrans stormwater permits

The most stringent TMDL requirements apply to the MS4 and Caltrans permit holders. This includes the Reach 2 participating jurisdictions, which are permitted under (1) the NPDES MS4 permit issued to Los Angeles County and 84 incorporated cities (all cities in the county except the City of Long Beach) (LARWQCB 2001); and (2) NPDES MS4 statewide permit issued to Caltrans.

Tables 1-2 through 1-4 summarize the Metals TMDL numeric targets, loading capacity, and wasteload allocations established for the Reach 2 watershed. These tables also provide information for Reach 1, the receiving waterbody for flows out of the Reach 2 area.

1.2.5 TMDL Compliance Requirements

As stated in the Metals TMDL, the Implementation Plan must be sufficient to address the following (LARWQCB 2005):

> "Each municipality and permittee will be required to meet the stormwater wasteload allocations shared by the…permittees at the designated TMDL effectiveness monitoring points. A phased implementation approach, using a combination of non-structural and structural BMPs, may be used to achieve compliance with the wasteload allocations. The administrative record and the fact sheets… must provide reasonable assurance that the BMPs selected will be sufficient to implement the waste load allocations."

Following are the interim compliance dates defined by the LARWQCB (LARWQCB 2005):

- **January 11, 2012** – demonstrate that 50-percent of the drainage area is in compliance with dry weather wasteload allocations, and 25-percent of the drainage area is in compliance with wet weather wasteload allocations

- **January 11, 2020** – demonstrate that 75-percent of the drainage area is in compliance with dry weather wasteload allocations

- **January 11, 2024** – demonstrate 100-percent of the drainage area is in compliance with dry weather and 50-percent of the drainage area is in compliance with wet weather wasteload allocations

- **January 11, 2028** – demonstrate 100-percent of the drainage area is in compliance with both dry and wet weather wasteload allocations

Table 1-2 Numeric Targets

TMDL Target	Waterbody	Metal (µg/L)			
		Cadmium	Copper[3,5,6]	Lead[3,5,6]	Zinc[4,5]
Dry Weather Total Recoverable Metals Targets[1,2]	Reach 2	-	22	11	-
	Reach 1	-	23	12	-
	Arroyo Seco	-	22	11	-
	Rio Hondo Reach 1	-	13	5	131
Wet Weather Total Recoverable Metals Target[7,8]	Reach 2 and 1, Arroyo Seco, Rio Hondo Reach 1	3.1	17	62	159

Notes:
1 Dry weather targets apply to days when maximum daily flow in the river is less than 500 cfs at Wardlow gage.
2 Dry weather conversion factors used to convert total recoverable to dissolved fraction: copper = 0.96; lead = 0.79; zinc = 0.61
3 Dry weather targets for copper and lead are based on chronic California Toxic Rule (CTR) criteria.
4 Dry weather targets for zinc are based on acute CTR criteria.
5 Copper, lead and zinc targets dependent on water hardness.
6 Copper and lead targets based on 50th percentile hardness values, since targets based on 10th percentile hardness values.
7 CF Wet weather conversion factors for copper, lead, and zinc to convert total recoverable to dissolved based on regression of data collected at Wardlow gage: copper = 0.65; lead = 0.82; zinc = 0.61. Conversion factor for cadmium taken from CTR = 0.94.
8 Wet weather targets for cadmium, copper, lead and zinc based on acute CTR criteria and the 50th percentile hardness values for stormwater collected at Wardlow gage station.

Table 1-3 Loading Capacity

TMDL Target	Waterbody	Critical Flow² (cfs)	Cadmium	Copper	Lead	Zinc
			kg/day			
Dry Weather[1,3]	Reach 2	4.44	-	0.16	0.084	-
	Reach 1	2.58	-	0.14	0.075	-
	Rio Hondo Reach 1	0.5	-	0.015	0.0061	0.16
Wet Weather[4]			(µg/L)			
	Daily Storm Volume (L) times:		3.1	17	62	159

Notes:
1. For dry weather, loading capacities are equal to reach-specific numeric targets multiplied by reach-specific critical dry weather flows.
2. Critical flow for entire river is 203 cfs, by summing critical flows for each reach and tributary. This is equal to the combined design flow of the 3 POTWs (169 cfs) (Tillman, Los Angeles Glendale, Burbank) plus median flow from storm drains and tributaries (34 cfs). Median storm drain and tributary flow is equal to the median flow at Wardlow gage (145 cfs) minus the existing median POTW flow (111 cfs).
3. The dry weather loading capacities for each impaired reach include the critical flows for upstream reaches, e.g., the dry-weather loading capacity for Reach 2 includes flow from Arroyo Seco.
4. Wet weather loading capacities are calculated by multiplying daily storm volumes by the wet weather numeric target for each metal. Resulting curves identify the load allowance for a given flow.

Table 1-4 MS4 Stormwater Wasteload Allocations (Total Recoverable Metals)

TMDL Target	Waterbody	Critical Flow (cfs)	Cadmium	Copper	Lead	Zinc
			(kg/day)			
Dry Weather[1]	LA River Reach 2	3.86	-	0.13	0.07	-
	LA River Reach 1	2.58	-	0.14	0.07	-
	Arroyo Seco	0.25	-	0.01	0.01	-
	Rio Hondo Reach 1	0.5	-	0.01	0.006	0.16
Wet Weather[2]			(µg /L/day)			
		Daily Storm Volume (L) times:	3.1×10^{-9} - 1.95	1.7×10^{-8} - 10.4	6.2×10^{-8} - 4.2	1.6×10^{-7} - 90

Notes:
1. Dry weather wasteload allocations for stormwater are equal to storm drain flows (critical flows minus median POTW flows minus median open space flows) multiplied by reach-specific numeric targets, minus the contribution from direct air deposition.
2. Wet weather wasteload allocations for the grouped stormwater permittees are equal to the total loading capacity minus the load allocations for open space and direct air deposition and the wasteload allocations for the POTWs. Wet weather wasteload allocations for the grouped stormwater permittees apply to all reaches and tributaries.

Section 2
Reach 2 Watershed

The Reach 2 watershed participating jurisdictions completed a characterization of the watershed during the development of this Implementation Plan. This information provides the foundation for the siting and selection of structural BMPs during implementation. The following sections provide a summary of key watershed characteristics and their relevance to BMP implementation.

2.1 Watershed Description

Local, county, state, and federal resources, regulations, and guidelines in conjunction with geographic information system (GIS) data maintained by the Southern California Area Governments (SCAG), have been used to evaluate hydrologic and water quality characteristics in the Reach 2 watershed that will impact BMP siting.

The Reach 2 watershed consists of approximately 167,130 acres (or 31-percent of the drainage area) of the LAR watershed, and is contained wholly within Los Angeles County. This analysis also includes approximately 200 acres of the Reach 3 watershed located within the jurisdictional limits of the City of Pasadena, bringing the total analyzed drainage area to approximately 167,330 acres. The watershed consists of a varied topography, including undeveloped areas in the San Gabriel Mountains, as well as large urban centers northeast of the City of Los Angeles.

2.1.1 Watershed Jurisdictions

Thirty-eight jurisdictions, including Caltrans, cross or are located within the Reach 2 watershed boundary, as shown in Figure 2-1. Table 2-1 provides a complete list of these local jurisdictions, with the percent of each jurisdictional area within the Reach 2 watershed. Table 2-1 also indicates the jurisdictions that are participants in this Implementation Plan. Within the Reach 2 watershed, Los Angeles County has the most drainage area within the watershed; the City of Pasadena is the second largest.

Table 2-1 Jurisdictions within Reach 2 Watershed

Jurisdiction	Total Jurisdiction Area (Acres)	Total Jurisdictional Area within Reach 2 (Acres)	Percent of Jurisdictional Area within Reach 2	Participant in the Reach 2 Implementation Plan
ALHAMBRA	4,884	4,884	100.0%	Yes
ARCADIA	7,110	6,974	98.1%	Yes
BELL	1,676	1,676	100.0%	Yes
BELL GARDENS	1,578	1,578	100.0%	Yes
BRADBURY	1,252	503	40.2%	Yes
CALTRANS	N/A	4,397	N/A	Yes
CARSON	12,122	8	0.1%	No
COUNTY	1,449,544	46,900	3.2%	No
COMMERCE	4,194	4,194	100.0%	Yes
COMPTON	6,464	340	5.3%	No
CUDAHY	786	786	100.0%	No
DOWNEY	8,044	3,645	45.3%	Yes
DUARTE	4,281	1,125	26.3%	Yes
EL MONTE	6,154	4,576	74.4%	Yes
GLENDALE	19,573	10	0.0%	No
HUNTINGTON PARK	1,930	1,884	97.7%	Yes
IRWINDALE	6,165	995	16.1%	Yes
LA CANADA FLINTRIDGE	5,534	4,110	74.3%	Yes
LONG BEACH	32,886	2,870	8.7%	Yes
LOS ANGELES	302,059	19,006	6.3%	No
LYNWOOD	3,099	1,285	41.5%	Yes
MAYWOOD	754	754	100.0%	Yes
MONROVIA	8,785	8,071	91.9%	Yes
MONTEBELLO	5,356	5,356	100.0%	Yes
MONTEREY PARK	4,952	4,952	100.0%	Yes
PARAMOUNT	3,085	1,982	64.2%	Yes
PASADENA(1)	14,805	14,805	100%	Yes
PICO RIVERA	5,697	1,536	27.0%	Yes
ROSEMEAD	3,311	3,311	100.0%	Yes
SAN GABRIEL	2,645	2,645	100.0%	Yes
SAN MARINO	2,410	2,410	100.0%	No
SIERRA MADRE	1,892	1,892	100.0%	Yes
SOUTH EL MONTE	1,824	1,593	87.3%	No
SOUTH GATE	4,706	2,459	52.3%	Yes
SOUTH PASADENA	2,186	2,186	100.0%	Yes
TEMPLE CITY	2,576	2,576	100.0%	Yes
VERNON	3,298	3,288	99.7%	Yes

(1) Total Jurisdictional Area within Reach 2 includes approximately 200 acres that were analyzed within Reach 3.

2.1.2 Watershed Catchment Hydrologic Connectivity

The Reach 2 watershed is comprised of approximately 320 stream miles in the Arroyo Seco subwatershed, Rio Hondo subwatershed, and the Reach 2 subwatershed. The watershed is defined from the LAR's confluence with the Arroyo Seco for the upstream limits and to its intersection with West Market Street in Long Beach, as shown in Figure 2-1. The main reach through the watershed is the LAR, with the Arroyo Seco and Rio Hondo reaches as major tributaries. The LAR in the watershed consists of a concrete and rip-rap lined channel spanning 175 to 500 feet in width. The Arroyo Seco and Rio Hondo also have concrete and rip-rap channels at their confluence with the LAR.

The Arroyo Seco subwatershed drains approximately 28,850 acres to its confluence with the LAR. Approximately 60-percent of this drainage area is undeveloped, and 43-percent is drained to tributaries through enclosed storm sewer. The upstream portion of the Arroyo Seco drains to the Arroyo Spreading Grounds, with excess runoff draining downstream to the LAR.

The Rio Hondo subwatershed drains approximately 91,455 acres to its confluence with the LAR. Approximately 41-percent of this drainage area is undeveloped, and approximately 80-percent drains to tributaries through enclosed storm sewer. Of this drainage area, approximately 95-percent drains to the Rio Hondo Spreading Grounds (RHSG) (Figure 2-2). If the groundwater recharge capacity of the RHSG is exceeded during wet weather events, excess runoff drains to the LAR.

The Reach 2 subwatershed drains runoff directly from urbanized area totaling approximately 46,825 acres. This area includes downtown Los Angeles. From its upstream confluence with the Arroyo Seco to its downstream confluence with the Compton Creek in the watershed, the LAR stretches approximately 18 miles.

The Hydraulic Water Conservation Division of the Los Angeles County Department of Public Works (LACDPW), as the Principal Permittee for NPDES MS4 municipal dischargers, was responsible for the delineation of the catchments within each subwatershed. Approximately 417 catchments are delineated for the study area, averaging 385 acres in size. These delineations are based on a combination of contour information and existing underground storm sewer systems. These catchment areas are shown in Figure 2-2.

Approximately 80-percent of the watershed is served by storm sewer systems, extending across 34 jurisdictions, connecting drainage in urbanized areas with the main tributaries. Figure 2-2 shows the hydrologic connectivity of these systems to the LAR. Though most jurisdictions are not directly adjacent to the LAR, their runoff ultimately reaches the LAR through its tributaries and connected storm sewer systems. The jurisdictions of Carson and Glendale have no storm sewer in the watershed.

Hydrologic connectivity will be reviewed when siting BMPs in order to estimate drainage areas to a potential location, as well as the added benefit that locations near a stormwater drainage network provides for discharge options.

2.1.3 Surface Impacts

The topography of the ground surface plays a critical role in finding an appropriate site for a structural BMP, or a BMP that is appropriate for the given site conditions. This requires an evaluation of both the natural and developed environment, and how these work together in the built environment.

2.1.3.1 Natural Environment

Natural topography is comprised of the existing soils, ground elevation/slope, vegetation, stream network, and groundwater. These features impact each other in both the natural and built environments, and therefore should not be analyzed independently when evaluating BMP location options.

Elevation Impacts

Elevation varies widely across the watershed, from the peak elevations of over 2,000 feet in the San Gabriel Mountains to the lowest elevations near sea level. When siting a BMP, the slope of the drainage area and/or storm sewer system should be considered. In general, drainage area slope to a BMP can vary from less than one percent to ten percent. Some BMPs (i.e. bioretention, rain gardens, and detention facilities) can handle incoming drainage from up to a 15-percent slope with proper grade control. Prior to BMP design and implementation, a topographical site survey should be completed to provide detailed site elevation information.

Soil Impacts

Pervious surfaces provide an opportunity for rainfall and dry weather water sources to infiltrate. This infiltration capability can be estimated by determining a soil's permeability, which is a function of the soil type. Therefore, determination of soil types in a given area is a recommended component in the selection of a site appropriate BMP.

Permeability analysis can be achieved using regional data or site specific investigation. For this analysis, regional soil data maintained by Los Angeles County was used. Soil permeability was estimated using saturated hydraulic conductivity rates, which provide a conservative infiltration estimate. Before design and construction of a BMP, on-site infiltration tests or percolation tests are recommended to determine site specific soil permeability. In the Reach 2 watershed, differences in soil type correlate to a soil permeability range from 0.23 to 2.59 inches per hour.

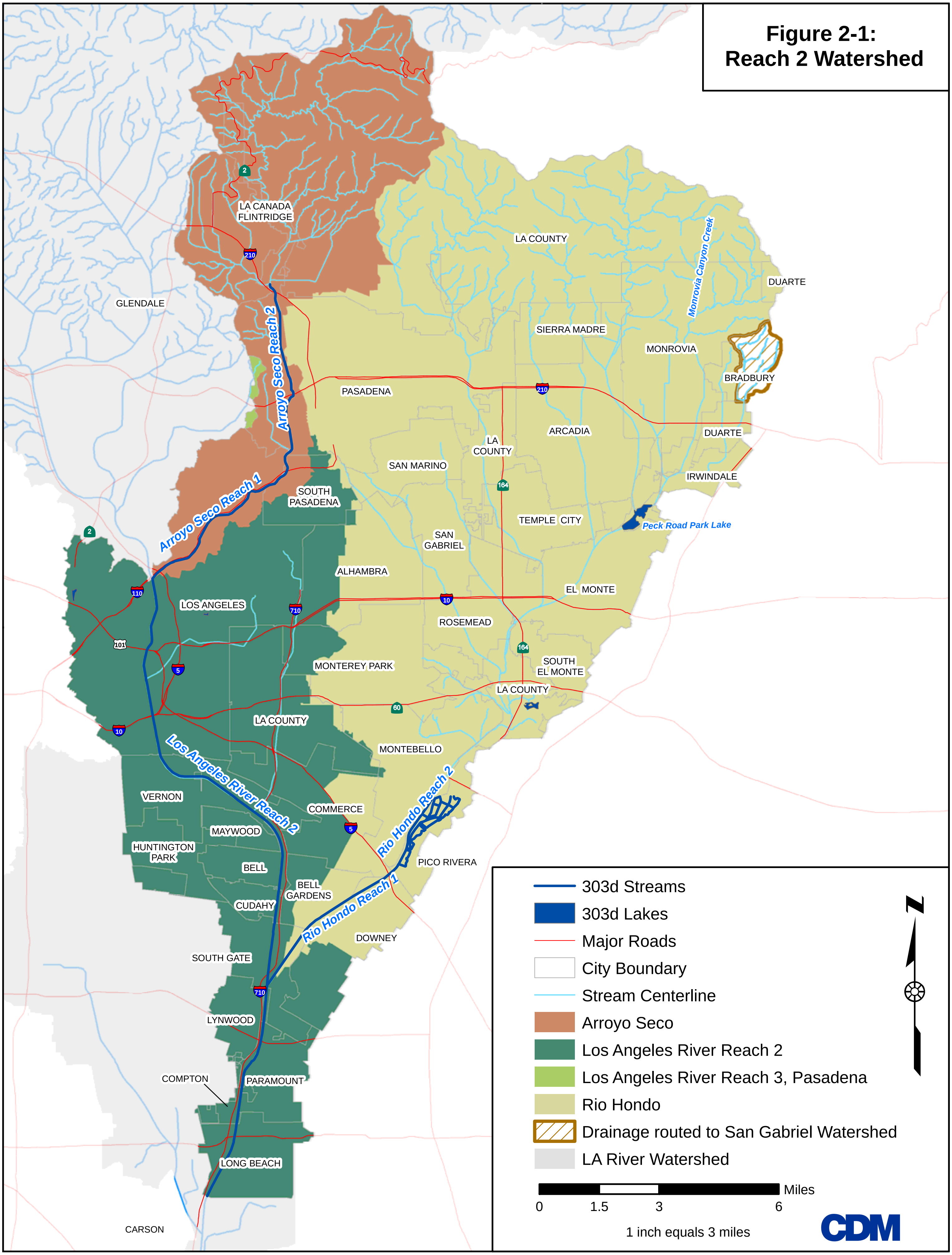


Figure 2-1: Reach 2 Watershed

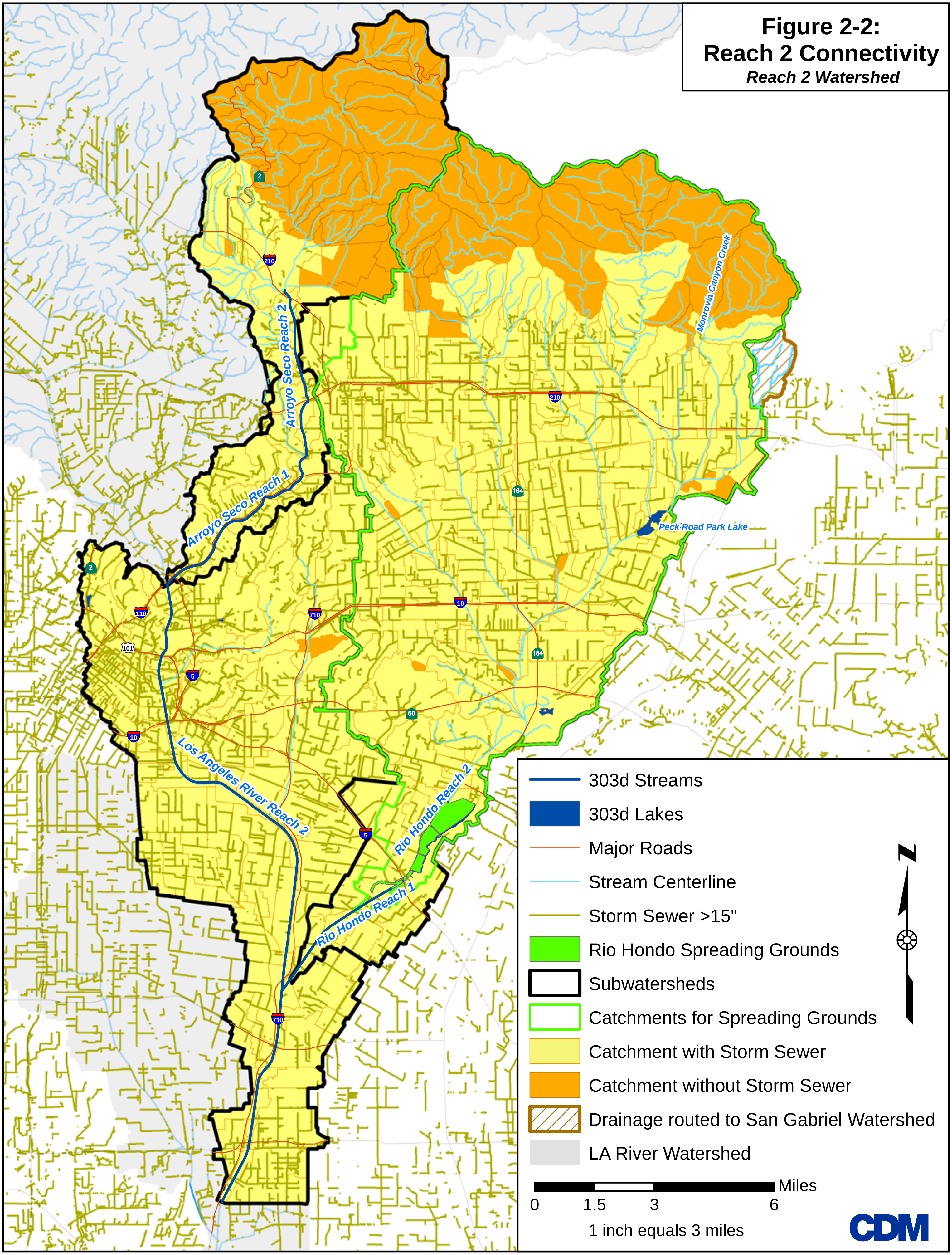


Figure 2-2:
Reach 2 Connectivity
Reach 2 Watershed
Arroyo Seco Reach 2
Arroyo Seco Reach 1
Monrovia Canyon Creek
Peck Road Park Lake
Los Angeles River Reach 2
Rio Hondo Reach 2
Rio Hondo Reach 1
303d Streams
303d Lakes
Major Roads
Stream Centerline
Storm Sewer >15"
Rio Hondo Spreading Grounds
Subwatersheds
Catchments for Spreading Grounds
Catchment with Storm Sewer
Catchment without Storm Sewer
Drainage routed to San Gabriel Watershed
LA River Watershed
Miles
0 1.5 3 6
1 inch equals 3 miles
N
CDM

In selecting an infiltration facility as a BMP, it is generally recommended for soils to have a minimum soil permeability of 0.5 to 1 inch per hour (Caltrans, 2007; CASQA, 2003). For the Reach 2 watershed, approximately 75-percent of the land area falls within or above this permeability range. These areas are potential sites for infiltration BMPs based on soil information alone. Figure 2-3 shows the range of soil permeability across the watershed.

Identified areas meeting recommended soil permeability ranges for BMP siting should also be evaluated for potential soil liquefaction or landslide. Potential soil liquefaction and landslide zones have been identified in regional data by SCAG, and are shown in Figure 2-3. These zones have been identified using a combination of soil data, elevation data, and depth to ground water. It is not ideal to site BMPs in these areas because of the potential for unstable soils.

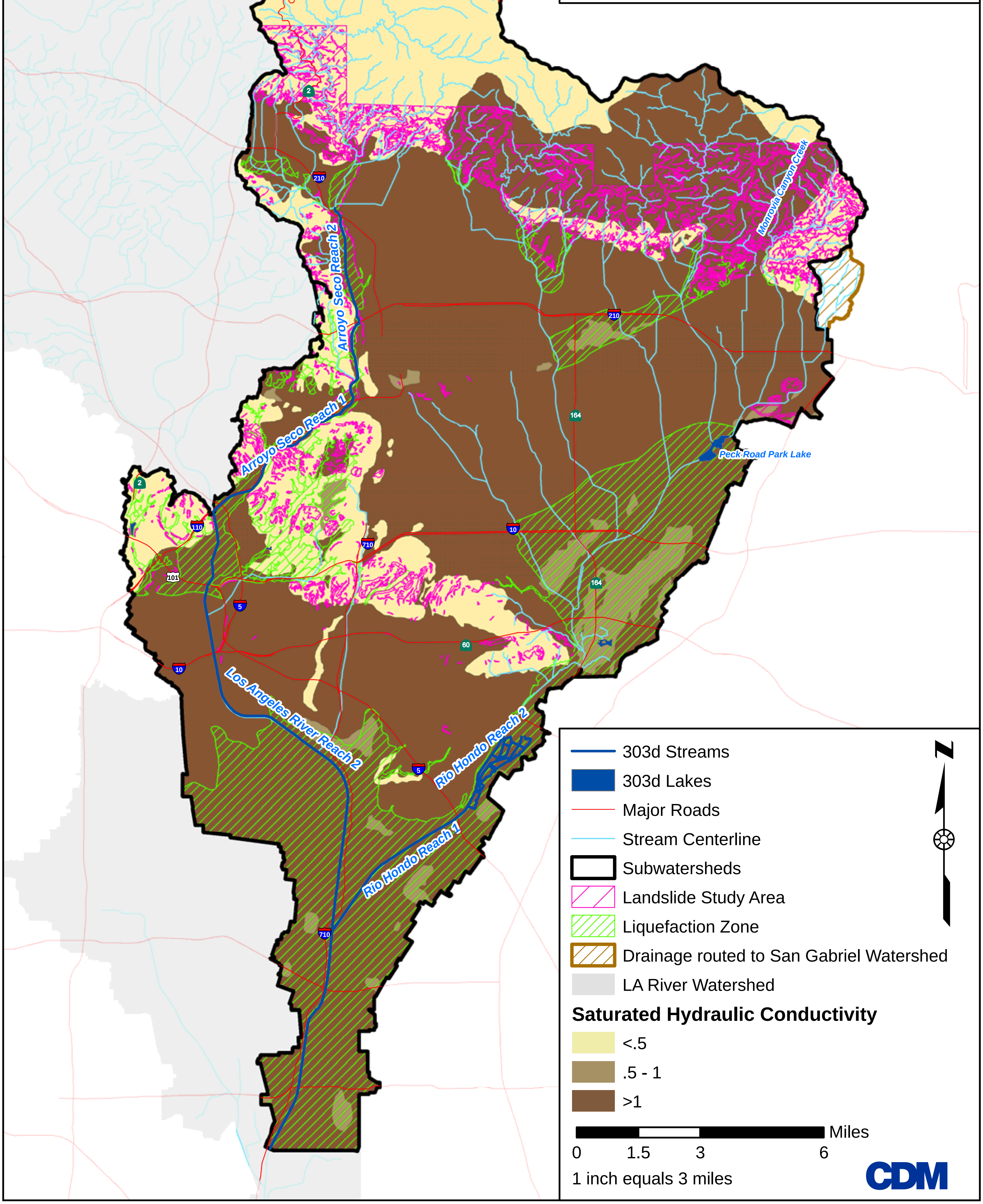
Soil liquefaction is when a soil transitions from a solid to a heavy, liquefied state during a sudden load, such as an earthquake. Granular soils with poor drainage or areas where groundwater levels are close to the surface are more susceptible to liquefaction due to the resulting increase in water pressure during a loading event. Areas having an increased probability of liquefaction are identified in Figure 2-3.

The rapid movement of slopes during a landslide can be attributed to external changes (i.e., manmade or natural activities that undercut a slope), earthquake shocks, and seasonal impacts of rainfall on ground water level and fluid pressures in a soil (Domenico, Schwartz 1998). While these are typical causes of a landslide, a typical trigger of a landslide is water. Increased surface runoff from rainfall, as well as variations in the groundwater level can trigger landslides by changing the fluid pressure in a soil.

Areas having an increased probability of a landslide due to these factors are identified on Figure 2-3.

Figure 2-3: Reach 2 Soil Information

Reach 2 Watershed



Conservation and Environmentally Sensitive Areas

Land areas identified for conservation or as environmentally sensitive may or may not be candidates for BMP siting. Prior to designing and implementing a BMP, stakeholders, including both public and private agencies (including but not limited to local jurisdictions, County of Los Angeles, state (e.g., California Department of Fish and Game), and federal (e.g., United States Army Corps of Engineers)), should be consulted to determine if the site is a conservation or environmentally sensitive area.

Resources for determining conservation and/or environmentally sensitive areas include, but are not limited to:

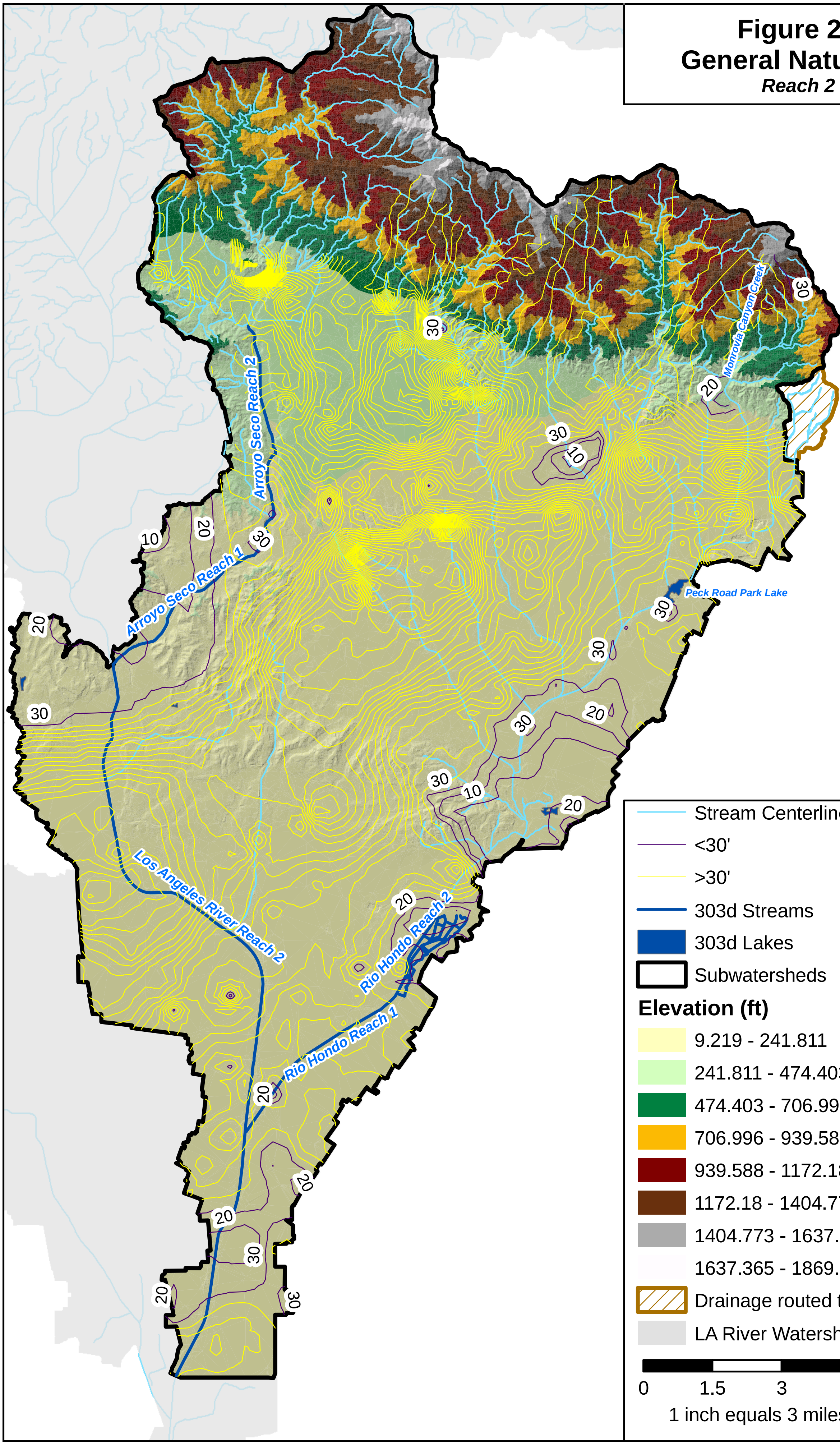
- County of Los Angeles 2008 Draft General Plan, Conservation & Open Space Element (http://planning.lacounty.gov/generalplan)
- California Natural Diversity Database (http://www.dfg.ca.gov/biogeodata/cnddb/)
- Natural Resources Conservation Service California (http://www.ca.nrcs.usda.gov/)
- California Biodiversity Council (http://biodiversity.ca.gov/)
- U.S. Fish & Wildlife Service Critical Habitat Portal (http://criticalhabitat.fws.gov/)
- Audubon's Important Bird Areas (http://www.audubon.org/bird/IBA/)
- The Trust for Public Land (http://www.tpl.org/)

Depth to Groundwater

For infiltration BMPs it is important to have sufficient distance between the groundwater table and the bottom of the BMP. This distance is necessary for removing pollutants before they reach the groundwater table as well as to allow for seasonal variation in the groundwater level. It is critical that the depth to groundwater be determined before implementing infiltration BMPs to identify contamination risks. Typically, infiltration BMP design criteria recommend a minimum of three meters (approximately 10 feet) of depth from ground surface to the highest groundwater level. Figure 2-4 provides estimated average depths of groundwater for the Reach 2 watershed.

Figure 2-4: Reach 2 General Natural Topography

Reach 2 Watershed



Stream Centerline

<30'

>30'

303d Streams

303d Lakes

Subwatersheds

Elevation (ft)

9.219 - 241.811

241.811 - 474.403

474.403 - 706.996

706.996 - 939.588

939.588 - 1172.18

1172.18 - 1404.773

1404.773 - 1637.365

1637.365 - 1869.957

Drainage routed to San Gabriel Watershed

LA River Watershed

0 1.5 3 6 Miles

1 inch equals 3 miles

CDM

2.1.3.2 Developed Topography

Developed, or built, topography includes parcel evaluation of designated land use, identification of ownership, and calculation of the existing impervious area. By overlaying this information, potential BMP locations can be identified, and then compared to natural topography factors to determine the best BMP fit.

Land Use

Land use is defined for a parcel that is platted and/or developed. It is reflective of the zoning of a parcel of land. Designated land use for parcels within the Reach 2 watershed was obtained using GIS files maintained by SCAG. Table 2-2 provides land use information by category for each subwatershed in the Reach 2 watershed. Figure 2-5 shows this information graphically. The two highest percentages of land use in the watershed are Open Space and Residential. Of the jurisdictions within the watershed, Carson has the lowest acreage of undeveloped land (agriculture and open space), while the County of Los Angeles has the highest percentage of undeveloped land. Undeveloped land is ideal for BMP implementation, in particular large or regional structural BMP facilities with more than 10 acres of drainage area.

Table 2-2 Categorization of Land Use in Reach 2 by Subwatershed

Basin	Land Use[1] (acres)						
	Agriculture/ Horse Ranch	Commercial/ Institutional	Industrial	Mixed Urban	Open Space/ Water	Residential	Transportation / Infrastructure
Arroyo Seco	52	1,249	267	27	10,841	12,479	2,353
Reach 2	333	7,710	10,336	342	4,027	22,770	3,586
Rio Hondo	738	10,784	5,931	120	21,459	47,043	4,667
Reach 3, Pasadena	0	1	2	0	79	108	8

(1) SCAG Parcel Data, 2005

Ownership

In addition to identifying a parcel's current land use, it is also helpful to identify current ownership as public or private. Public land ownership is defined as land owned by a city, county, state, or federal agency. Publicly owned land is typically easier to site and implement BMPs, as no land must be acquired. Private land owners whose land is currently undeveloped may be required to implement BMPs as part of the development process.

Distribution of parcel ownership in the Reach 2 watershed is shown by subwatershed in Figure 2-6. When comparing ownership to undeveloped land in the watershed, approximately 43,100 acres, or 26-percent, of the watershed are both undeveloped and publicly owned (Figure 2-6). However, the vast majority of this area is in the San Gabriel Mountains, which have steep slopes and poor soils and are, therefore, not ideal BMP site locations.

Figure 2-5:
Reach 2 Land Use by City
Reach 2 Watershed

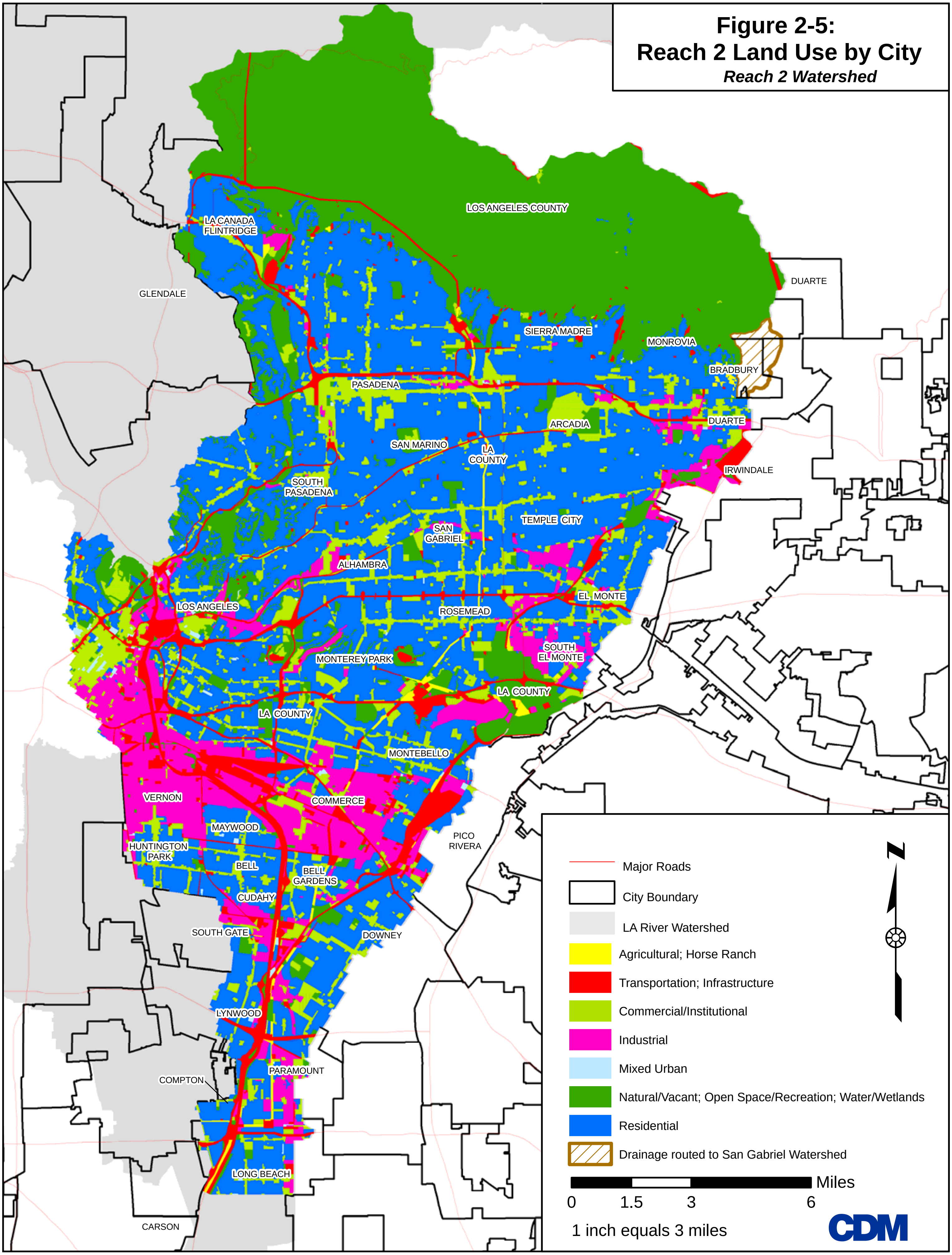
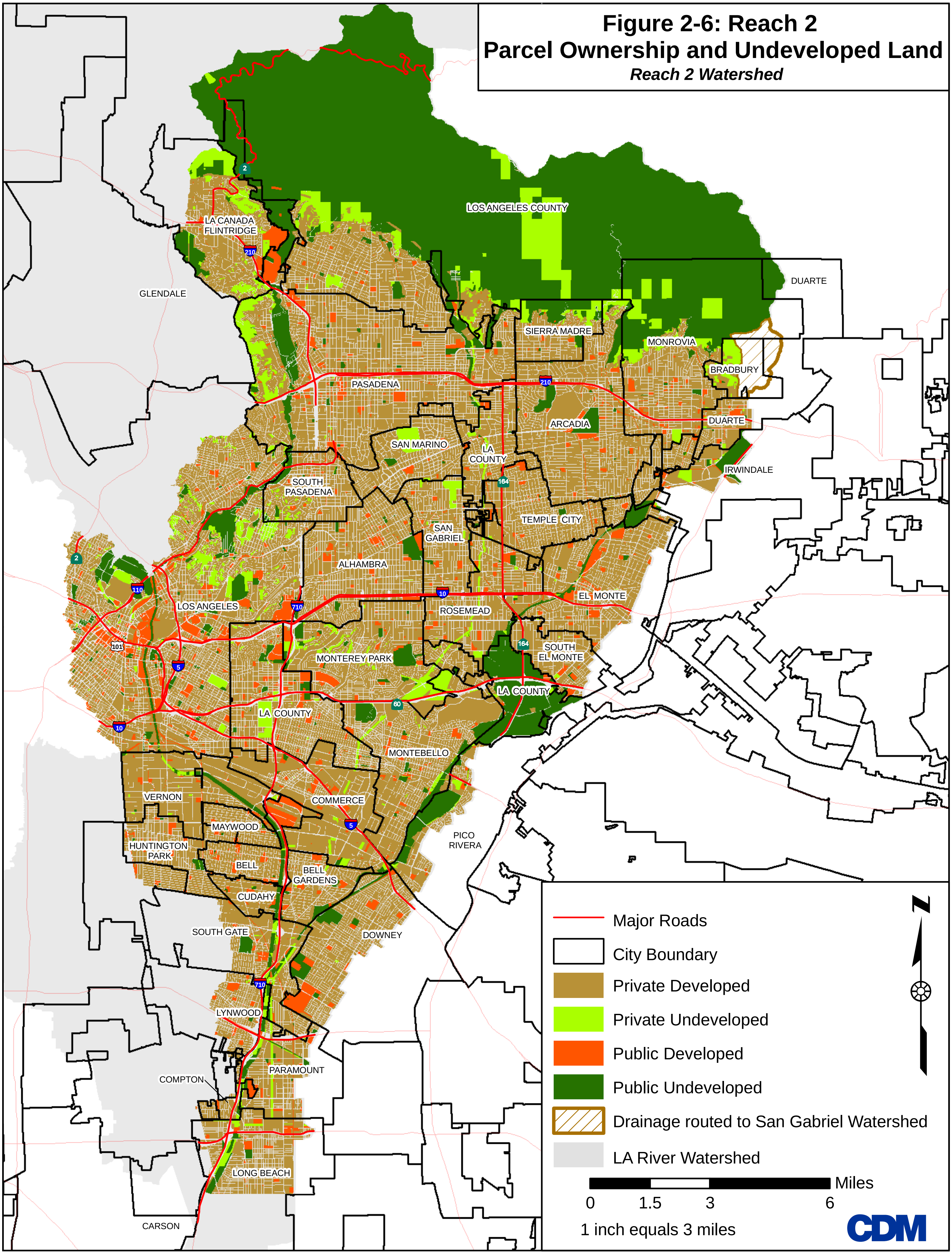


Figure 2-6: Reach 2
Parcel Ownership and Undeveloped Land
Reach 2 Watershed



Impervious Area

Defining land use for a parcel can provide an estimate of the amount of impervious area that parcel is expected to have, which will contribute to overall surface runoff, as well as how much pervious area may be available for BMP design and construction.

Determining the total impervious area in the watershed is critical in estimating the amount of direct surface runoff during a rainfall event. This total surface runoff is an important factor in determining an appropriate structural BMP. Impervious areas include paved surfaces, rooftops, and highly compacted soils.

The LACDPW Hydrology Manual has developed representative percentages of impervious area by land use type (LACDPW Hydrology Manual, Appendix D, 2006).

Table 2-3 calculates the estimated impervious acres in the Reach 2 watershed using the representative percentages of impervious area by land use type as defined in the Los Angeles County Hydrology Manual. It is estimated that 74,000 acres, equating to approximately 44-percent, of the watershed is impervious. BMPs located in these drainage areas will need to be sized to accommodate the increased runoff from these impervious surfaces. Capturing runoff from impervious surfaces in an urban area will have the greatest impact on water quality.

Table 2-3 Reach 2 Watershed Impervious Area by Land Use Category

Code	Land Use Category	Percent Impervious	Land Use Area of Watershed (acres)	Watershed Impervious Area (acres)
1111	High-Density Single Family Residential	42	51,882.82	21,790.79
1112	Low-Density Single Family Residential	21	4,653.55	977.24
1121	Mixed Multi-Family Residential	74	581.87	430.58
1122	Duplexes, Triplexes and 2 or 3-Unit Condominiums and Townhouses	55	211.70	116.44
1123	Low-Rise Apartments, Condominiums and Townhouses	86	6,466.96	5,561.58
1124	Medium-Rise Apartments and Condominiums	86	366.92	315.55
1125	High-Rise Apartments and Condominiums	90	74.16	66.75
1131	Trailer Parks and Mobile Home Courts, High Density	91	406.59	370.00
1140	Mixed Residential	59	7,220.59	4,260.15
1151	Rural Residential, High-Density	15	0.00	0.00
1152	Rural Residential, Low-Density	10	35.15	3.51
1211	Low and Medium-Rise Major Office Use	91	1,425.74	1,297.42
1212	High-Rise Major Office Use	91	186.84	170.03
1213	Skyscrapers	91	55.62	50.62
1221	Regional Shopping Center	95	181.49	172.42
1222	Retail Centers (Non-Strip With Contiguous Interconnected Off-Street)	96	1,404.01	1,347.85
1223	Modern Strip Development	96	3,467.10	3,328.41
1224	Older Strip Development	97	3,497.47	3,392.55
1231	Commercial Storage	90	198.34	178.51
1232	Commercial Recreation	90	693.01	623.71
1233	Hotels and Motels	96	211.23	202.78
1241	Government Offices	91	595.75	542.13
1242	Police and Sheriff Stations	91	73.50	66.88

(Table 2-3 Cont'd.)

Code	Land Use Category	Percent Impervious	Land Use Area of Watershed (acres)	Watershed Impervious Area (acres)
1243	Fire Stations	91	126.48	115.10
1244	Major Medical Health Care Facilities	74	413.40	305.92
1245	Religious Facilities	82	644.39	528.40
1246	Other Public Facilities	91	307.59	279.91
1247	Non-Attended Public Parking Facilities	91	258.15	234.92
1251	Correctional Facilities	91	99.12	90.20
1252	Special Care Facilities	74	343.36	254.09
1253	Other Special Use Facilities	86	147.88	127.17
1261	Pre-Schools/Day Care Centers	68	10.48	7.13
1262	Elementary Schools	82	1,847.56	1,515.00
1263	Junior or Intermediate High Schools	82	500.79	410.65
1264	Senior High Schools	82	1,326.35	1,087.61
1265	Colleges and Universities	47	514.91	242.01
1266	Trade Schools and Professional Training Facilities	91	70.55	64.20
1271	Base (Built-up Area)	65	67.05	43.58
1272	Vacant Area	2	0.00	0.00
1311	Manufacturing, Assembly and Industrial Services	91	11,222.15	10,212.16
1312	Motion Picture and Television Studio Lots	82	8.48	6.95
1313	Packing Houses and Grain Elevators	96	14.52	13.94
1314	Research and Development	91	143.62	130.69
1321	Manufacturing	91	87.57	79.68
1322	Petroleum Refining and Processing	91	20.02	18.22
1323	Open Storage	66	554.22	365.78
1324	Major Metal Processing	91	24.54	22.33
1325	Chemical Processing	91	36.20	32.94
1331	Mineral Extraction - Other Than Oil and Gas	10	350.80	35.08
1332	Mineral Extraction - Oil and Gas	10	520.04	52.00
1340	Wholesaling and Warehousing	91	1,914.04	1,741.78
1411	Airports	91	105.79	96.27
1412	Railroads	15	1,228.06	184.21
1413	Freeways and Major Roads	91	3,236.69	2,945.39
1414	Park-and-Ride Lots	91	13.11	11.93
1415	Bus Terminals and Yards	91	171.73	156.27
1416	Truck Terminals	91	657.52	598.34
1417	Harbor Facilities	91	0.00	0.00
1420	Communication Facilities	82	101.27	83.04
1431	Electrical Power Facilities	47	1,110.59	521.98
1432	Solid Waste Disposal Facilities	15	165.33	24.80
1433	Liquid Waste Disposal Facilities	96	0.00	0.00
1434	Water Storage Facilities	91	327.47	297.99
1435	Natural Gas and Petroleum Facilities	91	138.48	126.02
1436	Water Transfer Facilities	96	41.97	40.29
1437	Improved Flood Waterways and Structures	100	2,585.70	2,585.70
1438	Mixed Wind Energy Generation and Percolation Basin	100	0.00	0.00
1440	Maintenance Yards	91	433.80	394.76
1450	Mixed Transportation	90	838.32	754.49

(Table 2-3 Cont.d')

Code	Land Use Category	Percent Impervious	Land Use Area of Watershed (acres)	Watershed Impervious Area (acres)
1460	Mixed Transportation and Utility	91	50.63	46.08
1500	Mixed Commercial and Industrial	91	163.82	149.08
1600	Mixed Urban	89	178.60	158.96
1700	Under Construction	91	301.71	274.55
1810	Golf Courses	3	1,673.94	50.22
1821	Developed Local Parks and Recreation	10	1,899.07	189.91
1822	Undeveloped Local Parks and Recreation	2	2.94	0.06
1831	Developed Regional Parks and Recreation	2	804.77	16.10
1832	Undeveloped Regional Parks and Recreation	1	1,055.78	10.56
1840	Cemeteries	10	596.10	59.61
1850	Wildlife Preserves and Sanctuaries	2	63.64	1.27
1860	Specimen Gardens and Arboreta	15	427.43	64.11
1880	Other Open Space and Recreation	10	211.28	21.13
2110	Irrigated Cropland and Improved Pasture Land	2	70.15	1.40
2120	Non-Irrigated Cropland and Improved Pasture Land	2	0.00	0.00
2200	Orchards and Vineyards	2	15.06	0.30
2300	Nurseries	15	801.70	120.25
2600	Other Agriculture	42	0.00	0.00
2700	Horse Ranches	42	182.05	76.46
3100	Vacant Undifferentiated	1	41,845.05	418.45
3200	Abandoned Orchards and Vineyards	2	2.40	0.05
3300	Vacant With Limited Improvements	42	0.00	0.00
4100	Water, Undifferentiated	100	278.22	278.22
4200	Harbor Water Facilities	100	0.00	0.00
			Total Impervious Area =	74,041.60

2.2 Rainfall and Flow Characteristics

2.2.1 Rainfall Monitoring

Historical rainfall records from three existing rain gauges located in or adjacent to the Reach 2 watershed were obtained and utilized in this analysis. These meteorological stations and resulting rain gauge data are maintained by National Climatic Data Center (NCDC). These locations are shown in Figure 2-7 with detailed location information provided in Table 2-4.

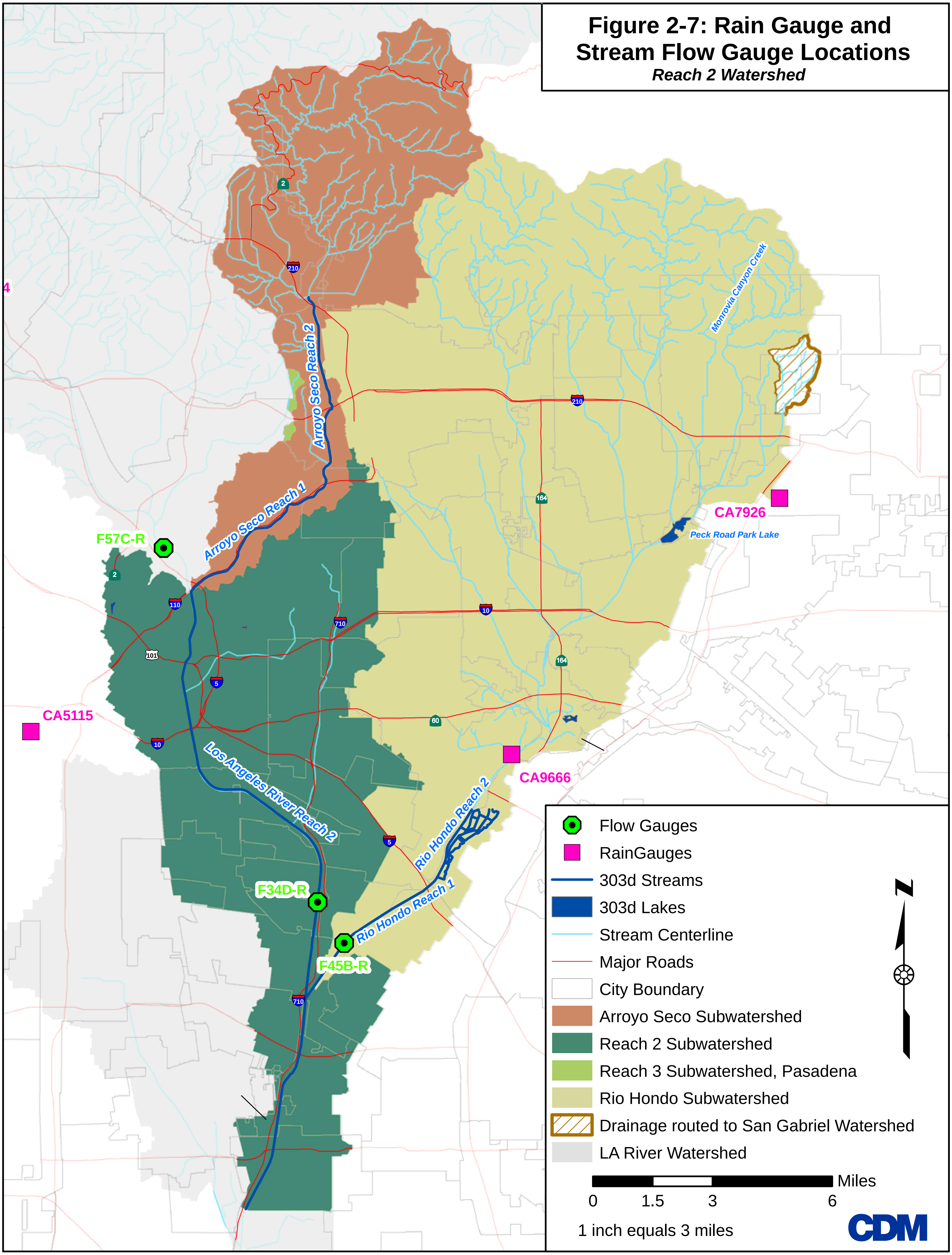
Table 2-4 Rainfall Data Summary

NCDC Station ID(1)	Station Name	Period of Record	Latitude	Longitude	Elevation (ft)	Mean Annual Precipitation (in)	85th Percentile Storm (in)
CA5115	LA Downtown	1948 - 2007	34.028	-118.296	185	14.51	1.53
CA7926	Sante Fe	1948 - 2007	34.113	-117.969	425	15.73	1.90
CA 9666	Whittier Dam	1972 - 2007	34.02	-118.086	200	13.53	1.74

(1) NCDC, http://lwf.ncdc.noaa.gov

Figure 2-7: Rain Gauge and Stream Flow Gauge Locations

Reach 2 Watershed



The San Gabriel Mountains create an orographic effect within the coastal plain where rainfall increases with proximity to the mountains. This is shown by the 15-percent variability in the average annual rainfall monitored for the historical record. This variability reduces to 8-percent for the 85th percentile storm, with rainfall depths ranging from 0.85 to 1.4 inches. This is represented graphically in Figure 2-8 using isohyets (NOAA, 2006). The isohyets represent lines of equal rainfall for the 85th percentile event.

Average monthly rainfall for the historical record has been calculated for each rain gauge and is provided in Table 2-5. The monthly values are similar among the three rain gauges, with the rain gauge closest to the San Gabriel Mountains having the highest average monthly rainfall. Overall, the total average monthly rainfall ranges from 1.1 to 1.3 inches.

Table 2-5 Summary of Average Monthly Rainfall

Month	Average Monthly Rainfall (in)[1]		
	CA5115	CA7926	CA 9666
	LA Downtown	Sante Fe	Whittier Dam
January	3.3	3.5	2.8
February	3.3	3.6	3.7
March	2.4	2.5	2.2
April	1.0	1.2	0.7
May	0.3	0.3	0.3
June	0.1	0.1	0.1
July	0.0	0.0	0.0
August	0.1	0.1	0.1
September	0.3	0.2	0.3
October	0.4	0.4	0.4
November	1.5	1.6	0.9
December	2.0	2.1	2.0
Total Average Monthly Rainfall	**1.2**	**1.3**	**1.1**

(1) NCDC, http://lwf.ncdc.noaa.gov

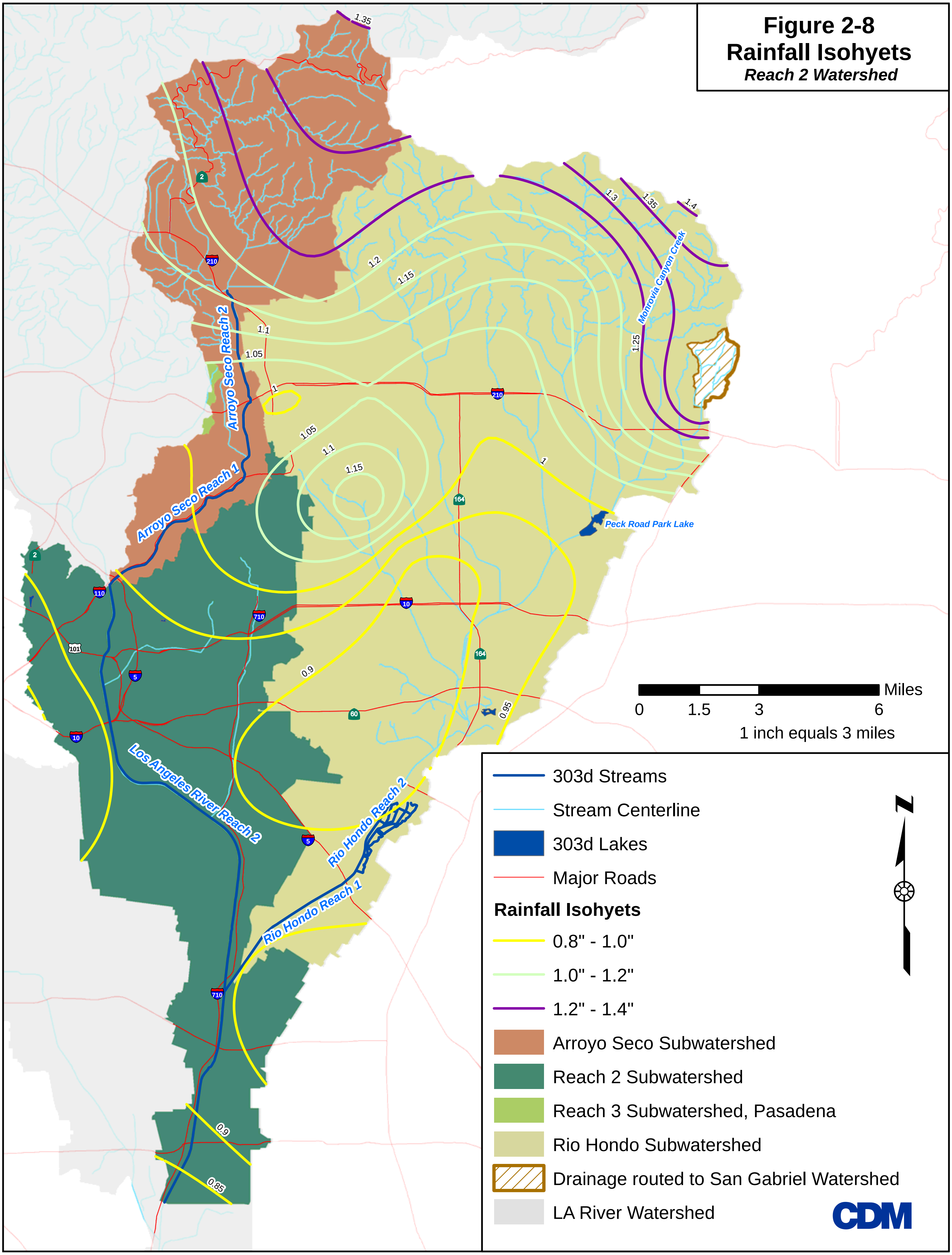


Figure 2-8
Rainfall Isohyets
Reach 2 Watershed

2.2.2 Stream Flow Monitoring

The Los Angeles County Department of Public Works maintains eight stream gauge stations in the LAR watershed, two within the Reach 2 watershed. Locations of the gauges within and near the watershed are shown in Figure 2-7. Table 2-6 lists these gauges from upstream to downstream in the watershed with corresponding drainage area.

Based on the drainage area, measured flows along the LAR should be increasing in rate from station F300-R to F57C-R to F34D-R and to F319-R, with the largest rate of flow measured at F319-R. Aerial photography and available GIS data do not indicate any impoundment of the LAR between these gauges that may be limiting flow.

Table 2-6 Stream Flow Gauges

Station No	Station Name	Drainage Area, acres
F300-R	LAR at Tujunga Avenue	256,640
F57C-R	LAR above Arroyo Seco	327,040
F34D-R	LAR below Firestone Blvd	381,440
F319-R	LAR below Wardlow River Road	521,600
F45B-R	Rio Hondo above Stuart and Gray Road	89,600
F285-R	Burbank Western Bank Storm Drain at Riverside Dr	16,000
F37B-R	Compton Creek near Greenleaf Drive	14,464
F252-R	Verdugo Wash at Estelle Avenue	17,152

Daily mean stream flows were analyzed. Figure 2-9 shows the daily mean flows at stations F300-R, F57C-R, F34D-R, and F319-R. Measured flows at these stations were compared to one another to assess the fraction of runoff in the LAR watershed that can be attributed to Reach 2. The comparisons revealed that such an estimate cannot be made using data from these stations, as measured flow is not increasing in order of magnitude with increasing drainage area.

TMDL targets are set based on the definitions of dry and wet weather days, which can be determined using the stream flow data. For the LAR and its tributaries, a dry weather day is defined as a day where the maximum daily flow at station F319-R is less than 500 cubic feet per second. Therefore, it is critical to have a complete data set of flow rates for station F319-R. Preliminary analysis of station F319-R data did reveal some missing flow data due to unknown circumstances. To provide an approximation of the maximum daily flows for the missing days, flows from the nearest upstream station (F34D-R) were utilized. This provided the needed information to designate a wet or dry day, and proceed with evaluating water quality in the watershed.

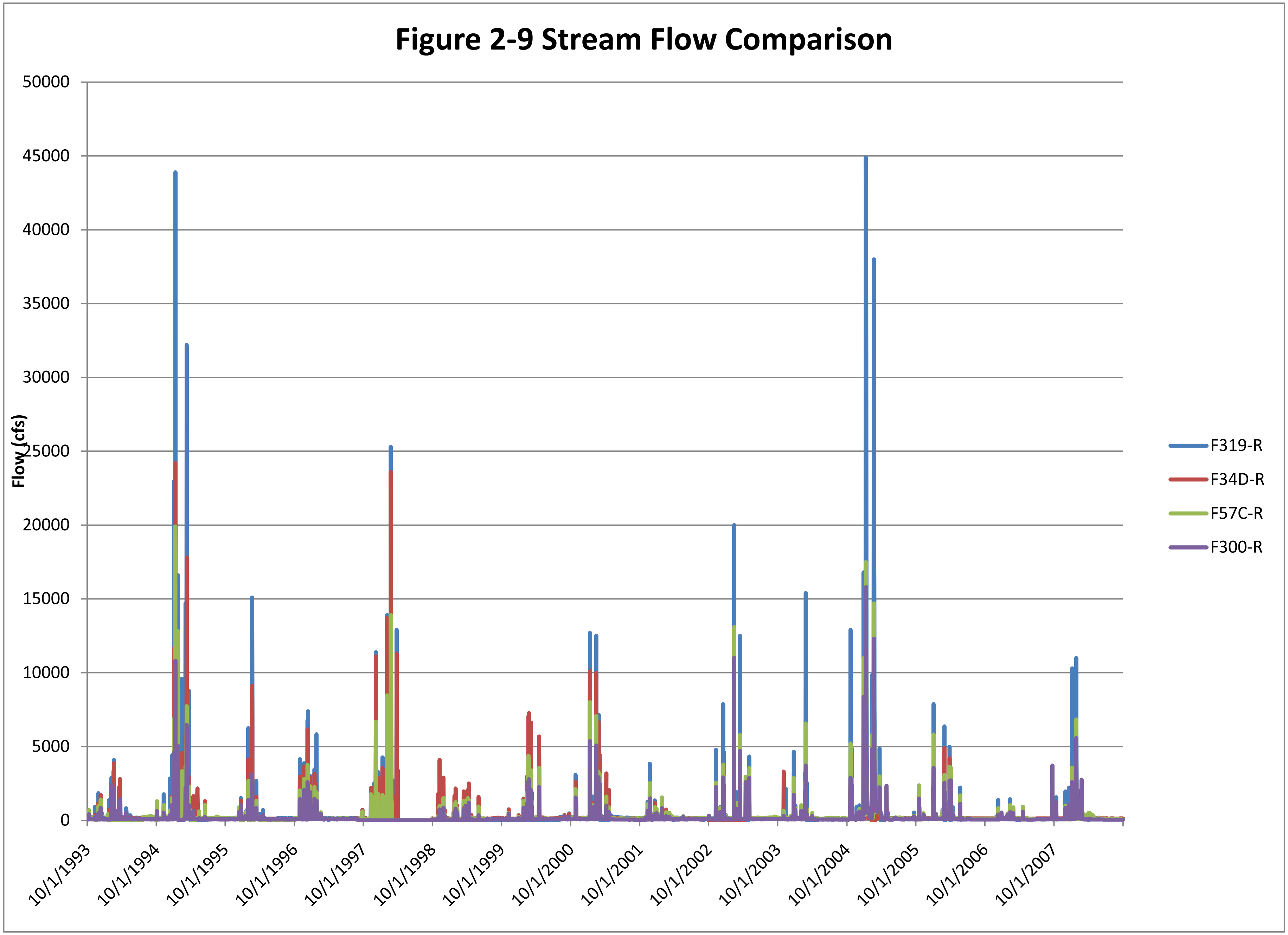


Figure 2-9 Stream Flow Comparison
Flow (cfs)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
10/1/1993
10/1/1994
10/1/1995
10/1/1996
10/1/1997
10/1/1998
10/1/1999
10/1/2000
10/1/2001
10/1/2002
10/1/2003
10/1/2004
10/1/2005
10/1/2006
10/1/2007
F319-R
F34D-R
F57C-R
F300-R

2.3 Surface Water Quality

The Reach 2 watershed currently has Metal TMDL limits defined for eight constituents. Water quality sampling for the watershed was evaluated for these constituents using data recorded by the City of Los Angeles Status and Trends from July 2000 through August 2008. Sampling locations are shown on Figure 2-10. Figure 2-11 shows the flow connectivity diagram of the sampling locations. A monitoring site is located at Del Amo Road within the Reach 2 watershed; however, flow data was not available for this site. For the compliance analysis (Section 6) it is necessary to use stream flow data to calculate the baseline copper load for Reach 2. This information is available at Wardlow, the next site downstream. Therefore, Wardlow data was used in this Implementation Plan.

Table 2-7 summarizes current Metals TMDL limits for the watershed, as well as observed trends over the sampling period. Three trends in constituent concentrations over time were observed in the water quality analysis – increasing, decreasing, or no change in concentration. Future prioritization of BMP implementation, could be weighted according to these observed subwatershed trends.

Table 2-7 Reach 2 Watershed TMDL Limits and Concentration Trends

Constituent	Los Angeles River Watershed TMDL Limit[1] (µg/L)					
	Reach 2[3]		Arroyo Seco[4]		Rio Hondo[5]	
	Wet Weather	Dry Weather	Wet Weather	Dry Weather	Wet Weather	Dry Weather[6]
Cadmium, Dissolved[2]	3	None	3	None	3	None
Cadmium, Total[2]	3.1	None	3.1	None	3.1	None
Copper, Dissolved	11	21	11	21	11	21
Copper, Total	17	22	17	22	17	22
Lead, Dissolved	51	7.3	51	7.3	51	8.2
Lead, Total	62	11	62	11	62	11
Zinc, Dissolved	97	None	97	None	97	272
Zinc, Total	159	None	159	None	159	278
Legend:	Increasing Concentration		Decreasing Concentration		No Change in Concentration	
	No Readings					

(1) TMDL limits from *Total Maximum Daily Loads for Metals Los Angeles River and Tributaries*, LARWQCB 2005.

(2) While there is currently no dry weather TMDL for this metal in the watershed, there is an increasing concentration level of this constituent in each subwatershed that should be monitored.

(3) Gauges for this subwatershed: LAR at Rosecrans; LAR at Washington

(4) Gauges for this subwatershed: Arroyo Seco at San Fernando Rd

(5) Gauges for this subwatershed: Rio Hondo at Garfield

(6) California Toxics Rule (CTR) criteria recompiled using recent dry weather hardness measurements.

- *Increasing Concentrations* - An increase in constituent concentration over time could indicate changes in land use, such as development of previously open space areas in the watershed. Areas where increasing concentrations are observed over time should be a higher priority for implementation of BMPs. This has been color coded as "red" in Table 2-7.

- *Decreasing Concentrations* - A decrease in constituent concentration over time may be an indication of existing BMPs or other practices improving the water quality for respective TMDLs in the watershed. These practices should be maintained to continue this downward trend. This trend has been color coded as "orange" in Table 2-7.

- *No Change in Concentration* - No discernable trend of an increase or decrease in constituent concentrations over time. This trend has been color coded as "green" in Table 2-7.

The plotted results for all water quality data by constituent can be found in Appendix A. TMDL limits are included on each figure in order to clearly define dates of exceedances. A summary of grab sample exceedances over the sampling period for dry weather is provided in Table 2-8.

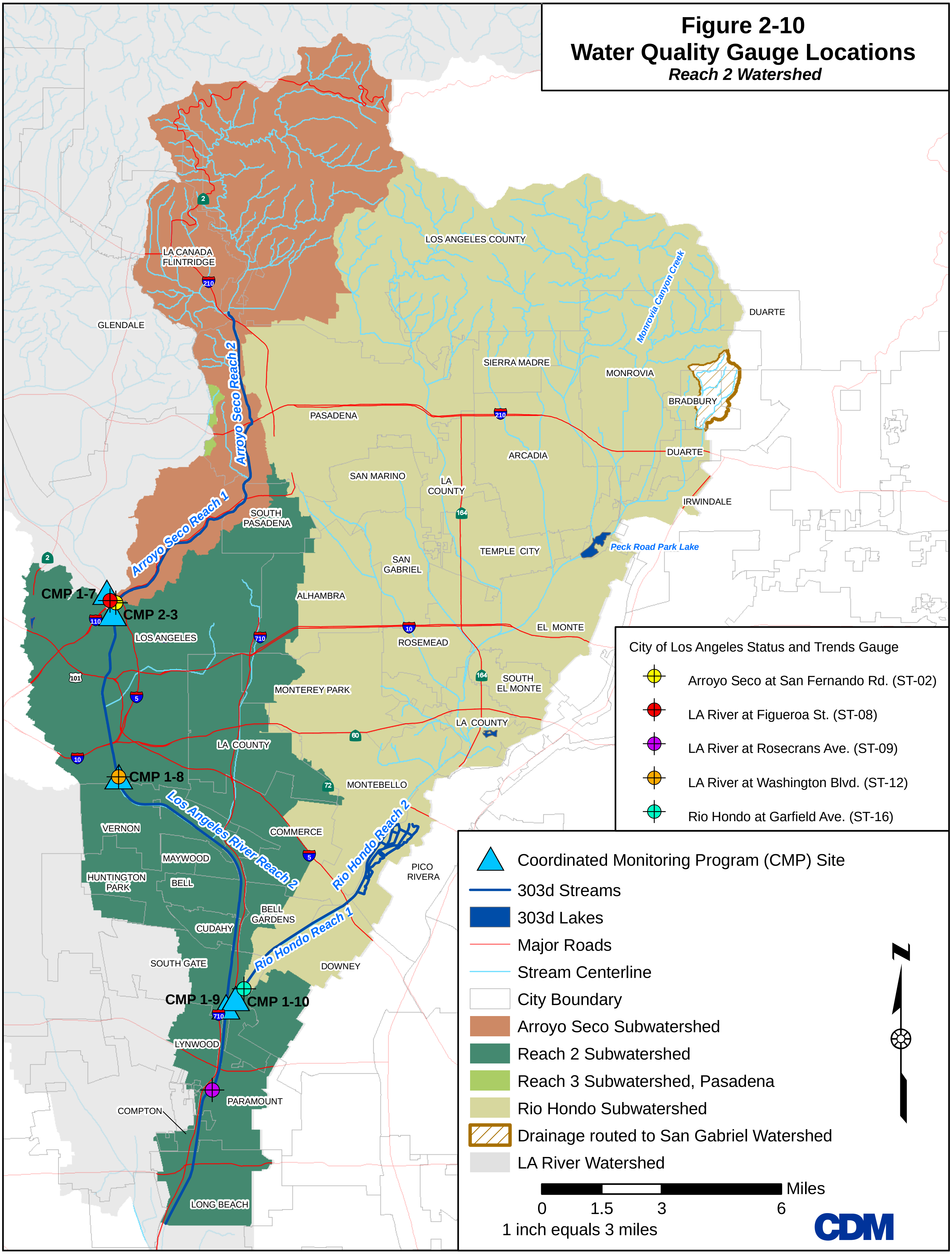
Table 2-8 Reach 2 Watershed Grab Sample Summary of Exceedances - Dry Weather

Constituent	Number of Exceedances by Location (Total Dry Samples)				
	Arroyo Seco @ San Fernando	LAR @ Rosecrans	LAR @ Washington Blvd.	Rio Hondo @ Garfield Ave.	LAR @ Figueroa
Copper, Dissolved	0 (34)	2 (73)	1 (69)	13 (34)	2 (73)
Copper, Total	1 (38)	7 (76)	9 (73)	20 (35)	7 (77)
Lead, Dissolved	2 (16)	2 (24)	1 (26)	3 (22)	3 (29)
Lead, Total	8 (26)	6 (34)	4 (41)	5 (32)	5 (40)
Zinc, Dissolved				0 (34)	
Zinc, Total				1 (35)	

(1) Based on TMDL limits from *Total Maximum Daily Loads for Metals Los Angeles River and Tributaries*, LARWQCB 2005

The Reach 3 watershed, upstream of the Reach 2 watershed (LAR at Figueroa sample location), was included in the evaluation to identify possible concentration trends that may be impacting concentration levels within the Reach 2 portion of the LAR watershed. While the Reach 3 watershed is reporting similar results as the Reach 2 watershed, detailed sampling of smaller drainage areas would be required to confirm this correlation.

Figure 2-10
Water Quality Gauge Locations
Reach 2 Watershed



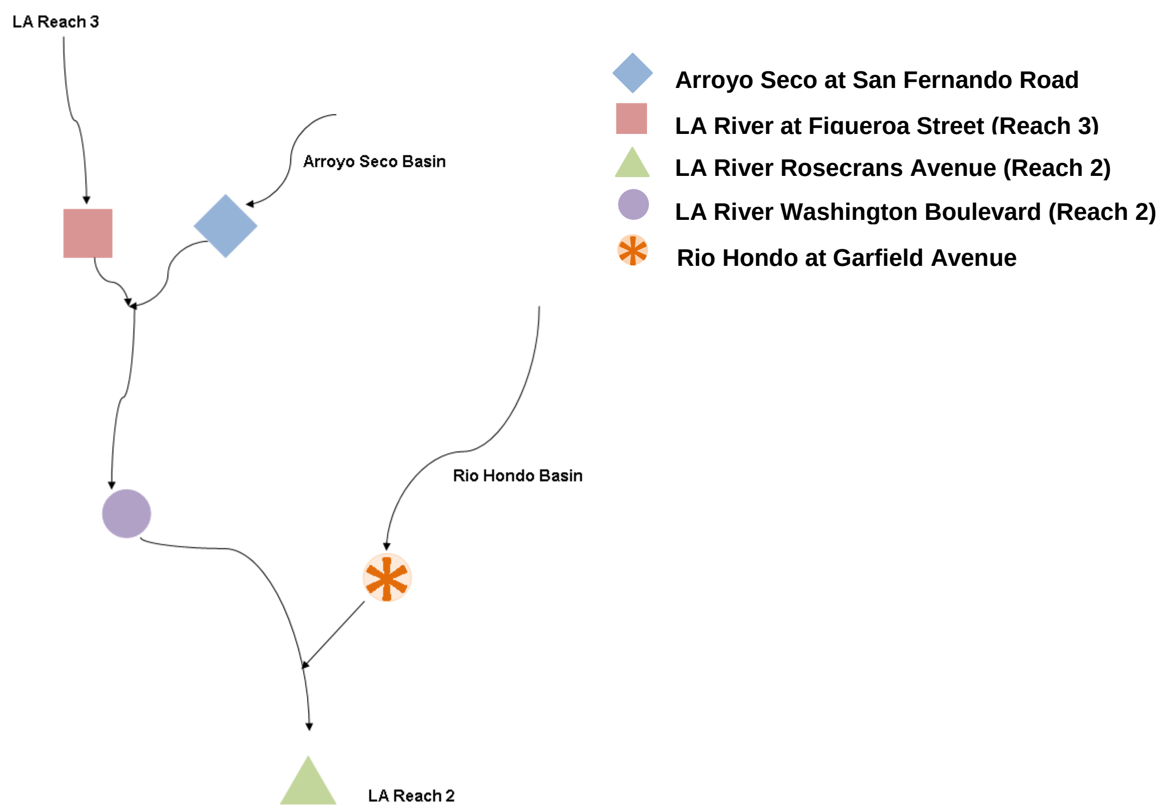


Figure 2-11 Sampling Locations

Flow weighted wet weather composite samples within the LAR watershed are best quantified through automated monitoring at the Wardlow Road stormwater mass emission station. This station is located in Reach 1 downstream of the Reach 2 watershed. The Wardlow Road station was used for the wet weather compliance analysis as part of this Implementation Plan (see Section 6) as it provides a comprehensive picture of constituent concentrations in the watershed. Table 2-9 provides a summary of exceedances for wet weather composite samples at Wardlow Road. Historical data for the watershed at Wardlow showed non-compliance with several TMDL targets, most notably copper.

Table 2-9 Summary of Wardlow Street Station Composite Wet Weather Exceedances in the LAR Watershed

Constituent	Wet Weather TMDL Numeric Target (ug/l)	Number of Exceedances (Total Samples)
Total Cadmium	3	4 (31)
Total Copper	17	21 (31)
Total Lead	61	5 (31)
Total Zinc	159	10 (31)

Section 3
MS4 Permit Implementation and Non-Structural BMPs

The Reach 2 participating jurisdictions currently implement stormwater management activities through the MS4 permit program. The most significant elements of this program are new development and significant redevelopment requirements and non-structural BMP programs, which have been implemented to reduce pollutants in urban runoff. This section summarizes existing activities in these permit program areas and identifies opportunities for program enhancements to support compliance with the Metals TMDL. Each jurisdiction will select from the phased non-structural BMP program as outlined in Section 5 to determine the most beneficial non-structural BMPs to implement for their city

3.1 Reach 2 MS4 Permits

Urban runoff discharges for the jurisdictions participating in this Reach 2 TMDL Implementation Plan are governed by the following NPDES MS4 permits:

- All participating municipal jurisdictions, except the City of Long Beach – this group is permitted under the MS4 permit issued to Los Angeles County and 84 incorporated cities (NPDES Permit #CAS004001; Order #01-182; issued by LARWQCB 2001).
- City of Long Beach – permitted under NPDES Permit #CAS004003; Order #99-060; issued by LARWQCB 1999).
- Caltrans – permitted under NPDES Permit #CAS000003; Order #99-06-DWQ; issued by LARWQCB 1999).

These permits contain a number of programmatic activities that are intended to reduce pollutants in urban runoff. These activities will continue as required by these existing permits or as required when these permits are reissued.

3.2 New Development and Significant Redevelopment Activities

The existing permits require that many development activities of a minimum size or type include structural BMP controls to achieve stormwater volume reductions and improve the quality of stormwater leaving the site. The following sections describe existing permit requirements for development activities and opportunities for program enhancements in the future.

3.2.1 Municipal MS4 Permits

The permits issued to the municipal dischargers require that developers prepare documentation to demonstrate compliance with new development and significant redevelopment requirements which are intended to reduce the quantity and improve the quality of offsite runoff during wet weather events. These post-construction stormwater treatment requirements apply in general to the following types of municipal projects:

- Single-family hillside residential developments of one acre or more of surface area;
- Housing developments (includes single family homes, multifamily homes, condominiums, and apartments) of ten units or more;
- A 100,000 square feet or more impervious surface area industrial/commercial development;
- Automotive service facilities (5,000 square feet or more of surface area; SIC 5013, 5014, 5541, 7532-7534 and 7536-7539);
- Retail gasoline outlets (5,000 square feet or more of impervious surface area and with projected Average Daily Traffic of 100 or more vehicles);
- Restaurants (5,000 square feet or more of surface area; SIC 5812);
- Parking lots 5,000 square feet or more of surface area or with 25 or more parking spaces;
- Projects located in, adjacent to, or discharging directly to an environmentally sensitive area that meet threshold conditions (as identified in the permit); and
- Redevelopment projects in subject categories above that meet redevelopment thresholds (significant redevelopment includes any land-disturbing activity that results in the creation, addition, or replacement of 5,000 square feet or more of impervious surface area on an already developed site).

Developers are required to prepare a Standard Urban Stormwater Mitigation Plan (SUSMP) for projects that fall in one of the above categories. Where SUSMP requirements apply, the project must meet minimum numeric design criteria, either flow-based or volumetric treatment control requirements. This is accomplished through the selection of appropriate structural BMPs as defined by existing SUSMP guidelines.

Within the implementation period associated with this Metals TMDL, water quality benefits will accrue from continued implementation of this program. Some participating jurisdictions have already implemented enhancements by establishing preferences or requirements for infiltration BMPs that maximize water quality benefits when implemented as part of development projects. All jurisdictions are committed to evaluate potential opportunities in the Reach 2 watershed for a more consistent application of structural BMPs during the development and redevelopment process that maximize water quality benefits. These opportunities will be evaluated as part of TMDL implementation.

3.2.2 Caltrans MS4 Permit

The Caltrans Stormwater Management Plan (SWMP) specifies requirements for the implementation of BMPs for state transportation projects (Caltrans 2003). The SWMP was updated in 2003 as required by its 1999 MS4 permit. When a Caltrans project results in stormwater runoff discharging directly or indirectly to a surface water, approved BMPs (referred to as Category III BMPs) are considered in all proposed new construction and major reconstruction projects, and, where feasible, installed. Approved treatment BMPs vary, but Caltrans maximizes the use of biofiltration strips and biofiltration swales to reduce runoff and pollutant loads. Other approved treatment systems include infiltration devices, detention devices, traction sand traps, dry weather flow diversions, gross solids removal devices, media filters, multi-chamber treatment trains (MCTT), and wet basins.

Similar to the municipalities, continued implementation of these requirements will provide water quality benefits over the long term. Caltrans is committed to evaluating appropriate use of structural BMPs that maximize infiltration onsite. Opportunities for such enhancements will be evaluated as part of TMDL implementation.

3.3 Non-Structural BMP Programs

Non-structural BMPs can provide cost-effective water quality benefits by reducing or eliminating pollutants at their source. Effective implementation of these BMPs reduces the need for more costly structural BMPs. Non-structural BMPs include public education and outreach programs to change behavior, development policies that reduce impervious areas, ordinances that conserve water and minimize sources of dry weather flows, and product replacement efforts that eliminate sources of pollutants in the environment.

Non-structural BMPs are typically implemented at the municipal, county, or agency level of government, but may also be implemented statewide, where sufficient interest exists to regulate products identified as significant pollutant sources. For example, product replacement efforts are typically most successful when applied statewide (or even nationally) rather than locally. Non-structural BMPs also may include business incentives to reduce stormwater runoff from commercial and industrial areas to storm drains. Benefits of a comprehensive, effective non-structural BMP program include:

- *Flexibility* – The level of effort applied to program elements may be increased or decreased based on need. For example, if a particular program is found to be especially beneficial, resources may be increased (or diverted from less effective BMPs) to enhance the program.

- *Cost effective* – Structural BMPs are not only costly to build, but have continuing operation and maintenance (O&M) costs associated with them. In contrast, non-structural BMPs often have minimal capital costs and O&M associated with them. Because these programs may be applied to large areas to reach large numbers of people at the same time, these programs can be very cost effective in terms of water quality benefits.

- *Urban retrofit potential* – Much of the Reach 2 watershed is highly urbanized. The potential to retrofit infrastructure to capture and treat urban runoff is somewhat limited unless extremely costly land use conversion activities are implemented. Accordingly, the use of effective non-structural BMPs provides a much less costly approach to reducing pollutants in urban runoff.

- *Target specific sources* – Non-structural programs often can be designed to target not only specific pollutant sources, but also target areas where pollutant loads are known to be particularly high.

3.3.1 Existing Programs

There are several existing non-structural programs in the Reach 2 watershed. Tables 3-1 through 3-3 summarize the non-structural BMP programs by participating jurisdiction, regardless of whether they target sources of metals or some other pollutant in urban runoff. For example, many of the Reach 2 participating jurisdictions are actively implementing programs to reduce trash to support the LAR Trash TMDL requirements. These BMPs are generally implemented independently by each jurisdiction; however, in some cases, BMP programs such as education/public outreach are being implemented jointly. Each jurisdiction will determine the most beneficial programs for their community and is committed to evaluating opportunities for enhancements to any existing programs as part of TMDL implementation.

Additional information about each City's non-structural BMP program is available from the Los Angeles River Watershed Management Committee (Los Angeles River Watershed Management Committee 2009) and the Los Angeles County stormwater program website[1]. Information regarding Caltrans non-structural BMP programs is available in Caltrans' SWMP (Caltrans 2003). To date, the primary areas of non-structural BMP activity that are common to the Reach 2 watershed include:

- Public Education & Outreach
- Street Sweeping
- Catch-Basin Cleaning
- Storm Drain Labeling

All of these activities can reduce metals loads in urban runoff. Various jurisdictions have implemented additional non-structural BMP activities that also can result in reduced metals loads, e.g., water conservation related activities that reduce the need for watering and thus the potential for dry weather runoff, implementation of green policies that target all pollutants in urban environments, and establishment of preferences or requirements to implement infiltration BMPs on new development or redevelopment projects.

[1] Individual City information provided at www.ladpw.org/wmd/NPDESRSA/AnnualReport/index.cfm

Table 3-1 General Source Control Non-Structural BMPs Implemented by Reach 2 Participating Jurisdictions

City	No Dumping Stencils/Markers	Street Sweeping	Catch Basin Cleaning
Alhambra	Located on catch basins; offered to businesses and residential	Sweeps weekly; some high traffic areas swept five days/week	Contracts with County to clean City-owned catch basins; catch basin screen devices installed at many locations
Arcadia	Storm drains marked	Enhanced program in residential areas (weekly); high priority commercial areas (twice per week)	Inserting catch basin inserts to capture trash
Bell	Storm drains marked	Enhanced program: commercial & industrial (six/week); multi-family (two/week); single family (one/week); sweeping of publicly owned properties weekly	Catch basin cleaning to remove trash
Bell Gardens	Catch basins and storm drain inlets marked	Street sweeping program	City cleans during dry weather months; contracts during wet weather
Bradbury	Storm drains marked	All streets priority C - cleaned as necessary but no less than once/year	Catch basin cleaning contracted out
Commerce	Storm drains marked	Weekly street sweeping	Contracts with County to clean City-owned catch basins
Downey	Storm drains marked	Weekly street sweeping	Catch basins periodically cleaned
Duarte	Storm drains marked	Streets swept at least twice/month	Catch-basins cleaned once per year; planning to install debris excluders
El Monte	Storm drains marked	Streets swept once or twice/week depending on priority; municipal parking lots swept three times/week	City contracts with County for cleaning; inserts in many catch basins to capture trash; many more planned
Huntington Park	Storm drains marked	Many streets swept (once or twice/month) based on their priority ranking	Insert screens inserted in a few catch basins; more planned; County maintains basins
Irwindale	Storm drains marked	Streets swept at least twice/month	Periodic catch basin cleaning
La Canada Flintridge	Storm drains marked	Sweeps streets regularly based on priority	City contracts with County for cleaning; full capture trash system being installed
Long Beach	Storm drains marked	Streets swept regularly; curbed streets at least twice/month; alleyways swept at least once/month	Catch basins periodically cleaned
Lynwood	Storm drains marked	Main arterials swept 3 times/week; medians, islands, some alleys and residential areas swept once/week	Catch basins periodically cleaned
Maywood	Storm drains marked	Street sweeping of varying frequency based on priority	Insert screens inserted in a few catch basins; more planned; County maintains basins

Table 3-1 (Continued)

City	No Dumping Stencils/Markers	Street Sweeping	Catch Basin Cleaning
Maywood	Storm drains marked	Street sweeping of varying frequency based on priority	Insert screens inserted in a few catch basins; more planned; County maintains basins
Monrovia	Storm drains marked	Sweeps streets once/week	Catch basins periodically cleaned
Montebello	Storm drains marked	Street sweeping of varying frequency based on priority	Catch basins periodically cleaned; planning to implement trash capture program
Monterey Park	Storm drains marked	Street sweeping of varying frequency based on priority	Catch basins periodically cleaned
Paramount	Storm drains marked	Street sweeping of varying frequency based on priority	Catch basins periodically cleaned; implementing trash capture program
Pasadena	Storm drains marked	Street sweeping of varying frequency based on priority	Catch basins periodically cleaned; extensive program to install catch basin inserts for trash; block catch basins during large events such as Rose Parade to reduce risk of trash entering catch basin
Pico Rivera	Storm drains marked	Street sweeping of varying frequency based on priority	Catch basins periodically cleaned
Rosemead	Storm drains marked	Street sweeping of varying frequency based on priority	Catch basins periodically cleaned
San Gabriel	Storm drains marked	Streets swept at least twice/month	Catch basins cleaned annually
Sierra Madre	Storm drains marked	Street sweeping of varying frequency based on priority	Catch basin inserts installed in many location; cleaned monthly
South Gate	Storm drains marked	Street sweeping of varying frequency based on priority	Catch basins periodically cleaned; all fitted with screens or inserts to capture trash
South Pasadena	Storm drains marked	Street sweeping of varying frequency based on priority	Catch basins periodically cleaned
Temple City	Storm drains marked	Street sweeping of varying frequency based on priority	Catch basins periodically cleaned; contracted to County
Temple City	Storm drains marked	Street sweeping of varying frequency based on priority	Catch basins periodically cleaned; contracted to County
Vernon	Storm drains marked	Street sweeping of varying frequency based on priority	Catch basins periodically cleaned; pilot program implemented to install catch-basin inserts for trash
Caltrans	Storm drains marked	Street sweeping implemented as part of highway maintenance program	Rejected BMP per SWMP. Catch basins not effective for removing pollutants; maintenance costs and risk to personnel high vs. benefits.

Table 3-2 Policy, Ordinance and Planning Type Non-Structural BMPs Implemented by Participating Jurisdictions

City	Enhanced Development & Re-development Requirements	Water Conservation	Green Policies & Planning
Alhambra			
Arcadia	Encourage infiltration or bio- filtration for all new development SUSMP sites	Promote BMPs to reduce need for water, fertilizers and pesticides, e.g., use of native vegetation	
Bell		Native plant use encouraged	
Bell Gardens			
Bradbury		Many residential projects installing infiltration systems to reduce site runoff; lots are large; often have undeveloped natural areas that are not irrigated	
Commerce	Enhanced MS4 development requirements	Water conservation ordinance adopted 5/5/2009	Updated General Plan to improve links to urban runoff management needs; floodplain management standards ordinance
Downey	Encourages infiltration-based rather than treatment or flow-based BMPs; e.g. implemented infiltration program for redevelopment projects of 400 sq. ft. or greater	Encouraging residents to install infiltration devices in their yards; city encourages use of drought tolerant plantings	
Duarte	Draft guidelines developed that require selection of preferred controls with infiltration as priority BMP type	Encouraging planting of native vegetation by City staff	
El Monte	Infiltration required to mitigate first 0.75 inch of rain	Encouraging use of drought tolerant vegetation	
Huntington Park		Considering installing native drought resistant vegetation where appropriate	
Irwindale	Revising guidelines to indicate preference for infiltration BMPs	Encouraging use of drought tolerant vegetation	
La Canada Flintridge	Encouraging use of infiltration BMPs	Adopted County Model Ordinance for efficient landscape design	
Long Beach			City-wide Task Force
Lynwood		Encouraging use of drought tolerant vegetation; Water conservation ordinance in place	
Maywood			

Table 3-2 (Continued)

City	Enhanced Development & Re-development Requirements	Water Conservation	Green Policies & Planning
Monrovia	Roof drains directed to vegetated areas	Encouraging use of drought tolerant vegetation	Monrovia Environmental Accords policy action items related to urban runoff management
Montebello		Encouraging use of drought tolerant vegetation	
Monterey Park	Encourage infiltration or bio- filtration for all new development SUSMP sites	Encouraging use of drought tolerant vegetation	
Paramount		City enacted County model landscape efficient watering provisions	
Pasadena	Enhanced MS4 development requirements for hillside areas to reduce erosion/sediment	Promotes native vegetation planting; developing water-wise planting designs; non-essential turf being evaluated for removal and replanting with water-wise planting	Numerous green City policies and resolutions; adopted Green City Action Plan
Pico Rivera			
Rosemead			
San Gabriel	Revised MS4 development program to reflect preference for infiltration BMPs; City considering routing roof-top runoff for any project over 400 sq ft.		Adopted green policy: San Gabriel Goes Green: A Sustainable Action Strategy which promotes green practices
Sierra Madre		Encouraging use of drought tolerant vegetation; native vegetation used only in downtown re-landscaping, park development	
South Gate	Encourage infiltration or bio- filtration for all new development SUSMP sites	Encouraging use of drought tolerant vegetation; Water conservation ordinance in place	
South Pasadena		Encouraging use of drought tolerant vegetation	Green policies in place
Temple City	Encourage infiltration or bio- filtration for all new development SUSMP sites	Encouraging use of drought tolerant vegetation	
Vernon	Projects conditioned to provide structural BMPs specific to heavy industry; enhanced post-construction inspection, maintenance BMP requirements		Implemented a restriction on cross lot drainage
Caltrans	Approved treatment systems for highway projects per SWMP	Water conservation practices incorporated into construction practices to reduce erosion and pollutant transport offsite	

Table 3-3 Public Education and Outreach Non-Structural BMP Implementation by Participating Jurisdictions

City	Outreach Events	Publications/Outreach	School Outreach
Alhambra	Participation in community events including hazardous waste roundup; Chinese Lunar New Year Festival, others	Brochures and tip cards available at public outlets; Stormwater Pollution Prevention article Annual Drinking Water Quality Report; newspaper ads; outreach to businesses	Stormwater/ environmental theme Calendars provided to schools
Arcadia	Participation in Community events; Participation in the annual water festival; Participation in local food festival promoting restaurant BMPs; Co-host the County's smart gardening workshop	Newspaper articles; brochures; materials also printed in Chinese, Spanish; joint venture public service announcement (PSA) with Monrovia, Sierra Madre, Duarte; Produce annual environmental awareness calendars for dissemination; Pet waste outreach implemented annually at local pet related businesses; POP outreach implemented annually; Restaurant BMP outreach implemented annually via mailers to local restaurants; Business BMPs outreach via mailers	Encourages schools to participate in the County Environmental Defenders program; Outreach materials including annual calendars and activity books distributed to local schools
Bell		Bilingual materials; articles published in City newsletter; materials posted at City Hall, offered through Chamber of Commerce, during business inspections or obtaining business license	Encourages schools to participate in programs created by County
Bell Gardens		Bilingual materials available at selected City locations; outreach to businesses as needed; articles in City newsletter; materials distributed to community organizations/businesses	
Bradbury	Participated with other cities in Concerts in the park	Material available through City Hall; monthly newsletter used to share information as needed	Bradbury students attend Duarte schools
Commerce	Hosts annual Home Improvement Fair; annual household hazardous waste roundup	Bilingual materials available in variety of locations and community events; Articles in City's monthly newsletter; PSAs on TV, radio; outreach to businesses thru inspection program	Schools notified of Environmental Defenders program
Downey	Trash emphasis at events such as annual Holiday Lane Parade; Keep Downey Beautiful campaign activities	Quarterly newsletter; mobile billboard; outreach materials provided to developers and their consultants; outreach to new businesses to assist with infiltration requirements; PSA thru newspaper	Stormwater pollution prevention assembly at Rio Hondo Elementary School; students given Heal the Bay "Protecting Your Watershed" Adventure Guide
Duarte		Bilingual materials available in variety of locations and community events; PSAs on TV, radio; outreach to businesses thru inspection program	Schools notified of Environmental Defenders program

Table 3-3 (Continued)

City	Outreach Events	Publications/Outreach	School Outreach
Huntington Park	Distribute bilingual materials to children and general public at local outreach meetings and events such as job fairs, collection activities	Materials available at selected City locations and made available during community events; distributed with annual and biannual business inspections	
Irwindale		Materials available at selected City locations and made available during community events; PSAs via newspaper, radio and TV	Schools notified of Environmental Defenders program
La Canada Flintridge	City Park holiday events for Labor and Memorial days	Materials available at selected City locations; city shows information on the Community bulletin board on water quality; supports media time purchase by County	
Long Beach	Community events such as Coastal Awareness Day and Beach Cleanups; Los Angeles County Fair; Pollution Prevention Awareness Week Programs; quarterly education programs through Parks & Recreation	Materials available at selected City locations; bilingual information published in newsletter, brochures; outreach to businesses and industry	Implements a number of education programs through schools and Parks & Recreation, e.g., Protect our Watery World; Traveling Recycling Education Center, Aquatics Wild, Adopt a Gutter etc.
Lynwood	Pollution prevention activities at Earth Day event, St. Francis Medical Earth Day Festival, fair housing events, new park grand openings	Materials available at selected City locations and distributed at Town Hall meetings; outreach to businesses that contact City	Elementary schools host County's Environmental Defenders program
Maywood	Distribute bilingual materials to children and general public at local outreach meetings and events	Materials distributed with annual and biannual inspection program; available at selected City locations or outreach events; supports media time purchase by County	
Monrovia	Educational display board used at special events; information available at Monrovia Days, Biodiversity Fair, Earth Day and Monrovia Area Partnership Neighborhood Block Party events	Materials available at selected City locations; Downtown Caretaker contact with businesses, sidewalk area cleanup, inspections. Joint newspaper ads with Arcadia, Sierra Madre, Bradbury, Duarte	Outdoor education program for youth (5th and 6th graders)
Montebello		Materials available at selected City locations and made available during community events; distributed to business and industry as part of inspection program	Schools notified of Environmental Defenders program

Table 3-3 (Continued)

City	Outreach Events	Publications/Outreach	School Outreach
Monterey Park	Letter sent to schools re stormwater programs to support participation in earth day events; participate in the City's annual Green Festival; Partner with local library to host Earth Day special story time and presentation	Articles published in City's newspaper; Produce joint venture Chinese newspaper ad with Alhambra, Temple City, and San Gabriel on Earth Day; Pet waste outreach implemented annually at local pet related businesses; POP outreach implemented annually; Restaurant BMP outreach implemented annually via tri-lingual mailers to local restaurants; Business BMPs outreach via mailers	Encourage schools to participate in the County Environmental Defenders program; Outreach materials including bookmarks and activity books distributed to local schools.
Paramount	City Park holiday events for Labor and Memorial days	Materials available at selected City locations and made available during community events; stormwater article in Chamber of Commerce newsletter	County program promoted to school district and has been held at several schools
Pasadena	Gardening Workshop	To support Green City program, developed a variety of educational materials for public and business community; implemented web-based training for all residents and businesses; outreach to business during inspections; uses County materials as well.	Offer the County's Environmental Defenders and Generation Earth programs in schools
Pico Rivera		Materials available at selected City locations	Visited two schools as part of public works week/career day events
Rosemead		Materials available at selected City locations; developed City pamphlet in English, Spanish and Chinese; Chamber of Commerce newsletters to share information; quarterly City newsletter, "Rosemead Source Report" sent to all properties	Schools notified of Environmental Defenders program and encouraged to implement
San Gabriel	Participation in Community events, e.g., Chinese New Year's Parade & Festival, Grapevine Festival, Chamber of Commerce Business Expo	Bilingual materials available in variety of locations and community events; contribution to County's PSA program to TV, radio; outreach to businesses thru inspection program	Schools notified of Environmental Defenders program and encouraged to implement
Sierra Madre	City provided information at community events including Public Works Open House; County Smart Gardening Workshop	Materials available at selected City locations and included with development permits; information provided via local access cable channel and city website; press release to newspapers (Sierra Madre Weekly, Mountain Views Observer, San Gabriel Valley Weekly, Pasadena Star News)	Schools notified of Environmental Defenders program; information regarding stormwater quality provided to two schools to be used in conjunction with environmental-oriented curriculum

Table 3-3 (Continued)

City	Outreach Events	Publications/Outreach	School Outreach
South Gate	Participation in City's community events; Partner with City's recycling programs to host Earth Day event annually; Partner with City's used oil program to disseminate stormwater information at its annual filter exchange event	Product annual environmental awareness calendars for dissemination; Produce articles to be published in City quarterly newspaper; Partner with City's recycling programs to disseminate trash reducing/recycling awareness message as a whole; Pet waste outreach implemented annually at local pet related businesses; POP outreach implemented annually; Restaurant BMP outreach implemented annually via bi-lingual mailers to local restaurants; Business BMPs outreach via mailers	Encourage schools to participate in the County Environmental Defenders program; Outreach materials including annual calendars and activity books distributed to local schools
South Pasadena	Participate in the City's "Doggy Day in the Park" event; Participate in the City's "Clean Car Show"	Produce annual environmental awareness calendars for dissemination; Produce articles to be published in City quarterly newsletter; Pet waste outreach implemented annually at local pet related businesses; POP outreach implemented annually; Restaurant BMP outreach implemented via mailers to local restaurants; Business BMPs outreach via mailers	Encourage schools to participate in the County Environmental Defenders program; Outreach materials including annual calendars and activity books distributed to local schools
Temple City	Partner with City's used oil program to disseminate stormwater information at its filter exchange event; Participate in City's community events	Produce annual environmental awareness calendars for dissemination; Produce articles to be published in City quarterly newsletter; Produce joint venture Chinese newspaper ad with Alhambra, Temple City, and San Gabriel on Earth Day; Partner with City's used oil recycling program to disseminate trash reducing/recycling awareness as a whole; Pet waste outreach implemented annually at local pet related businesses; POP outreach implemented annually; Restaurant BMP outreach implemented annually via bi-lingual mailers to local restaurants.	Encourage schools to participate in the County Environmental Defenders program; Outreach materials including annual calendars and activity books distributed to local schools
Vernon		Materials available at selected City locations and community events including by way of Chamber of Commerce; monthly article in newsletter; business outreach through inspections and licensing; contribution to County's PSA program to TV, radio	
Caltrans	Outreach activities to construction contractors	Variety of written materials available including monthly and quarterly bulletins, a website, workshops and the Department's Adopt-a-Highway Program	

3.3.2 Non-Structural BMP Opportunities

A number of additional non-structural BMP opportunities exist to reduce metal sources in the environment. These opportunities range from direct product replacement, which eliminates metals from the environment, to targeted activities such as street sweeping or catch basin cleaning, which remove sediments that are often a significant source of metals. As stated previously, some of these BMPs are already being implemented in various jurisdictions, but could potentially be enhanced to provide even more water quality benefits. The following sections describe opportunities for non-structural BMP implementation. Where possible, potential water quality benefits of non-structural BMPs are quantified in Section 3.4. Each jurisdiction will select from the phased non-structural BMP program as outlined in Section 5 to determine the most beneficial non-structural BMPs to implement for their city

3.3.2.1 Direct Source Control

Direct source control BMPs focus on preventing metals from being deposited in the environment and the potential transport by urban runoff. Some BMPs are highly effective, e.g., product replacement, while others have limited benefit because they require substantial changes in behavior, e.g., increased use of public transportation. Direct source control activities can be categorized in various ways. For example:

- *Product Replacement* - Metals used in vehicles, building structures and chemical products can become a significant source of metals in urban runoff. Where opportunities exist for the use of alternative products with reduced or no metals, these opportunities can be promoted in various ways, e.g., by encouraging or requiring manufacturers to change product formulations.

- *Source Reduction Activities* - Some source control BMPs do not eliminate the source but can greatly reduce the metals load reaching storm drains. The degree of success with these types of BMPs depends on successfully changing behavior or implementing standard local drainage practices that change how stormwater leaves a site.

- *Source Removal* - Source removal activities involve preventing pollutants already deposited in the environment from moving through storm drains and entering waterways. Street sweeping and catch basin cleaning are common BMPs that remove metals present on roadways and from storm drain infrastructure. The benefits of the latter, catch basin cleaning, can be increased further through installation of BMPs that capture trash.

The following sections describe various direct source control non-structural BMPs evaluated for potential inclusion in this Implementation Plan.

Vehicle Brakes Pads

One of the most significant sources of copper in urban watersheds is copper contained in vehicle brake pads. The copper load generated from brake pads varies based on factors such as frequency and level of brake use, vehicle speeds, the age and type of vehicle, amount of traffic, and type of brake pads used.

The Brake Pad Partnership (BPP), a collaborative effort representing water quality regulatory agencies, automobile brake pad manufacturers, environmental groups, and stormwater management agencies has led the effort in California to change how brake pads are manufactured so that copper loads are greatly reduced in the environment. The BPP has completed numerous studies which demonstrate the water quality benefits that may be achieved through changes in brake pad manufacturing methods (see detailed information available at the following website: http://www.suscon.org/bpp/reference/).

The BPP led efforts to promulgate legislation that reduces the amount of copper used in brake pads. Senate Bill 346, signed into law on September 27, 2010, places a 5 percent by weight limit on the amount of copper used in brakes sold in California by 2021. This percentage would be reduced to just 0.5 percent by 2025. The legislation also requires that copper not be replaced with an alternative material that would also ultimately result in impaired waters.

Pesticide Use

The BPP has also conducted studies to identify sources of urban copper other than brake pads. The results of one study showed that a number of copper-based pesticides are in use in the area and a significant contributor of copper loading in the San Francisco Bay area (see the BPP website document library: http://www.suscon.org/bpp/reference/). No local studies have been conducted in the LAR watershed, but given that copper-based pesticides are relatively commonly used, it can be assumed that pesticides have the potential to be an important source. Reducing the load from this source can be achieved either by using pesticides without metals as a primary component or through education on the proper use and disposal of chemicals.

Vehicle Tire Lead Weights

Studies conducted by the Center for Environmental Health (CEH) in California have shown that wheel weights used to balance vehicle tires are an important source of lead in the states waters (www.ceh.org). Based on these studies, the CEH is promoting legislation to replace lead-based wheel weights with an alternative safer product. Senate Bill 757, as currently introduced in the California legislature, would prohibit the manufacture, sale, or installation in California of wheel weights that contain more than 0.1 percent lead. Similar to the brake pad legislation, this bill contains language that ensures that the lead wheel weights are not replaced with an alternative constituent that may also cause environmental concerns.

Vehicle Tires

A number of studies have shown a close link between debris generated by vehicle tire wear and metals loading to receiving waterbodies (Councell et al. 2004, Davis 2001). These studies show that tire debris contributes to metals loadings of lead, copper and cadmium. Using relationships between debris generated per distance traveled, the estimated load from vehicle use has been developed (Councell et al. 2004). If technically feasible, the best way to eliminate this source is to reduce the metals content of vehicle tires. No known studies are available that show whether this approach is technically possible. However, another mechanism to reduce this source is to promote activities that reduce driving and increase use of public transport. It may be possible to develop incentive programs to encourage this type of behavior change; however, the expected degree of success cannot be estimated.

Roof Materials

Roofing materials (including metal sheet roofing, gutters and downspouts) are an important source of metals in the environment (Chang et al. 2004, Van Metre and Mahler 2003, Davis et al. 2001). Zinc is often considered the most important metal associated with roofing materials, but these studies also show that lead, copper and cadmium can be mobilized by rainfall. At this time, no effort to reduce the metals content of roofing materials has been identified. However, an alternative approach for reducing metals loading from this source is to implement BMPs that promote the retention of stormwater on site rather than running off to the storm drain. Examples of such BMPs include redirection of roof downspouts to pervious areas and the use of rain barrels or cisterns to collect roof runoff for reuse on lawns or gardens. These BMPs can be implemented on any type of land use. Not only do they reduce stormwater runoff and pollutant loading, but their implementation promotes water conservation.

Street Sweeping

Paved areas including both streets and parking lots receive a substantial build up of fine particulates during periods of dry weather. Sources of particulates include air deposition, vehicle tire wear, and dust from adjacent lands. These particulates, which contain a variety of pollutants, including metals, gradually build up during dry weather and are washed into storm drains during stormwater runoff events. To reduce the volume of material that builds up on these impervious surfaces, street sweeping practices are implemented as a routine stormwater management BMP. All participating jurisdictions are currently implementing some degree of street sweeping to reduce particulates and associated metals on impervious surfaces. However, it may be possible to achieve even better metals load reductions by implementing enhancements to street sweeping programs, e.g., through use of more effective sweeping equipment, targeting hot spots, or changing the frequency of sweeping. Pilot studies would be needed to determine if it is possible to gain any additional water quality benefits from an enhanced program.

Catch Basin Cleaning

As noted in the Street Sweeping discussion above, metals are often bound to fine particulate material. During stormwater runoff events, this material can be captured in catch basins and removed before it discharges to receiving water. The key to the effectiveness of catch basins is their ability to settle out suspended solids. If water flows through too quickly or is too turbulent, then the effectiveness declines. Over time, sediment build up occurs in catch basins. This sediment can contain a substantial amount of captured pollutants; accordingly, regular catch basin cleaning removes these potential pollutant sources to downstream waters.

Trash can also be an important source of pollutants, including metals and bacteria. Therefore, catch basins, which have been retrofitted with trash capture devices, also provide potential water quality benefits. Not only is the trash captured but the associated pollutants adhered to the trash are also removed.

To gain the greatest water quality benefit from catch basins, they need to be cleaned on a regular basis. Cleaning frequency can vary depending on need, e.g., degree of sediment/trash buildup. However, through appropriate studies, cleaning frequency can be targeted based on where debris buildup occurs the most rapidly or where the debris is known to be particularly high in pollutant loads. With the exception of Caltrans[2], all participating jurisdictions currently have a catch-basin cleaning program, and many cities are installing trash capture devices to meet requirements of the LAR Trash TMDL. Pilot studies would be needed to determine if it is possible to gain any additional water quality benefits from a modified program.

3.3.2.2 Public Education and Outreach

Public education and outreach programs focus on changing behaviors that are known to result in increased loadings of pollutants in the environment. As with any public education and outreach program it is difficult to quantify potential benefits of these programs since it is difficult to measure behavior changes. However, it is clear through surveys that public attitudes/awareness do change through such programs. Therefore continuation of these programs is an important part of a non-structural BMP program. Following are specific education and outreach activities that can result in reduced metals loadings to waterbodies.

Individual Car Washing

As noted above, brake pad wear and vehicle tires are important sources of metals. While the above BMPs can reduce these sources over large areas, BMPs that target local residential areas are important as well. For example, additional metals loading occurs when residents wash their cars in driveways and parking lots (e.g., charity car washes), and the resulting water flows directly to a storm drain. Studies by the Center for Watershed Protection (CWP) have demonstrated residential car washing as a contributor to metals loadings (CWP 2008). Public education and outreach efforts can be implemented to encourage residents to take their vehicles to commercial car

[2] Caltrans has rejected the use of cleaning catch basins as a BMP because studies have shown them to be ineffective has a highway BMP. In addition, the maintenance cost and risk to personnel trying to clean them is high (Caltrans 2003).

washes where runoff is captured, consider washing their vehicles on a pervious surface, or wash the car in a way that the runoff water is directed to a pervious surface. For charity car washes, car wash kits could be provided to block runoff from reaching a storm drain and direct the runoff water to a pervious area.

Used Oil
Household hazardous waste management programs have been targeting disposal of used oil for many years. However, a recent study by Nixon and Saphores (2007) still found that used oil is a significant source of metals and other toxic contaminants in the environment. It may be appropriate to re-evaluate existing public education and outreach materials/programs and determine if a renewed emphasis on this source needs to be developed and implemented.

Vehicle Maintenance
Homeowners often perform their own maintenance on vehicles, including oil changes, on their properties. This activity can result in spills of metals and other toxic contaminants and cause the build-up of metals around areas where these maintenance activities are carried out. Similar to used oil it may be appropriate to re-evaluate existing public education and outreach materials/programs and determine if additional emphasis on this potential metals source needs to be developed and implemented.

3.3.2.3 Policies and Ordinances

Urban runoff management can be improved through the adoption of policies and ordinances that seek to change how water is generated in an urban environment and how stormwater is managed onsite. In particular, emphasis on the following will result in improved quality of urban runoff:

- Reduce the volume of urban runoff by implementing actions that keep runoff onsite; and

- Removing pollutants from urban runoff through increased use of natural processes that prevent pollutants from ever reaching storm drains.

Examples of how implementation of these principles through policies and ordinances can improve water quality include:

Water conservation
A common source of dry weather flows in storm drains is over-irrigation of both public and private green areas. Ordinances that focus on water conservation not only reduce water usage (an important need in southern California), but also can significantly reduce a key dry weather source of flows in storm drains. Caltrans requires water conservation as a construction practice, and many Reach 2 Cities are already encouraging use of native vegetation in public areas, which will reduce the need to irrigate.

Downspout disconnection

In areas where downspouts discharge directly to storm drains, Cities could develop programs to encourage property retrofits to keep as much stormwater runoff onsite as possible, e.g., through use of rain barrels or cisterns to store and reuse rainwater or by redirecting downspouts to pervious areas. An obvious additional benefit of these retrofits is increased water conservation.

Development practices

Establishment of development policies that maximize retention of stormwater onsite will over the long term greatly reduce the volume of stormwater and associated pollutant loads, e.g., implementation of low impact development practices as a requirement for all new development and re-development projects. This effort could include a requirement that infiltration be the preferred BMP type for all projects. In addition, as participating jurisdictions implement roadway improvement projects new policies could be implemented that require installation of bioretention in all potential public areas including highway and sidewalk easements and street medians.

As part of TMDL implementation the opportunity exists for each participating jurisdiction to evaluate whether water quality benefits may be achieved through the establishment of modified or new policies and ordinances to better manage runoff. In many instances there may opportunities for multiple jurisdictions to work jointly to develop common policies or ordinance requirements that provide maximum regional benefits.

3.3.2.4 Planning and Coordination

Increased emphasis on planning and coordination activities either within jurisdictions or across multiple jurisdictions increases the potential for improved quality of urban runoff. This category of non-structural BMPs focuses on two areas:

Long range planning

Each City has a General Plan that guides implementation of all City programs. Many of the key elements of a General Plan, e.g., land use, zoning, or development requirements, have an urban runoff management component. Water quality benefits may be achieved over the long term through better linkage between the City's General Plan requirements and the need to improve the quality of urban runoff. A potential non-structural BMP would be for Cities to evaluate their General Plans and, where appropriate, seek changes to the Plan to facilitate better urban runoff management.

Watershed coordination

Capital projects to improve water quality are costly, especially to small communities. However, opportunities often develop where multiple stakeholders can share costs for projects that provide multiple benefits. Cities may be interested in the project to provide stormwater management benefits, but other potential partners, e.g., non-governmental organizations, may be interested in increased open space for recreational activities. Working jointly may improve the opportunity for state or federal grants to help pay for the project cost. Coordination is already occurring through implementation of the stormwater program; however, there may be additional opportunities for increased coordination that have not yet been considered or implemented.

3.4 Non-Structural BMP Program Runoff Capture Evaluation

In general, it is very difficult to estimate the effectiveness of non-structural BMPs because sources and activities that mobilize different metals are numerous and diverse. Non-structural BMPs reduce pollutant loads by either reducing the source of a pollutant or capturing built-up pollutants before they can be washed off by stormwater into local waterbodies. Estimating the pollutant load reduction achieved through the implementation of these BMPs involves two distinct computations:

- Pollutant Buildup – Determining the relative contribution of the pollutant from a targeted source to the watershed land surface
- Pollutant Wash-off – the transport of pollutants from the watershed surface to downstream waterbodies

The following sections describe the quantification methodology used to evaluate potential benefits from non-structural BMP implementation and the result of applying this methodology to selected BMPs. As will be noted in this discussion, these benefits were evaluated only for those BMPs where a link between the activity and the result can be directly measured.

3.4.1 Quantification Methodology

Historical rainfall records were used to estimate the buildup of metals from controllable sources prior to a storm event (P_t), as a function of preceding dry days (DD). Rational method hydrologic simulations for distinct storm events in the historical rainfall record were used to estimate the wash-off of pollutant from the watershed surface (W), as a function of runoff depth (R). Numerous studies have found that pollutant buildup and wash-off are most appropriately estimated using non-linear relationships. Pollutant buildup occurs at the fastest rate in the initial days following a wash-off event, but decline as buildup approaches the maximum carrying capacity (P_{max}) for the watershed over longer dry periods (Sartor and Boyd, 1972; EPA NURP Study, 1983). These studies also show that the greatest amount of pollutant wash-off occurs with the first ½ inch of runoff, with lower wash-off rates associated with each increment of additional runoff. Therefore, exponential functions were used to estimate pollutant buildup and wash-off associated with specific sources of metals in the watershed;

$$P_t = P_{max} * \left[1 - e^{(-k_b * DD)}\right] + \left[P_{t-1} - W_{t-1}\right] * e^{-k_b * DD}$$

$$W_t = P_t * \left[1 - e^{(k_w * R)}\right]$$

The variables used in these exponential functions for buildup (k_b) and wash-off (k_w) were derived so that ultimate loading to receiving waterbodies is approximately 20-percent of metals accumulated on the watershed, consistent with what has been recorded from urban catchments by Pitt et al., (2004). In addition, the values used in this analysis (k_b = 0.25; k_w = 0.85) are within the range used in technical modeling for the development of the LAR Metals TMDL (TetraTech 2004) as well as recent models of highly urbanized subwatersheds in the Great Lakes region (Chen and Adams 2006).

3.4.2 Potential Water Quality Benefits

Pollutant buildup and wash-off analyses were completed for specific sources of metals, including copper in brake pad wear debris and atmospheric deposition, to quantify water quality benefits associated with brake pad product replacement and roof downspout disconnection, respectively. These are provided in the following sections.

Other non-structural BMPs that could be incorporated into this Implementation Plan were not quantified because of the difficulty in quantifying direct linkages between an activity and a water quality benefit. However, it is expected that many of these BMP opportunities can provide additional pollutant removal. Over time, water quality monitoring will determine if the non-quantified BMPs provide the anticipated additional benefits. Such a finding would likely result in a reduction in the need for structural BMPs to comply TMDL compliance targets.

3.4.2.1 Brake Pad Replacement

Copper from vehicle brake pad wear debris accounts for a significant portion of total copper loads in urban watersheds. In subwatersheds of the San Francisco Bay area, brake pad wear debris accounted for 15- to 50-percent of total copper loads, depending upon the land use in each subwatershed (AquaTerra 2007). The Santa Clara Valley Urban Runoff Program estimated that brake pads are responsible for 42-percent of copper loading to the San Francisco Bay (SCVURP 1997).

A similar analysis for the LAR watershed estimated the fraction of total copper loading manageable through direct source control activities related to copper content in brake pads. The mass of copper released to the watershed per vehicular kilometers traveled (VKmT) provides a basis to quantify baseline loads of total copper from brake pad wear debris. Copper loading rates per VKmT were estimated in several targeted studies conducted by the Brake Pad Partnership (Rosselot 2006). Rosselot (2006) identified a copper brake pad wear rate of approximately 0.55 mg per VKmT. Rosselot (2006) also evaluated the copper content in different types of vehicles within the San Francisco Bay area.

Based on the above studies, an average copper content for vehicles in the LAR watershed was assumed to be 6.5-percent. Thus, 6.5-percent of 7.0 mg per VKmT is the rate at which copper is released to the watershed for every VKmT. Daily VKmT was estimated by taking the population in the Cities participating in this TMDL Implementation Plan (~750,000) and applying a per capita vehicular travel estimate of ~45 VKmT/day, which was computed in the SCAG Regional Transportation Plan

(SCAG, 2008). However, studies have shown equilibrium of pollutant carrying capacity occurs after approximately 20 dry days within an urban watershed (Pitt and Shawlee, 1982). The mass of accumulated sediment on a given day is an exponential function of this maximum carrying capacity, residual pollutant not washed off during the preceding runoff event, and dry days prior to the event.

Senate Bill 346 requires new brake pads in the State of California to contain less than 5-percent copper by 2021 and 0.5-percent copper by 2025. Given these changes in copper content in brake pad wear debris, the mass of copper built up on the watershed, and available for wash-off, will be reduced. To account for the gradual introduction of new brake pads into the market, this compliance analysis assumed average copper content could be reduced to 5-percent by the 2028 compliance milestone (allowing for seven years – a typical length of time for consumers to purchase a new car).

3.4.2.2 Downspout Disconnection

Rooftop runoff is another source of metals loading in the watershed, due to atmospheric deposition and leaching of building materials. Disconnection of rooftop drainage downspouts involves redirection of rooftop runoff from impervious surface runoff or gutter flow to pervious land where bioretention and infiltration can occur. Reduction in runoff from a property provides a reduction in metals loads, estimated as a function of the accumulation of metals on the roof prior to the runoff event. Due to limited information on types of roofing materials used throughout the watershed, load reductions are quantified based on atmospheric deposition alone. Therefore, estimated reductions are conservative.

Monitoring of metals deposition from the atmosphere onto the LAR watershed during dry weather occurred during 2002-2003 at three locations spanning the lower and upper portions of the watershed (Lim et. al., 2006). Averages of measured depositional fluxes for metals addressed by this Plan, including copper, lead, and zinc were 21, 19, and 120 $\mu g/m^2/day$, respectively. Applying these fluxes to rooftop area provides an estimate of metals accumulation on roofs as a function of dry days prior to a storm event. Using this rate of accumulation for 20 days following a wash-off event, a maximum carrying capacity of metals on an estimated 2,200 acres of single-family residential rooftops within the Reach 2 MS4 area (as calculated in Section 6) is approximately 0.7 kg cadmium, 43 kg copper, 39 kg lead, and 248 kg zinc. The estimation of 2,200 acres of single-family residential rooftops was calculated using the building footprint area as quantified in the Los Angeles County parcel database. It was assumed that rooftop area is equal to the building footprint. The mass of accumulated sediment on a given day is an exponential function of this maximum carrying capacity, residual pollutant not washed off during the preceding runoff event, and dry days prior to the event.

The above approach assumes that sources of metals from atmospheric deposition continue to be addressed through the MS4. As will be discussed in Section 8, the SWRCB has acknowledged that some of this metals source could be addressed through air quality regulatory actions. Progress in that area would result in less metals deposition and potentially reduce the number of downspout disconnections needed to support compliance with the metals TMDL targets.

Section 4
Structural BMP Runoff Capture Evaluation

4.1 Introduction

Metals TMDL implementation in the Reach 2 watershed is expected to require implementation of a number of structural BMPs to comply with later term wet weather TMDL targets, in particular the 2024 and 2028 targets. Accordingly, the Reach 2 participating jurisdictions have conducted preliminary analyses needed to lay a foundation for selection of structural BMPs during implementation of this Plan. The purpose of this section is to characterize the BMP selection process and provide baseline information on BMP types, effectiveness and runoff capture capabilities. Five major components are discussed:

- Identification of priority catchments for structural BMP implementation;
- Methodology for identifying ideal structural BMP locations;
- Potential structural BMP types for implementation;
- Evaluation of treatment capacity based on hypothetical BMP characteristics; and
- Quantification of potential pollutant removal that would result from implementation of structural BMPs.

4.2 Priority Areas for Structural BMP Implementation

Priority areas for structural BMP implementation were identified based on a multi-constituent prioritization approach. The goal was to identify catchments that generate the highest levels of metals so that structural BMPs can ultimately be placed in these high priority areas.

As described previously, the pollutants of concern in the receiving waters of the LAR are cadmium, copper, lead, zinc, and selenium, which are the metals listed in the LAR Metals TMDL. Pollutant loads for copper, lead and zinc were used to prioritize the watershed's catchments. Two constituents were not included in this prioritization step for the following reasons:

- Cadmium - This constituent was not included in the catchment pollutant load analysis because it was not detected in 80-percent or more of the water quality samples.
- Selenium – TMDL targets for this metal do not apply to the Reach 2 watershed. Water quality data indicate that concentrations exceed 5 micrograms per liter (µg/l) on few occasions. Specific selenium concerns can be evaluated during BMP design.

4.2.1 Calculation of Pollutant Loading Potential

In order to estimate a pollutant load for the Reach 2 watershed, the volume of runoff from each catchment and the typical concentration of each constituent were determined.

Volume of Runoff

Runoff volume was determined for each catchment in this study area based on a runoff coefficient directly related to a defined land use and the 85th percentile rainfall event (see Section 2), using the following calculation:

$$V = \sum_{LU} P_{85} \times C \times A$$

Where:

V = Runoff Volume

C = Runoff Coefficient based on land use

P_{85} = Rainfall depth for 85th percentile rainfall event, inches

A = Tributary drainage area by land use, acres

Land use is assigned on a parcel basis, and therefore each catchment has multiple land uses. An area-weighted runoff coefficient for each catchment based on land use category was calculated using Table 4-1.

Table 4-1 Runoff Coefficient for a Defined Land Use

Land Use Category	Runoff Coefficient 'C'
Agriculture	0.24
Commercial	0.83
Education/Institution	0.74
Industrial	0.79
Multi-Family Residential	0.71
Open Space	0.09
Other Urban	0.80
Single-Family Residential	0.42

Typical Concentration of a Pollutant

Pollutant concentrations generated by each land use were determined using a Land Use Based Event Mean Concentrations (EMC). EMC values (µg/L) were used to estimate pollutant runoff concentration for a given catchment. The underlying assumption is that similar activities occur in a given land use, and therefore a general estimation of a pollutant can be approximated if the land use is known. EMCs for the study area were defined using a water quality dataset developed by LADPW (Table 4-2).

Table 4-2 Land Use Based Event Mean Concentrations

Land Use Category	Total Copper (μg/l)	Total Lead (μg/l)	Total Zinc (μg/l)
Agriculture	100	30	275
Commercial	31	12	237
Education/Institution	20	4	118
Industrial	35	16	537
Multi-Family Residential	12	5	125
Open Space	11	3	26
Other Urban	52	9	293
Single-Family Residential	19	11	72

Pollutant Load

For each pollutant of concern defined, pollutant load potential for a respective catchment for each land use category was estimated using the following general equation:

Load (kg) = EMC(μg/L)*Runoff (acre-in) / 9728.6

The pollutant loads for each respective land use category were added together for a cumulative constituent load for the catchment.

4.2.2 Prioritization Using a Multi-Constituent Approach

The first step was to determine the overall impact of each pollutant on the catchment. Impacts from copper and lead were normalized using a five-point scale. Catchments with a score of five are those identified as the highest priority for BMP implementation. The impact of zinc on a catchment was normalized on a three-point scale, with a score of "three" indicating catchments with the highest priority.

Using the normalized priority for each constituent, an overall priority was assigned to each catchment using a multi-pollutant catchment prioritization index (CPI). A CPI for a catchment is calculated by summing the normalized priorities for the defined constituents. The CPI was normalized on a five point scale, with a rating of five correlating to the highest priority. Figure 4-1 shows the prioritization of catchments by CPI across the Reach 2 watershed and Table 4-3 summarizes the total area per CPI. Catchments with a CPI of four or five should be given the highest priority for BMP implementation. In these high priority catchments, the largest percentage of land use is industrial at 37-percent as shown in Figure 4-2.

Figure 4-1
Catchment Prioritization by CPI
Reach 2 Watershed

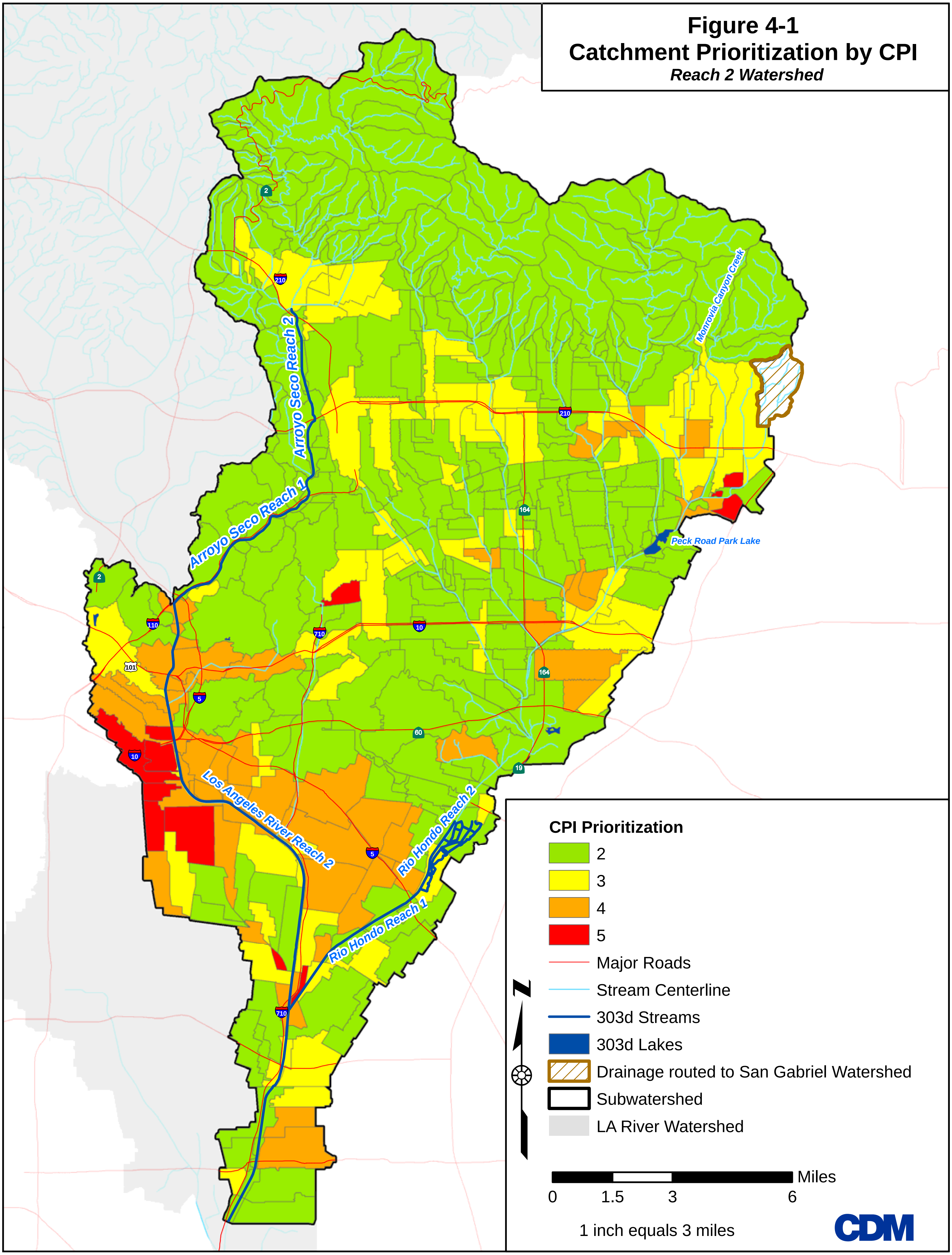


Figure 4-2: Reach 2 Study Area: Metals Composite CPI Rating 4 & 5 Land Use Distribution

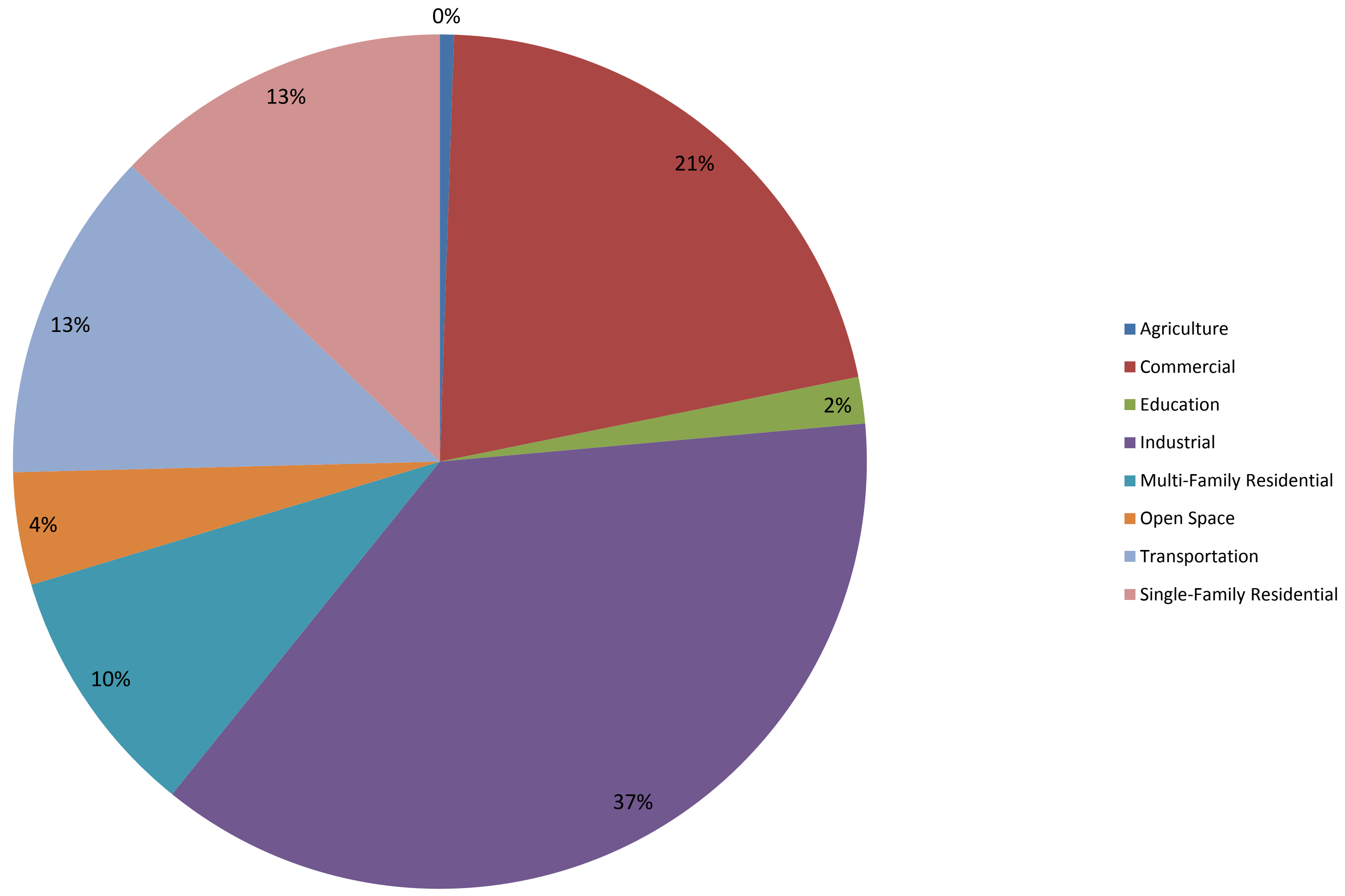


Table 4-3 Reach 2 Watershed Catchment Prioritization Summary

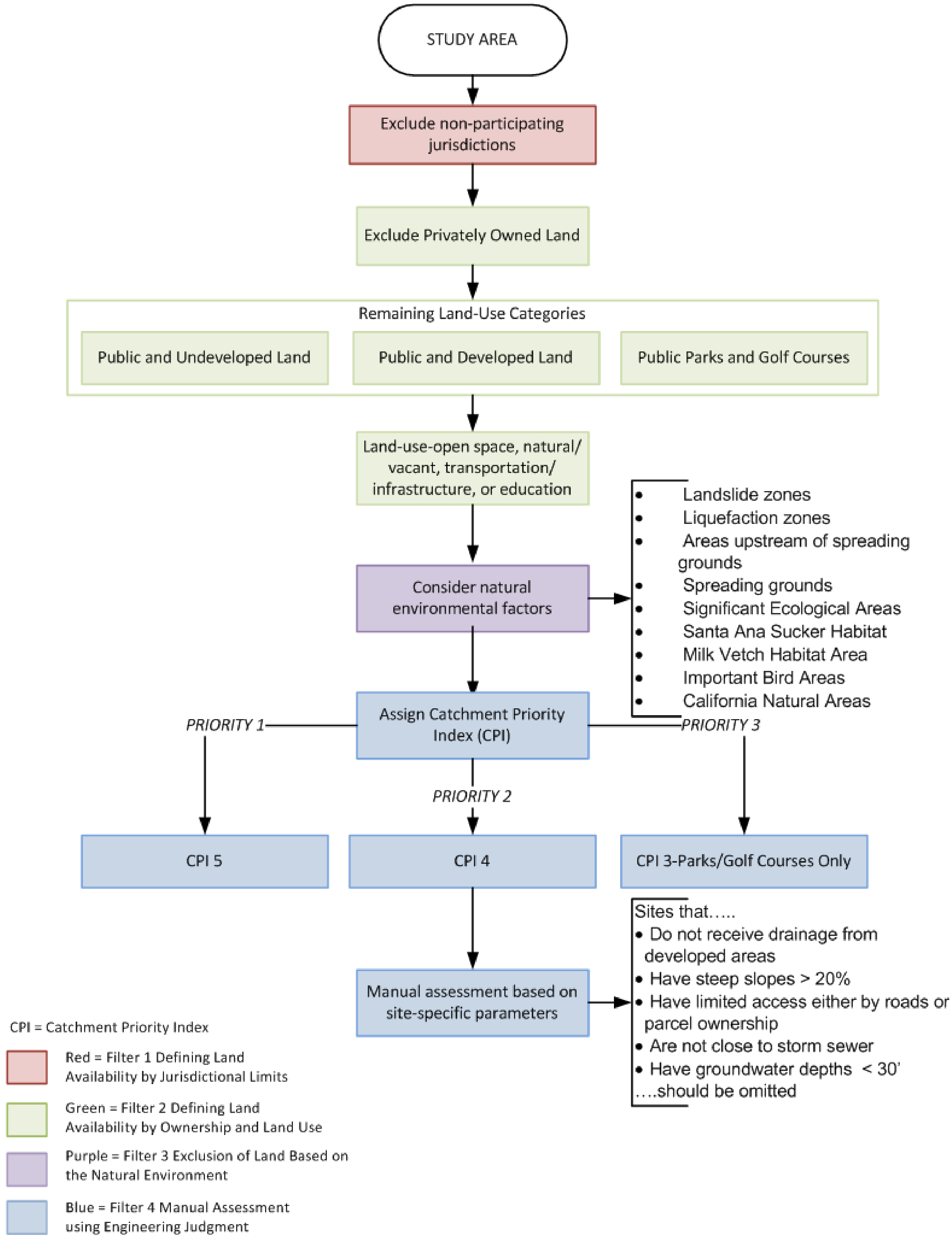
Reach 2 Metals Composite CPI Ratings		
Composite CPI	**Total Area (acres)**	**Percent of Basin Area**
1	0	0
2	126,000	72
3	26,000	15
4	19,000	11
5	3,000	2

4.3 Site Identification Process for Structural BMP Implementation

Potential sites for stormwater structural BMP implementation were identified using a spatial filtering procedure using available GIS layers. Figure 4-3 is a visual representation of this process. A potential structural BMP site should meet defined criteria for land use, land ownership, and environmental sensitivity. Specific sites will be identified and investigated as part of Phase 1 of this Implementation Plan (see Section 5). The site identification process has four general steps:

- Filter 1 - Defining Land Availability by Jurisdictional Limits.
- Filter 2 – Defining Land Availability by Ownership and Land Use.
- Filter 3 – Exclusion of Land Based on the Natural Environment.
- Filter 4 - Manual Assessment Using Engineering Judgment.

Figure 4-3 Structural BMP Site Identification Process



The tables in the following subsections track the available land area for potential structural BMP siting after the application of each filter's criteria.

4.3.1 Filter 1 - Defining Land Availability by Jurisdictional Limits

Filter 1 is shown in reddish brown in Figure 4-3. This filter is used to define the availability of land for potential structural BMP sites in the Reach 2 watershed based on jurisdictional limits. The first step in the filter is to exclude non-participating jurisdiction land area from consideration, such as the City of Los Angeles and Los Angeles County. These entities prepared independent TMDL implementation plans. After the exclusion of this land area for consideration, approximately 101,425 acres remain, as shown in Table 4-4.

Table 4-4 BMP Filter 1 Incremental Results

Filter 1-Land Availability		
Reach 2 Watershed	167,330	ac
−Non-Participating Jurisdictions	-65,905	ac
Area for Potential Structural BMP Sites	101,425	ac

4.3.2 Filter 2 – Defining Land Availability by Ownership and Land Use

Using available GIS layers maintained by SCAG, lands designated as private ownership are excluded from consideration for BMP siting. Private lands are removed from the analysis because of the expected difficulty of acquiring rights to use of the land for BMP implementation. Applying this filter to the Reach 2 watershed, as shown in green in Figure 4-3, resulted in 18,737 acres of area available for potential structural BMP consideration. Of this area, approximately 11,020 acres of land are designated public-undeveloped, 5,100 acres are public-developed, and 2,600 acres are public parks and golf courses. Parcels with a land use category of open space, natural/vacant, transportation/infrastructure, or education should be given the highest priority for structural BMP site consideration. This is due to a reduced construction cost and easier BMP implementation on the site. The incremental results from Filter 2 are shown on Table 4-5.

Table 4-5 BMP Filter 2 Incremental Results

Filter 2-Land Availability		
Land Available After Filter 1	101,425	ac
−Privately-Owned Parcels	-68,688	ac
−Other Land Uses (agricultural land, commercial/institutional, horse ranch, industrial, mixed urban, residential, and water/wetlands)	-14,000	ac
Area for Potential Structural BMP Sites	18,737	ac

4.3.3 Filter 3 - Exclusion of Land Based on the Natural Environment

Filter 3 considers elimination of acreage in the Reach 2 watershed for structural BMP site consideration due to environmental factors identified in Section 2. This part of the site identification process is shown in purple in Figure 4-3. Any elimination due to environmental factors should be site specific, and involve input from all stakeholders. Environmental factors include:

Soil Impacts

- **Landslide Zones**-areas that have an increased probability of landslides due to seasonal fluctuations in groundwater levels, soil pressure, earthquakes, and/or external changes that may undercut slopes.

- **Liquefaction Zones**-areas susceptible to liquefaction due to poorly-drained soils and/or high groundwater levels. These areas may or may not be candidates for BMP projects, and will require a site specific analysis.

Spreading Grounds

Spreading ground locations identified by Los Angeles County and acreage upstream of the Rio Hondo Spreading Grounds were excluded from consideration for structural BMP sites. Approximately 95-percent of the Rio Hondo subwatershed drains to the Rio Hondo Spreading Grounds. These grounds control runoff from up to a half-inch rain event for the upstream drainage area, providing a regional infiltration site. Expansion of this analysis and the associated water quality benefits is provided in Section 6.

Conservation and Environmentally Sensitive Areas

Land areas identified for conservation or as environmentally sensitive may or may not be candidates for BMP projects. For the purposes of this Implementation Plan, areas identified using the sources as defined in Section 2 have been excluded from consideration for structural BMP sites. This exclusion should be revisited during site specific analysis as part of Phase 1. The incremental results from Filter 3 are shown on Table 4-6.

Table 4-6 BMP Filter 3 Incremental Results

Filter 3-Environmental Factors		
Land Available after Filter 2	18,737	ac
−Soil Impacts	-11,058	ac
−Spreading Ground Locations and Subwatershed Area Upstream of the Rio Hondo Spreading Grounds	-6,045	ac
−Conservation & Environmentally Sensitive Areas	-540	ac
Area for Potential Structural BMP Sites	1,094	ac

4.3.4 Filter 4 - Manual Assessment Using Engineering Judgment

Filter 4, shown in blue in Figure 4-3, consists of a manual assessment of potential BMP sites on a site-by-site basis using the results of Filter 3. Potential sites should be assigned a priority based on the results of the multi-pollutant CPI described in Section 4.2. Sites with a CPI of 4 or 5 should be evaluated first given their high priority for BMP implementation. However, a majority of these catchments are fully developed. Due to this limited open space available for structural BMP implementation, public parks and golf courses can also be evaluated as potential structural BMP sites.

Using road and parcel information, storm sewer locations, river locations, and aerial photos, the following criteria should be evaluated during the manual assessment on a site specific basis:

1. **Does the potential site accept drainage from developed areas?**
   Developed areas typically generate stormwater runoff with increased concentrations of metals. Structural BMP sites downstream of developed areas therefore have the opportunity to treat the stormwater for these constituents.

2. **Is the potential site high, or upstream, in the catchment?**
   A site's location in the catchment impacts the amount of drainage area routed to or through a site. This will impact the types of structural BMPs proposed for a site, and the required footprint for the BMP construction.

3. **Are slopes on the potential site greater than 20-percent?**
   Slopes greater than 20-percent can present constructability issues, as well as reduce the effectiveness of infiltration BMPs. If 20-percent or greater slopes are present, the site should be removed from consideration.

4. **Is there easy access to the potential site?**
   Access to a potential structural BMP site will impact cost of BMP construction as well as long-term maintenance costs.

5. **Is the site inline or adjacent to an existing storm sewer or a channel?**
   In general, it is ideal for BMPs to be within 50 feet of a storm sewer system. This allows stormwater to easily be routed to a structural BMP, or for underdrains/overflows to be connected back to the storm sewer system.

6. **Is the depth to groundwater greater than 30 feet?**
   Where groundwater depths are estimated to be greater than 30 feet from the surface, infiltration BMPs can be constructed on a site as adequate depth is available for infiltration, reducing the threat of groundwater contamination. For sites where the groundwater depth averages between 10 and 30 feet below the surface, site specific investigations should be performed prior to design and installation of any infiltration based BMPs. For sites where the groundwater depth is 10 feet or less from the surface, infiltration BMPs should not be considered.

7. **What is the most cost-effective structural BMP for implementation?**
   For a given site, various BMP types may be applicable to achieve compliance. Cost-effectiveness of each potential BMP solution should be compared in terms of initial construction cost and estimated long-term maintenance. Initial construction costs will vary by BMP type and land acquisition requirements. Long-term maintenance costs will vary by BMP type. Potential structural BMP types for a site are evaluated in Section 4.4.

4.3.5 Summary of Site Identification Process

Application of Filters 1, 2 and 3 in the Reach 2 watershed identified 1,100 acres as high priority areas for BMP implementation. Filter 4 (Manual Assessment) will be completed as part of Phase 1 of this Implementation Plan (see Section 5). If additional sites are needed to achieve compliance with Reach 2 Metals TMDL targets, sites that may have been excluded based on some aspect of the filtering process, e.g., the natural environment or CPI, privately-owned lands, as well as green street opportunities, may also be considered for BMP implementation. Final selection of structural BMP sites will be coordinated among the participating jurisdictions identified in Section 1 of this Implementation Plan.

4.4 Potential Structural BMP Types

Structural BMPs are engineered systems that can provide benefits for both water quantity and quality. The focus of this evaluation is to evaluate water quality benefits to the Reach 2 watershed by removing metals from urban runoff through structural BMP implementation. To implement the most effective structural BMP on a site, many factors about the BMP itself should be evaluated including construction and maintenance costs as well as overall effectiveness. The highest ranked structural BMP based on cost and effectiveness should be given the highest priority for implementation.

This section will evaluate types of structural BMPs for potential implementation to treat stormwater for metals contamination. The International BMP Database, which is periodically updated, provides metals removal effectiveness data based on BMP type (www.bmpdatabase.org). However, the International BMP Database does not provide this information for infiltration facilities. General heavy metals removal efficiencies are reported by CASQA for infiltration facilities. Table 4-7 summarizes metals removal efficiencies based on BMP type.

Table 4-7 Summary of Removal Efficiencies

BMP System Type	Influent(1)	Effluent(1)	Percent Removal
Total Copper (μg/l)			
Constructed Wetland	2.67-38.61	0.62-7.83	77-80
Detention (2)	6.85-22.16	5.06-13.41	23-28
Filtration (3)	18.06-28.44	7.95-12.99	47-49
Infiltration (4)			85-90
Total Lead (μg/l)			
Constructed Wetland	1.43-11.89	2.31-4.22	62-65
Detention (2)	10.19-29.18	3.15-17.94	43-61
Filtration (3)	8.1-22.75	1.95-8.52	62-77
Infiltration (4)			85-90
Total Zinc (μg/l)			
Constructed Wetland	24.47-90.51	12.8-66.69	26-48
Detention (2)	48.37-123.95	20.92-68.63	46-57
Filtration (3)	90.29-178.78	22.41-55.01	66-73
Infiltration (4)			85-90

(1) Taken from the Summary of Performance by BMP Category and Common Pollutant type on the International BMP database
(2) Detention Influents and Effluents-average of detention pond and wet pond
(3) Filtration Influents and Effluents-average of biofilter and media filter
(4) General efficiencies for heavy metal removals are reported by CASQA for infiltration facilities.

4.4.1 Evaluation of Potential Structural BMPs Types

Structural BMPs considered for potential implementation in the Reach 2 watershed were classified as having a regional, neighborhood, or lot level application. A regional or neighborhood BMP application is capable of accepting drainage from larger areas, typically spanning multiple land uses as well as owners. Lot level BMPs are better suited for accepting smaller drainage areas and are more appropriate for treating stormwater runoff from individual parcels of land.

Regional or neighborhood structural BMPs can be advantageous because they can manage stormwater from multiple projects or properties. This can provide initial construction cost savings, as well as reduced long-term maintenance costs. Regional facilities maximize available land and provide an opportunity for an aesthetic or recreational amenity to a community in addition to stormwater benefits. Though a neighborhood structural BMP provides stormwater treatment for multiple properties, these applications involve much smaller drainage areas than regional applications. Because both regional or neighborhood structural BMPs provide benefits to multiple parcels of land, implementation requires extensive planning and coordination efforts between community leaders and the development community in regards to siting, cost sharing, and long-term maintenance.

Lot level structural BMPs are typically the most common approach for providing stormwater quality controls on a given parcel of land but are most effective when several sites are located throughout a watershed. These BMPs are commonly implemented as a requirement of the development or re-development process. Construction and maintenance costs are typically the responsibility of the individual property owner.

Common categories of regional, neighborhood, and lot level structural BMPs considered for potential implementation include:

- **Infiltration Systems.** Infiltration systems are constructed to infiltrate a calculated volume of water into the ground. Examples of infiltration systems include infiltration trench, infiltration basin, and porous or permeable pavement.
- **Detention Systems.** Detention systems are designed to temporarily detain a volume of water, allowing solids to settle out, before release to a downstream system. A detention system can be designed with a permanent pool (wet detention), where storage is provided above a defined permanent pool elevation.
- **Constructed Wetland Systems.** A constructed wetland is similar to a detention system, with the general exception of a shallower footprint that retains water to support wetland vegetation growth. Examples of constructed wetland systems include subsurface wetlands with detention and constructed wetlands/wet ponds.
- **Filtration Systems.** Filtration systems consist of a granular filtration media or separation process that removes constituents found in stormwater runoff. Examples of these systems include catch basin inserts, media filters, gross solids removal devices, and hydrodynamic devices. These are typically manufactured devices.
- **Biofiltration and Vegetated Systems.** Biofiltration and vegetated systems are designed to utilize vegetation to accept and treat stormwater runoff through infiltration into layers of plant roots and the growing medium. These systems can be as simple as a filter strip, a swale, a rain garden, or as complex as a bioretention cell.

In each participating jurisdiction within Reach 2, opportunities exist for installation of BMPs in the existing street right-of-way. This application is typically called "Green Streets." A green street is a neighborhood structural BMP. Potential green streets should be identified by targeting areas that have large impacts on water quality. Ideal opportunities for green street implementation occur at storm sewer discharge points to a respective river, where stormwater is routed from adjoining developed drainage areas.

Neighborhood structural BMPs that can be implemented in a street right-of-way and at adjacent storm sewer discharge points as part of the green streets process include:

- Porous and/or permeable pavement for road surface parking areas and sidewalks. When utilized for parking areas, consideration should be made for loads and turning radius traffic.

- Swales instead of curb and gutter systems. Removal of curb and gutter would direct stormwater runoff into swales. Swales would not only provide stormwater conveyance, but also provide infiltration and filtration benefits.

- Bioretention cells or rain gardens in medians. Depressed landscape planters may function as a small retention area and provide removal of pollutants through plant uptake and infiltration. These facilities capture stormwater from a street and encourage percolation into the ground.

4.4.2 Structural BMP Type Prioritization through a Tiered System

Structural BMPs considered for regional applications are listed in Table 4-8. Structural BMPs typically considered for a neighborhood or lot level application are listed in Table 4-9. BMPs in both tables have been prioritized using a tiered system according to cost and effectiveness. Cost and effectiveness scores are adapted from the Los Angeles County-Wide Structural BMP Prioritization Methodology, 2006. BMPs have been classified into three tiers, with a tier assignment of "1" indicating the most preferred based on cost and effectiveness. This tiered system serves as a guide for eventual structural BMP implementation. A specific site should be evaluated for BMP implementation feasibility before any final decision is made regarding specific BMP characteristics.

Figure 4-4 outlines the process for assigning a potential BMP to a given site. There is no "one-size-fits-all" BMP; each potential site must be independently evaluated to determine the BMP best suited for construction. The following items should be considered as part of the BMP site assignment process:

- BMP treatment (infiltration, retention/detention, filtration, and vegetation uptake)

- Site Characteristics (drainage area, slope, soil permeability, depth to groundwater, and soils ability to support plants)

- Proximity to existing utilities, buildings, and other structures

- Land ownership and use

- Impacts to the existing environment and community

Table 4-8 Regional Structural BMPs Implementation Tier

Structural BMP Tier Factors [1]		Weight	Infiltration Systems	Detention Systems		Constructed Wetland Systems		Filtration Systems		Channel Naturalization
			Infiltration Basin	***Dry***	***Wet***	***Subsurface Wetlands with Detention***	***Constructed Wetlands/ Wetponds***	***Treatment***	***Hydrodynamic Devices***	
Cost *(1-expensive; 5-inexpensive)*	Capital	25.0%	4	4	4	2	4	1	3	4
	Maintenance	25.0%	1	3	3	2	2	2	4	3
Effectiveness *(1-worst; 5-best)*	Metals Removal	20.0%	5	3	3	5	5	5	3	4
	Other Pollutants	7.5%	5	3	3	4	4	4	3	3
	Volume Mitigation	7.5%	5	3	3	3	3	2	1	2
	Reliability	15.0%	2	3	3	3	3	5	3	3
Weighted Total:			3.30	3.25	3.25	2.98	3.48	2.95	3.10	3.38
Implementation Tier[2]:			**2**	**2**	**2**	**3**	**1**	**3**	**2**	**2**

(1) Adapted from Los Angeles County-Wide Structural BMP Prioritization Methodology, 2006.

(2) Implementation Tiers calculated as a function of the Average Weighted Total and the Standard Deviation of the Weighted Total. Tier 1 is designated by individual weighted totals greater than the average weighted total plus one standard deviation. Tier 3 is designated by individual weighted totals less than the average weighted total minus one standard deviation. Tier 2 is represents everything in between Tiers 1 and 3. (Tier 1 > 3.39; 3.39 > Tier 2 > 3.03; Tier 3 < 3.03)

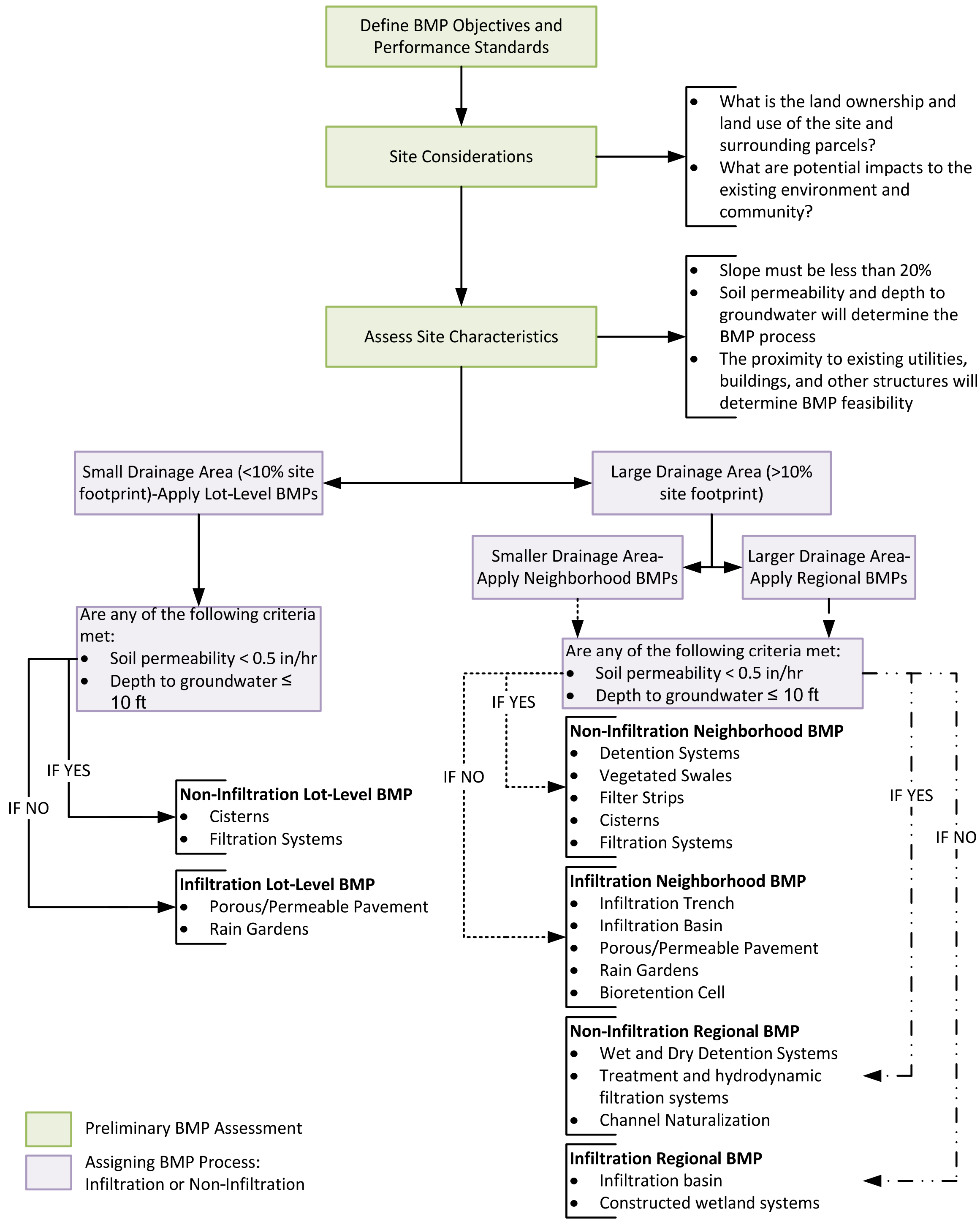
Table 4-9 Neighborhood or Lot Level BMPs Implementation Tier

Structural BMP Tier Factors [1]		Weight	Infiltration Systems				Detention Systems	Biofiltration Systems		Filtration Systems			Vegetated Swales
			Infiltration Trench	***Infiltration Basin***	***Rain Garden***	***Porous/ Permeable Pavement***	***Cistern***	***Bioretention***	***Filter Strips***	***Manufactured Separation Systems***	***Media Filters***	***Catch Basin Inserts***	
Cost *(1-expensive; 5-inexpensive)*	Capital	25.0%	4	4	4	2	3	2	4	2	3	5	4
	Maintenance	25.0%	1	1	2	5	5	3	4	3	4	4	4
Effectiveness *(1-worst; 5-best)*	Metals Removal	20.0%	5	5	5	5	5	5	5	2	4	1	4
	Other Pollutants	7.5%	5	5	5	4	4	4	4	1	4	1	4
	Volume Mitigation	7.5%	5	5	3	4	3	4	3	1	1	1	4
	Reliability	15.0%	2	2	2	2	3	4	4	3	3	3	4
Weighted Total:			3.30	3.30	3.40	3.65	3.98	3.45	4.13	2.25	3.38	3.05	4.00
Implementation Tier[2]:			**2**	**2**	**2**	**2**	**1**	**2**	**1**	**3**	**2**	**2**	**1**

(1) Adapted from Los Angeles County-Wide Structural BMP Prioritization Methodology, 2006.

(2) Implementation Tiers calculated as a function of the Average Weighted Total and the Standard Deviation of the Weighted Total. Tier 1 is designated by individual weighted totals greater than the average weighted total plus one standard deviation. Tier 3 is designated by individual weighted totals less than the average weighted total minus one standard deviation. Tier 2 is represents everything in between Tiers 1 and 3. (Tier 1 > 3.96; 3.96 > Tier 2 > 2.92; Tier 3 < 2.92)

Figure 4-4 BMP Assignment Process



4.5 Hypothetical BMP Sites

Final structural BMP type and site selection will require extensive coordination among multiple jurisdictions for design, construction, and operation and maintenance. This activity will occur during Phase 1 implementation. To support this effort, this section provides information on potential water quality benefits of structural BMPs through the use of hypothetical scenarios. This information provides a baseline for evaluating what types of structural BMPs would be most beneficial to participating jurisdictions, in terms of construction cost and overall water quality benefit.

The effects of implementing a structural BMP on a given site were approximated using hydrology modeling software. This hypothetical model evaluated impacts of BMP installation in the watershed, assuming optimal use of a given site. The results of the percent stormwater runoff capture determined as part of this analysis were then extrapolated over the Reach 2 watershed. The goal of the model was to find when optimal treatment of a respective structural BMP is achieved for constituent reduction in the hypothetical drainage area. For evaluation, optimal parameters were established by finding when the hypothetical site's treatment capacity would need to be increased in order to achieve needed pollutant removal.

4.5.1 Hypothetical BMP Applications

The hypothetical structural BMP site evaluation considered the following BMP size categories: regional, neighborhood and lot level. Typical BMPs associated with each of these categories were evaluated to approximate optimal treatment capabilities. The categories and structural BMP types evaluated include:

- **Regional Structural BMPs.** Hypothetical models were developed for an infiltration basin, detention basin, and wetland facility.
- **Neighborhood Structural BMPs.** A hypothetical model was developed for a bioretention cell application.
- **Lot Level Structural BMPs.** A hypothetical model was developed for a porous pavement application.

Table 4-10 summarizes model assumptions for the hypothetical structural BMPs evaluated as part of this analysis.

Table 4-10 Model Assumptions for Hypothetical BMP Applications

Modeling Parameters	Hypothetical BMP Application				
	Infiltration Basin	Detention	Wetland	Bioretention	Porous Pavement
Drainage Area (acres)	200	200	200	20	1
Runoff coefficient	0.8	0.8	0.8	0.8	0.8
Treatment Rate (acre-ft/day)	4	6.25	4.2	0.6	0.021
Available BMP Footprint (acres)	4	4	4	1.2	0.5
Drawdown (days)	2	2	3	2	2

4.5.1.1 Regional BMP Applications

A regional BMP application is capable of accepting drainage from larger areas, typically spanning multiple land uses as well as multiple landowners. Drainage areas for this type of BMP can be thousands of acres. Regional structural BMPs maximize available land and often provide an opportunity for an aesthetic or recreational amenity to a community in addition to stormwater benefits. For this evaluation a hypothetical infiltration basin, detention basin, and constructed wetland facility have been analyzed.

Infiltration Basin Analysis

For this analysis, it was assumed that the hypothetical site for infiltration basin construction of 4 acres had ideal soils providing a hydraulic conductivity of 0.5 inch per hour. Unit conversions equate the treatment rate for modeling purposes to 4 acre feet per day.

For a hypothetical 200 acre drainage area with this treatment rate, and an available infiltration basin site footprint of 4 acres, the optimal treatment volume for the hypothetical infiltration basin is approximately 8 acre feet. At this point, approximately 58-percent of the stormwater runoff for the given drainage area would be captured and treated. Construction of this volume of infiltration basin on this site is feasible. Beyond this runoff volume, additional treatment capacity would need to be provided for a 4 acre infiltration basin site.

Detention Basin Analysis

The hypothetical detention basin was assumed to treat the WQv for the drainage area over a 48 hour period, using standard engineering practices for detention basin design. The water quality rainfall event for this analysis is 0.75-inch. Unit conversions equate the detention basin treatment rate for modeling purposes to 6.25 acre feet per day.

For the hypothetical 200 acre drainage area with this treatment rate, and an available detention basin footprint of 4 acres, the runoff volume for treatment on this site is 12.5 acre feet. At this point, approximately 73-percent of the stormwater runoff for the given drainage area would be captured and treated. Beyond this runoff volume, additional treatment capacity would need to be provided on this hypothetical site. Construction of this volume of basin is feasible.

Constructed Wetland Facility

The hypothetical wetland was assumed to treat the WQv for the drainage area using standard engineering practices for wetland design. The water quality rainfall event for this analysis is 0.75-inch. Unit conversions equate the treatment rate for this hypothetical facility for modeling purposes 4.2 acre feet per day.

For the hypothetical 200 acre drainage area with a 72-hour drawdown, and an available wetland facility footprint of 4 acres with a maximum depth of 2 feet, the runoff volume for treatment on this site is 8 acre feet. This maximizes the treatment facility size at the site. At this point, approximately 58-percent of the stormwater runoff for the given drainage area would be captured and treated. Beyond this runoff volume, additional treatment capacity would need to be provided, which would require a larger site.

4.5.1.2 Neighborhood BMP Applications

Neighborhood structural BMPs are stormwater management facilities that are dispersed throughout a catchment and that typically accept runoff from small to medium sized drainage areas, typically not exceeding 50 acres. Like regional BMP applications, neighborhood structural BMP applications can be advantageous because they can manage stormwater from multiple projects or properties providing an opportunity for an aesthetic or recreational amenity to a community in addition to stormwater benefits. For this evaluation, a bioretention neighborhood structural BMP application has been analyzed.

The hypothetical bioretention cell was assumed to treat the WQv for the drainage area over a 48 hour period, using standard engineering practices for bioretention cell design (LACDPW, 2009). The water quality rainfall event for this analysis is 0.75 inches. Unit conversions equate the bioretention cell treatment rate for modeling purposes to 0.6 acre feet per day.

For the hypothetical 20 acre drainage area, and an available bioretention cell footprint of 1.2 acres, the runoff volume for treatment on this site is 1.8 acre feet, assuming a maximum bioretention depth of 3 feet. At this point, approximately 75-percent of the stormwater runoff for the given drainage area would be captured and treated. Beyond this runoff volume, additional treatment capacity would need to be provided on this hypothetical site.

4.5.1.3 Lot Level BMP Applications

Lot-level BMPs are defined as small-scale stormwater controls that accept and treat stormwater runoff from an individual parcel of land. These BMPs are most effective when several sites are located throughout a watershed. Often, multiple lot-level BMPs are used on a given parcel to provide maximum stormwater runoff treatment. These BMPs may be implemented as a requirement of the development or redevelopment process, and are typically managed by the individual property owner. For this evaluation, a permeable pavement structural BMP application has been analyzed.

The hypothetical porous pavement installation was assumed a treatment rate through the BMP of 0.5 inches per day for the 1-acre drainage area. Unit conversions equate the porous pavement treatment rate for modeling purposes to 0.021 acre feet per day.

For the hypothetical porous pavement installation with of 0.5 acres footprint, the runoff volume for treatment on this site is 0.04 acre feet. At this point, approximately 58-percent of the stormwater runoff for the given drainage area would be captured and treated. Beyond this runoff volume, additional treatment capacity would need to be provided on this hypothetical site.

4.6 Quantification of Structural BMP Pollutant Load Removal

The results of hydrologic simulations were used to estimate metals load removal from different size storm events as a function of influent concentration and effluent concentration based on the following equation. Equation parameters are discussed in the following subsections.

$$M_{removed} = V_{capture} * \left(C_{influent} - C_{effleunt}\right)$$

Because total copper was the most prevalent constituent identified in the water quality analysis (see Sections 2 and 6), quantification of pollutant load removal will be based on this constituent.

4.6.1 Volume Capture ($V_{capture}$)

Table 4-11 summarizes the volume capture of each BMP analyzed in Section 4.5, by application. When comparing BMP applications, a detention and bioretention system maximize the treatment capacity available, therefore capturing the most stormwater runoff for the parameters of the hypothetical model. The hypothetical infiltration basin, wetland, and permeable pavement provided similar capture rates at their optimal storage point.

Table 4-11 Hypothetical BMP Site Volume Capture Summary

Hypothetical BMP Site Summary			
BMP	Optimal Storage (acre feet)	Treatment Capacity (acre feet/day)	Capture Rate (%)
Regional			
Infiltration Basin	8	4	58
Detention	12.5	6.25	73
Wetland	8	4.2	58
Neighborhood			
Bioretention	1.5	0.42	75
Lot Level			
Porous Pavement	0.04	0.021	58

For a neighborhood application, the hypothetical model shows that multiple sites of bioretention cells could provide significant stormwater runoff capture and treatment for a given drainage area. The hypothetical lot level application of porous pavement could be just one of multiple lot level BMPs implemented on a given site to capture and treat stormwater runoff, as just one BMP application on the hypothetical site can treat more than 50-percent of the runoff.

4.6.2 Pollutant Load Removal

Influent Concentration ($C_{influent}$)

Influent concentrations in runoff to a structural BMP may be influenced by land use and associated pollutant sources in the upstream watershed; therefore BMPs can provide greater pollutant load removal when sited downstream of areas of concern. As described in Section 4.2, catchments of concern in the Reach 2 watershed were identified using the CPI, with the highest priority for pollutant removal receiving a rating of 4 or 5.

To estimate watershed-wide concentrations that would result from implementation of these hypothetical structural BMP scenarios, measured influent concentrations at the Wardlow Road mass emission site were used. This is a conservative approach, as the Wardlow site is considerably downstream of Reach 2 on the LAR. Use of water quality data from a CMP sampling location with the Reach 2 watershed was considered for this analysis. Wet weather sampling data was available at the Del Amo site within the Reach 2 watershed; however, flow data was not available for this site. For the compliance analysis (Section 6) it is necessary to use stream flow data to calculate the baseline copper load for Reach 2. This information is available at Wardlow, the next site downstream. Therefore, Wardlow data was used in this Implementation Plan.

Effluent Concentration ($C_{effluent}$)

Effluent concentration ranges for different types of structural BMPs were summarized in Table 4-7 previously. Using these ranges as a guideline, effluent concentrations were assigned to each hypothetical BMP for quantification, as shown in Table 4-12. For infiltration basins and bioretention facilities, it is assumed that each BMP will capture and treat 100-percent of the influent through infiltration process. Therefore, effluent concentrations for these two structural BMP types are assumed to be zero.

Table 4-12 Effluent Concentrations for Hypothetical Structural BMP Applications

BMP Type	Effluent Concentration (μg/l)		
	Total Copper	Total Lead	Total Zinc
Infiltration basin	0	0	0
Wetland Facility	4.2	2.1	64.8
Detention basin	12.1	15.8	60.2
Bioretention	0	0	0
Permeable Pavement	2.8	7.9	16.6

4.6.3 Structural BMP Applications Quantification

Analysis shows that infiltration basins, bioretention and permeable pavement are the most effective at reducing metals loading for total copper in Reach 2 during small to medium size runoff events. These BMPs capture most upstream runoff and remove associated pollutant loads from the downstream waterbodies. Detention basins and constructed wetlands are flow through systems, which discharge back treated effluent to receiving waterbodies, with a reduced but not completely eliminated metals concentration.

During larger events, it is difficult to predict the differences in runoff capture, because site specific factors become more and more constraining. The compliance analysis in Section 6 shows how small to medium size storms were the primary driver for developing the Implementation Plan. Differences in load reduction between BMP types for small to medium size storms are attributed to:

- Variations in total copper effluent concentrations associated with BMP type
- The volume of runoff capture that would be technically feasible given actual BMP siting constraints.
- General BMP sizing criteria.

Section 5
Implementation Plan

5.1 Overview

The Reach 2 Metals TMDL Implementation Plan categorizes BMP implementation into three key areas:

- *New Development and Significant Redevelopment* – Water quality benefits to be obtained through ongoing implementation of new development and significant redevelopment activities;
- *Non-structural BMPs* – This area identifies new or enhanced existing non-structural BMP activities that will result in reductions of metals in urban runoff; and
- *Structural BMPs* – Emphasis of this area is identifying and implementing the necessary structural BMPs to fill expected water quality gaps not addressed by any of the above.

A fourth category would be to consider structural BMPs that have been implemented by developers or public agencies and demonstrate pollutant removal benefits. Since these projects provide water quality benefits not previously accounted for in the development of the Metals TMDL, credit may be taken for their implementation. At this time, such projects have not yet been identified for the Reach 2 watershed. However, during Phase 1(as described below), these BMPs will be identified by participating jurisdictions and considered as part of the process to identify locations for structural BMP implementation.

Implementation activities will be phased over the period of TMDL implementation. During the initial phase, water quality control activities will focus on (1) implementation of non-structural BMPs; and (2) completion of detailed analyses to identify the locations and types of structural BMPs for implementation during later phases. During the preparation of this Implementation Plan, a methodology for identifying ideal locations for structural BMPs was developed. This methodology will be used during Phase 1 to identify structural BMP locations. Deferring this activity until Phase 1 is warranted because quantitative analyses demonstrate compliance with the near term TMDL targets for the Reach 2 watershed (see Section 6).

The following sections describe (1) key implementation elements proposed for the Implementation Plan; and (2) phased structural and non-structural BMP activities.

5.2 New Development and Significant Redevelopment

Developers are required to prepare a SUSMP for new development and redevelopment projects that fall into the categories outlined in Section 3.2. Where SUSMP requirements apply, the project must meet minimum numeric design criteria, either flow-based or volumetric treatment control requirements. This is accomplished through the selection of appropriate structural BMPs as defined by existing SUSMP guidelines.

Throughout the implementation of this TMDL Plan, all participating municipal jurisdictions will continue to implement these requirements which will provide important water quality benefits over the long term. In addition, the Reach 2 participating jurisdictions will evaluate opportunities to enhance treatment controls by establishing a preference or a requirement for the use of infiltration BMPs where feasibly possible[1]. The process for updating SUSMP treatment control requirements is included as a policy and ordinance type of non-structural BMP (see Section 3.2.1).

The SWMP specifies requirements for the implementation of BMPs in state transportation projects. Similar to the purposes of SUSMP, these requirements focus on minimizing stormwater runoff from highway projects that reduce stormwater volume and pollutant load. Under this Plan Caltrans will continue to implement these approved BMPs for its transportation projects. Caltrans will also update its practices as required by future MS4 permits.

5.3 Non-Structural BMP Programs

Section 3 summarizes non-structural BMP programs that could be implemented to reduce metals in urban runoff. Many of these BMPs are multi-benefit, that is, they provide opportunities to reduce other pollutants and non-stormwater management benefits such as water conservation. These potential non-structural BMPs have been incorporated into this Plan, but prioritized as high, medium or low. Four factors were considered in the prioritization:

- Effectiveness at pollutant removal/reduction, considering applicability to dry or wet weather management needs
- Ease of implementation, considering the process or need for coordination with various agencies and organizations
- Incremental benefit of implementation given that the BMP may already be actively implemented
- Cost of implementation; however, even if the cost is high, if the BMP is particularly effective at providing water quality benefits it may still have been given a higher priority since it may be less costly to implement the non-structural BMP than to implement structural BMPs.

While all of the non-structural BMP opportunities can be effective at removing or reducing metals some would not be particularly easy to implement or may be somewhat costly. The following sections and Table 5-1 provide an overview of the prioritized non-structural BMP activities considered for implementation under this Plan. Each jurisdiction will select from the phased non-structural BMP program as outlined in Table 5-1 to determine the most beneficial non-structural BMPs to implement for their city.

[1] The existing municipal MS4 permits were last adopted in 1999 (Long Beach) or 2001 (other participating municipalities). It is likely that the LARWQCB will issue new MS4 permits early in the implementation of this TMDL. Based on requirements required in other recently adopted southern California MS4 permits, infiltration type BMPs will be a requirement for priority projects where technically feasible.

Table 5-1 Prioritization and Potential Implementation Approach for Non-Structural BMPs

BMP Category	BMP Type	Priority	Basis for Prioritization	Proposed Implementation Approach
Direct Source Control	Vehicle Brake Pad Replacement	High	Removes a primary source of anthropogenic copper in the environment. Considered one of the primary keys to compliance with copper TMDL targets, which is shown by the compliance analysis to be the primary metal of concern (see Section 6). This BMP should also be a high priority for all stormwater dischargers in the Los Angeles River watershed. Accordingly, if implemented jointly benefits will accrue at relatively low cost.	• Consider participating in BPP activities to stay informed of implementation status, e.g., through California Stormwater Quality Association (CASQA) • Consider developing educational materials as needed to highlight impacts from brake pads • Where appropriate, consider coordinating with transportation agencies to promote water quality benefits of using public transportation which will enhance BPP benefits
	Tire Wheel Weight Replacement	Medium	Removes an important source of anthropogenic lead in the environment. Similar to vehicle brake pad replacement, the cost of implementation is low per the benefits gained. However, lead is not as important of a water quality of concern as copper (see Section 6); therefore, implementation of this BMP has a lower priority than brake pad replacement	• Consider providing funding to support passage of Senate Bill 757 in state legislature • Consider participating in relevant activities, as needed, to stay informed on implementation status, e.g., through CASQA • Consider developing educational materials as needed to highlight impacts from lead tire weights and need to support implementation of legislation • Where appropriate, consider coordinating with transportation agencies to promote water quality benefits of using public transportation
	Pesticide Use	Low	Studies have shown that copper-based pesticides are commonly used in the San Francisco Bay Area and can be an important source of anthropogenic copper. It is assumed that these findings are applicable to the Reach 2 area as well. Use of replacement products may provide benefits as long as the replacement does not cause its own water quality concern. Implementation of this BMP is of lower priority than the brake pad replacement BMP and may be best handled through hazardous waste use practices/ordinances.	• Consider conducting study to evaluate opportunities to reduce metals in pesticides: o Identify commonly used/sold pesticides that are potential metals sources in region o Identify safer alternative products, if any o Evaluate effectiveness of existing pesticide management policies/ordinances o Develop recommendations to reduce metals-based pesticides with implementation schedule • Consider implementing recommendations of any completed study activities, as appropriate

Table 5-1 (Continued)

BMP Category	BMP Type	Priority	Basis for Prioritization	Proposed Implementation Approach
Direct Source Control	Vehicle Tire Wear Reduction	Low	Tread wear is a significant source of particulate pollutants which contain metals; however, the means to reduce this source is limited at this time to programs that reduce vehicle usage, e.g., through increased use of public transportation. Because of limited expectation for significant reduction through this type of BMP, implementation priority is low.	• Consider evaluating the effectiveness of public transportation education campaigns and incentive programs, and develop recommendations for modifications to enhance programs • Consider developing new or revise existing educational materials as needed to highlight impacts of driving on water quality • Consider coordinating where appropriate with transportation agencies to promote water quality benefits of using public transportation
	Roof Materials Control	High	Roofing materials contain numerous metals, including copper, which readily leach during wet weather runoff. There may be opportunities to work with the building industry to identify alternative roofing materials that have reduced metals content. In addition, control of roof-based metals can be enhanced through a strong downspout disconnect program that is coupled with other BMPs that discourage runoff, e.g., development practices that reduce offsite runoff through appropriate post-construction treatment controls. Implementation of this program not only reduces metals, but other pollutants of concern including bacteria. Long term benefits are significant if linked up with the downspout disconnection BMP; accordingly, this BMP was given a high priority.	• Consider coordinating with California Building Industry Association and other relevant stakeholders to support use of alternative materials with reduced metals content • Consider working with planning agencies and regulators to encourage incorporation of alternative materials into building guidelines • If sufficient need and alternative materials available, consider developing an ordinance to require use of specified materials for building • Consider coordinating implementation of this BMP program with downspout disconnection BMP.
	Street Sweeping	Medium	Program already provides significant water quality benefits and such efforts should continue. It may be appropriate to conduct pilot study to evaluate if program can be enhanced to provide additional water quality benefits. However, because any improvements represent an incremental benefit that may be somewhat costly vs. the benefit, the priority is listed as medium.	• Consider conducting study to evaluate opportunities to enhance/modify street sweeping programs: o Collect data to identify hot spot or target areas to focus street sweeping o Evaluate potential benefits from changes in sweeper type, frequency of sweeping, targeted vs. general sweeping, etc. • Consider implementing recommendations from any completed study activities, as appropriate

Table 5-1 (Continued)

BMP Category	BMP Type	Priority	Basis for Prioritization	Proposed Implementation Approach
Direct Source Control	Catch Basin Cleaning	Medium	Program already provides significant water quality benefits and such efforts should continue. It may be appropriate to conduct pilot study to evaluate if program can be enhanced to provide additional water quality benefits. However, because any improvements represent an incremental benefit that may be somewhat costly vs. the benefit, the priority is listed as medium.	• Consider conducting study to evaluate opportunities to enhance/modify catch-basin cleaning program: o Collect data to identify hot spot or target areas to focus catch-basin cleaning o Evaluate effectiveness of existing program and develop recommendations to enhance program to increase water quality benefits • Consider implementing recommendations from any completed study activities, as appropriate
Public Education and Outreach	Used Oil Recycling Individual Car Washing Vehicle Maintenance	Medium	Education BMPs are low cost and easily implemented; accordingly, all existing education programs would be reviewed under this BMP to evaluate how materials need to be changed or updated (if at all) to improve the message and better target metals. Although a low cost BMP, because this BMP already exists any additional water quality benefits from enhanced of modified education materials are expected to be relatively small. Accordingly this BMP was given a medium priority.	• Consider evaluating effectiveness of existing public education materials to target metals sources; similarly, evaluate targeted audience for public outreach to ensure education message is targeted appropriately • Consider modifing material/outreach venues as needed to increase opportunities to target message
Policies and Ordinances	Water Conservation	Medium	Encouraging and even enforcing water conservation provides multiple community benefits that go far beyond water quality benefits. A strong program will significantly reduce dry weather flows in the MS4 that not only greatly reduces metals reaching storm drains but other pollutants as well. Implementation of this BMP, which is best supported through the adoption and implementation of an ordinance, will greatly increase the likelihood of consistent compliance with the 2024 dry weather TMDL target. This BMP was given only a medium priority because the primary water quality concerns in Reach 2 exist during wet weather. Focus on wet weather controls will likely address any remaining dry weather runoff concerns.	• Consider evaluating existing water conservation programs, policies and ordinances to (1) determine where improvements are needed in areas such as coverage, implementation method, and enforcement; (2) consolidate and coordinate water conservation efforts; (3) develop recommendations for development of an ordinance • Consider developing model ordinance for optional use by Reach 2 participating jurisdictions (Note: existing ordinances already in use in the area could be used as template). • Consider establishing and implementing water conservation ordinance

Table 5-1 (Continued)

BMP Category	BMP Type	Priority	Basis for Prioritization	Proposed Implementation Approach
Policies and Ordinances	Development Practices	High	Where physically possible, increased emphasis on the use of BMPs that reduce or eliminate urban runoff from a new development or significant redevelopment (e.g., infiltration), will over a long period of time not only support compliance with the metals TMDL but future TMDLs as well, e.g., bacteria. This BMP should be a high priority, not only because of the potential water quality benefits, but because the next Phase I MS4 permit is expected to contain more stringent development requirements. Developing this BMP now will ultimately support MS4 permit requirements.	• Consider evaluating existing BMP requirements applicable to new development or redevelopment projects • Consider taking into account local/physical limitations, identify alternative practices that promote reduction of urban runoff to storm drains • Consider developing model new development and redevelopment requirements that would result in reduced runoff from development projects (requirements already in use by Reach 2 cities could be used as a template) • Consider developing necessary policies or ordinances, as needed, to support implementation • Consider developing specifications or guidelines, as needed, to support implementation, e.g., specifications for use of porous pavement or construction of green streets
	Downspout Disconnection Program	High	Where roof downspouts can be retrofitted to direct runoff onsite rather than to a storm drain (or stored for future use in a cistern or rain barrel), reductions in pollutant loads during wet weather can be significant. This program can be relatively expensive to implement, but the long-term benefits of increased water conservation and reduced loads of all pollutants, especially bacteria, are significant. Program should be a high priority for implementation, but phased to spread out the cost.	• Consider developing and implementing downspout disconnection program. Activities may include: o Developing specifications for downspout disconnect program, including redirection of downspouts to pervious areas, use of rain gardens, rain barrels and cisterns (Information can be developed from existing programs in other areas) o Identifying areas for prioritized targeting of downspout disconnect program o Developing model pilot program for targeted implementation within participating jurisdictions, including development of incentive programs to encourage implementation on private land o Implementing pilot program in targeted areas o Developing and implementing phased area-wide program based on findings from pilot program

Table 5-1 (Continued)

BMP Category	BMP Type	Priority	Basis for Prioritization	Proposed Implementation Approach
Planning & Coordination	General Plan Update	Low	Incorporation of urban runoff management principles into city planning decisions provides the foundation needed to drive ordinances and policies regarding how water is managed and the city is developed. Modifications of General Plans can be time intensive processes and involve agencies or departments outside of those tasked with managing stormwater; therefore, this BMP was given a low priority.	• Consider coordinating with City planning department (or department tasked with maintaining City's General Plan) on opportunities to revise the General Plan to incorporate urban runoff management elements • Consider developing recommendations and schedule for modifications to City's General Plan, including zoning, transportation, and land use development, to promote better urban runoff management • Consider working with appropriate departments to implement recommendations
	Watershed Coordination Activities	High	Given the significant budget concerns of all governmental jurisdictions, opportunities need to be actively sought to collaborate on project implementation - regardless of whether the BMPs are structural or non-structural. This BMP is intended to provide a mechanism for each participating jurisdiction to stay aware of where opportunities exist for joint implementation of BMPs that provide benefits to multiple jurisdictions.	• Consider reviewing the following: o Existing practices to ensure that an appropriate level of coordination among legal entities (e.g., cities, agencies and NGOs) is occurring o Methods to simplify/improve cost-sharing among potential watershed partners to achieve needed water quality improvements, e.g., through development of MOAs or MOUs o Existing approach for taking advantage of state and federal grant opportunities • Consider developing recommendations based on the findings from the review of existing practices and methods for coordination • Consider implementing recommendations, as appropriate

5.3.1 Direct Source Control

Direct source control BMPs focus on preventing metals from being deposited in the environment in the first place and then potentially being picked up and transported by urban runoff. Some BMPs are highly effective, e.g., product replacement, while others have limited benefit because they require substantial changes in behavior, e.g. increased use of public transportation.

Table 5-1 identifies a number of potential non-structural BMPs to reduce metals and recommended implementation activities for each. For example, implementation of the Brake Pad Partnership (BPP) legislation, signed into law on September 27, 2010, will greatly reduce the copper content of brake pads. This will have far-reaching, long-term benefits because it will eliminate a significant copper source in the region. The cost is also relatively low, limited to activities such as providing public education and outreach activities. Accordingly, this specific BMP is given a high priority. In comparison, implementation of BMPs to reduce tire wear and subsequent deposition of metals on roadways is given a lower priority because limitations on the ability to change public behavior sufficiently to cause a major shift from private vehicle use to public transportation. Moreover, such programs to encourage use of public transportation are already in use; accordingly the incremental increase in benefits expected from additional effort in this area will not necessarily result in significant additional water quality benefits.

5.3.2 Policies and Ordinances

Urban runoff management can be improved through the adoption of policies and ordinances that seek to change how water is generated in an urban environment and how stormwater is managed onsite. In particular, emphasis on the following will result in improved quality of urban runoff:

- Reductions in the volume of urban runoff by implementing actions that keep runoff onsite; and
- Removal of pollutants from urban runoff through increased use of natural processes that prevent pollutants from ever reaching storm drains.

Three critical policy and ordinance BMPs can be implemented in this area that can provide significant water quality benefits – not only for metals, but other pollutants as well. These BMPs include water conservation, development practices, and downspout disconnection. Table 5-1 describes potential implementation steps for each of the policy and ordinance BMPs. Development practices and downspout disconnection BMPs are given a high priority because of the expected significant benefits they provide in controlling pollutants during wet weather. Specifically,

- These BMPs reduce the volume of urban runoff, thus removing a significant pollutant load to storm drains during wet weather runoff events.
- Implementation of the downspout disconnect program supports other important BMPs, in particular management of runoff from roofs which is an important metals source.

- These BMPs provide benefits other than water quality, in particular reduced water use (e.g., where rainwater is captured and reused), increased groundwater recharge and potentially more green space.

BMPs with a water conservation component were given a medium priority. While water conservation is certainly important by itself, as a non-structural BMP its benefits are primarily limited to managing pollutants in dry weather runoff (or construction activity associated with Caltrans projects). As will be noted in Section 6, the most significant compliance issues in the Reach 2 watershed are associated with wet weather rather than dry weather.

5.3.3 Education and Outreach

Public education and outreach programs focus on changing behaviors that are known to result in increased loadings of pollutants in the environment. As with any public education and outreach program it is difficult to quantify potential benefits of these programs since it is difficult to measure behavior changes. However, it is clear through surveys that public attitudes/awareness do change through such programs. Therefore continuation of existing education and outreach programs is an important part of a non-structural BMP plan.

The three areas previously identified as targets for additional public education and outreach effort are: individual car washing, used oil disposal, and vehicle maintenance. Table 5-1 summarizes the potential water quality benefits from these programs collectively and considers the priority for additional effort in this area as "medium". Existing programs, including hazardous waste collection activities, already provide a base level of information for the public. Accordingly, it will be difficult to gain significantly greater incremental water quality benefits through additional expenditure of resources in this area. However, it would be beneficial during TMDL implementation for the participating jurisdictions to evaluate their existing education programs to ensure that (1) the appropriate message is contained in literature and outreach materials; and (2) the correct audience is being targeted. As needed, public education and outreach materials can be revised to support this need.

5.3.4 Planning and Coordination

Increased emphasis on planning and coordination activities among participating jurisdictions increases the potential for improved quality of urban runoff. Two key BMPs have been identified in this area: long range planning associated with updated City General Plans and increased watershed coordination. Table 5-1 provides a summary of the expected water quality benefits. While these benefits may be difficult to quantify in the short term, attention to these areas is expected to provide long term benefits. In terms of priority, watershed coordination is given a high priority since continued or increased coordination can result in better cost-sharing during implementation. In contrast, the General Plan update BMP is given a low priority. This does not diminish the importance of this BMP but recognizes that implementation will likely require effort by city agencies or departments not involved in stormwater management.

5.4 Potential Structural BMP Implementation

Structural BMPs will be implemented in the Reach 2 watershed only to the extent needed to comply with Metals TMDL requirements. The need for increased or decreased structural BMP implementation activity will be periodically assessed using available water quality data from impaired waters. If monitoring data indicate that additional structural BMP implementation is needed, then the participating jurisdictions will identify additional projects targeted to the areas with the most significant water quality concerns. However, if water quality data indicate that compliance with Metals TMDL targets is being achieved with existing BMP activities (e.g., non-structural programs or rigorous SUSMP implementation), then fewer structural BMP projects will be implemented.

During the initial implementation phase (see Section 5.5 for phased schedule), the participating jurisdictions will select structural BMP projects for implementation. This activity will rely on information developed from the following sources:

Post-TMDL Structural BMP Implementation

Since the adoption of the Metals TMDL, a number of participating jurisdictions have implemented structural BMPs that support compliance with the Metals TMDL. These projects need to be identified and the associated water quality benefits quantified. Credit will be taken for the pollutant load reduced as a result of these projects. The remaining pollutant load reduction needed from structural BMPs will be achieved through structural BMPs identified from watershed plans, Caltrans, or the use of BMP site selection methodology, as described in the following subsections.

Existing Watershed Plans

Watershed plans have been developed in the Arroyo Seco and Rio Hondo subwatersheds within the Reach 2 watershed. These plans identify potential projects that participating jurisdictions could choose to implement to support compliance with the Metals TMDL. Existing plans include:

- *Arroyo Seco* - A series of master plans for the Arroyo Seco, developed by regional stakeholders, provide a framework for the implementation of potential improvement projects to provide multiple benefits, including recreation, habitat enhancement, water supply, and water quality (City of Pasadena 2003 a, b, c):
  - Hahamongna Watershed Park Master Plan (HWP)
  - Central Arroyo Master Plan (CAMP)
  - Lower Arroyo Master Plan (LAMP)

The key elements contained in these plans are diverse, but with the exception of the HWP, generally do not include significant control of urban runoff or water quality from areas of concern for metals loading. However, the potential exists for incorporating stormwater control elements into most project implementation activities.

- *Rio Hondo* - The Rio Hondo Watershed Management Plan (RHWMP) was developed by a large group of stakeholders in the Rio Hondo Watershed, and provides a framework for improvement projects to provide multi-level benefits (San Gabriel & Lower Los Angeles Rivers and Mountains Conservancy, October 2004). Some of the key benefits focused on are water quality, flood control, recreation, and habitat enhancement. The RHWMP also incorporated goals to eliminate impairments in Rio Hondo Reaches 1 and 2.

Caltrans

Caltrans has developed specific soil sampling guidelines for lead, as well as implemented various structural BMPs that support compliance with the Metals TMDL. This includes:

- *Lead Variance Program.* Caltrans standard approach to managing lead impacted soils utilizes the California Department of Toxic Substances Control (DTSC) variances. DTSC has issued variances governing the management of wastes that are considered hazardous only due to the presence of lead at concentrations exceeding regulatory limits. The variance applies to projects conducted by Caltrans operating within a Caltrans right-of-way. Caltrans has developed specific study and sampling procedures for analysis of lead content of soils which ultimately recommend specific soil management procedures on Caltrans projects.

- *Structural BMP Implementation.* Caltrans has implemented numerous structural BMPs in its right-of-way, including those installed as part of a Retrofit Pilot Study completed in 2002. Structural BMPs implemented include infiltration systems, detention systems, filtration systems, and biofiltration and vegetated systems. As part of Phase 1 BMPs implemented by Caltrans in Reach 2 since the adoption of the Metals TMDL will need to be identified. This may impact the total number of structural BMPs that need to be implemented in Reach 2.

Structural BMP Site Selection Methodology

Any remaining structural BMP needs will be identified through the use of the site selection methodology described in detail in Section 4. This methodology includes use of a catchment prioritization index and a data filtering process which identifies ideal areas within the Reach 2 watershed for BMP implementation based on the following major criteria:

- *Land Availability by Jurisdictional Limits* - Those jurisdictions in the study area not participating in this study were excluded from potential structural BMP site selection.
- *Catchment Prioritization Index (CPI)* **-** Sites in catchments with a CPI rating of 4 or 5 should be considered the highest priority for implementation (see Section 4).
- *Ownership and Land Use* **-** BMP siting will focus on the use of land owned by public entities Available open space (including existing park land) was considered the highest priority for regional structural BMP applications, schools and small parks

for neighborhood structural BMP applications, and existing jurisdictional buildings and parking lots for lot level structural applications.

- *Environmental Factors* **-** Areas identified for conservation or as environmentally sensitive may or may not be considered for potential structural BMP sites (see Section 2). Discussions would be held among all stakeholders in these areas to provide the best assessment of the site's conditions and BMP applicability. For example, the filter screen for liquefaction zones may be inappropriately eliminating potentially good sites for BMP implementation.
- *Manual Assessment Using Engineering Judgment* **-** Previous factor evaluations can mostly be completed through the use of desktop and GIS tools. Following completion of these evaluations a manual assessment is still required to evaluate factors such as: development upstream of the site; location of site within the catchment; land slope on the site; access to the site; site location with regards to an existing storm sewer; and depth to groundwater.

In addition to the above criteria, final selection of structural BMPs will also consider site and project specific factors, including:

- *Pollutant removal effectiveness* – The BMP type identified for implementation on a site should be evaluated for heavy metals removal efficiency (Section 4.4). This pollutant load removal should be quantified as defined as discussed in Section 4.6, and compared to needed reduction for TMDL compliance.

- *Site-specific characteristics* – Site specific characteristics can influence the BMP type that is the most appropriate for implementation in regards to pollutant load removal and implementation. These characteristics can include the site's proximity to developed land area; the site location in a catchment, ground slope across the site; proximity of storm sewers; and depth to groundwater (Section 4.3.4).

- *Costs* – Cost effectiveness of each potential BMP solution identified for a site should be compared in terms of initial construction cost and estimated long-term maintenance (Section 4.4.2). Initial construction costs will vary by BMP type and any require land acquisition. Long term maintenance costs will vary by BMP type.

The compliance analysis conducted to determine the project treatment to comply with the metals TMDL is discussed in Section 6. The planning level costs associated with this estimate are provided in Section 7. These analyses are provided as only one potential scenario for implementation. During the initial phase of implementation participating jurisdictions will select the actual combination of BMP projects for implementation. The relative combination of BMP types and locations affects compliance and costs. For example, fewer regional projects treating less drainage area may ultimately be selected for implementation. This would reduce the overall drainage area treated in the Reach 2 watershed. As a result, additional neighborhood or lot level projects would have to be identified to treat the remaining drainage area in order to achieve compliance.

The differences in treatment provided as well as cost of implementation will be affected under revised implementation scenarios. Therefore, as specific sites are selected, the compliance and cost analyses will be updated to determine progress towards compliance based on the revised scenario. In addition, as noted above, the compliance analysis will also be updated periodically using the most recent water quality data to evaluate the status of compliance with TMDL targets. Based on the outcome of these periodic evaluations, the participating jurisdictions reserve the right to adjust implementation schedules and activities as needed. This adjustment could include reducing the number of BMP projects or activities if water quality data indicate that compliance is being achieved as required by the TMDL targets.

5.5 Implementation Plan Schedule

This section describes the phasing of BMP implementation in the Reach 2 watershed. This schedule illustrates the relative emphasis of non-structural and structural BMPs to be implemented from 2010 to the date when full compliance is to be achieved in 2028. This schedule takes into account existing water quality (as discussed in Section 6) and the interim and final TMDL target dates.

The TMDL dry and wet weather targets are based on the percent of the MS4 drainage compliant at interim and final TMDL compliance dates as shown on Table 5-2. The basis for evaluating compliance with these targets is the Coordinated Monitoring Plan (CMP) developed and implemented jointly by the Los Angeles River Watershed MS4 permittees. The CMP was implemented in October 2008.

Table 5-2 Interim and Final TMDL Compliance Target Dates

MS4 Drainage Area	Compliance Target Date	
	Dry Weather Flow	Wet Weather Flow
25%	No Target	2012
50%	2012	2024
75%	2020	No Target
100%	2024	2028

Results from the first year of CMP sampling indicate that the 2012 and 2020 dry weather targets are currently being met. In addition, based on analyses of the Reach 2 watershed, which includes the RHSG, the 2012 wet weather target is currently being met and the 2024 is largely met. Section 6 provides a detailed analysis of these results.

Given these findings, a four-phased Implementation Plan schedule was developed that varied the relative emphasis of non-structural and structural BMPs (Table 5-3). The participating jurisdictions will begin implementation by (1) focusing on non-structural BMP activities; and (2) finalizing the siting of structural BMPs. In the latter phases of implementation, the need for structural BMPs will likely increase, in particular, to meet the 2028 wet weather compliance target. As long as engineering processes are implemented by early Phase 2, there is sufficient time in the schedule for the needed planning, design and construction activities to take place before these BMPs need to be in place and functioning.

Tables 5-4 and 5-5 provide more detailed information regarding phased implementation of non-structural and structural BMP activities, respectively. The emphasis during Phase 1 will be (1) implementation of selected non-structural BMP programs; and (2) identification of prioritized locations for structural BMP implementation. The planning, design and construction activities of these structural BMPs will begin in Phase 2 and continue through Phase 4. Deferring implementation of structural BMP projects until Phase 2 is warranted given that the Reach 2 watershed is currently in compliance with the 2012 dry and wet weather targets (see Section 6 for details).

The phased structural BMP approach established by this Plan recognizes that the Reach 2 watershed is comprised of many legal jurisdictions. Implementing BMP projects in areas where the sources of urban runoff may be derived from a number of jurisdictions requires that the Plan factor in the time needed to develop and implement mechanisms for potential cost-sharing of implementation. Without significant state and federal sources of funding, it will be difficult to implement significant BMP projects.

Table 5-3 Phased Implementation in Reach 2 Watershed

Phase	Period of Implementation[1]	Applicable Compliance Target	Key Implementation Activities[2]
Phase 1	2010 – 2011	2012 – dry (50%) wet (25%)	<u>Non-Structural</u> • Implement non-structural BMPs according to phased schedule in Table 5-4 <u>Structural</u> • Finalize identification of structural BMP locations and develop prioritization (high, medium, low) and implementation approach for selected BMPs
Phase 2	2012 – 2019	2020 – dry (75%)	<u>Non-Structural</u> • Implement non-structural BMPs according to phased schedule in Table 5-4 <u>Structural</u> • Complete planning and design phases for medium and high priority structural BMPs • Construct highest priority structural BMPs <u>Other</u> • Periodically evaluate compliance status; revise BMP requirements, as needed
Phase 3	2020 – 2023	2024 – wet (50%)	<u>Non-Structural</u> • Implement non-structural BMPs according to phased schedule in Table 5-4 <u>Structural</u> • Construct medium priority structural BMPs • Implement planning and design phases for low priority structural BMPs <u>Other</u> • Periodically evaluate compliance status; revise BMP requirements, as needed
Phase 4	2024 - 2028	2028 – wet (100%)	<u>Non-Structural</u> • Implement non-structural BMPs according to phased schedule in Table 5-4 <u>Structural</u> • Construct low priority structural BMPs

1 – End of the period of implementation coincides with upcoming compliance target date that falls on January 11th of the following year.

2 – Note: Priority, types and number of structural BMPs may be revised during implementation based on periodic evaluation of water quality compliance status.

Table 5-4 Phased Implementation of Non-Structural BMP Program

BMP	Phase 1 (2010 – 2011)	Phase 2 (2012 – 2019)	Phase 3 (2020 – 2023)	Phase 4 (2024 – 2028)
Vehicle Brake Pad Replacement	Senate Bill 346 signed into law September 27, 2010	Support implementation activities		
Tire Wheel Weight Replacement	Support legislative efforts for passage of Senate Bill 757	No new activity (assumes legislative success by 2012)		
Pesticide Use	No activity	Evaluate potential for action and implement as needed by end of Phase 3		No new activity
Vehicle Tire Wear Reduction	No activity	Evaluate potential for action and implement as needed by end of Phase 3		No new activity
Roof Materials Control	Implement building and planning agency coordination activities; evaluate need for ordinance/revised specifications	Establish and implement as needed ordinance and/or revised specifications; implement downspout disconnect program	No new activity	
Street Sweeping	No new activity – continue implementation at current levels	Evaluate existing program to identify opportunities to increase efficiency		No new activity
Catch Basin Cleaning	No new activity – continue implementation at current levels	Evaluate existing program to identify opportunities to increase efficiency		No new activity
Public Education & Outreach	Evaluate and revise public education and outreach materials/programs as needed to focus on metals	Continue to review and revise as needed		
Water Conservation	Develop water conservation model ordinance	Establish ordinance by end of Phase 3		No new activity
Development Practices	Establish model requirements that reduce offsite runoff consistent with future MS4 permit expectations	Revise MS4 program as needed and implement new practices; update as needed over long term to incorporate new concepts or methods		
Downspout Disconnect Program[1]	Establish program for implementation	Implement downspout disconnects at rate determined by Phase 1 structural BMP selection	Implement downspout disconnects at rate determined by Phase 1 structural BMP selection	Implement downspout disconnects at rate determined by Phase 1 structural BMP selection
General Plan Update	Identify areas for revision and establish schedule for implementation	Revise General Plan by end of Phase 3		No new activity
Watershed Coordination	Review existing coordination; identify improved mechanisms and implement	Continue high level of coordination		

1 – The number of downspout disconnections implemented in the Reach 2 watershed is dependent on the number of structural BMPs implemented. The rate of implementation needed will be determined during Phase 1.

Note: Each jurisdiction will select from the phased non-structural BMP program as outlined in Table 5-1 to determine the most beneficial non-structural BMPs to implement for their city..

Table 5-5 Phased Structural BMP Implementation Activities

Activity	Phase 1[1] (2010 – 2011)	Phase 2[1, 2] (2012 – 2019)			Phase 3[1, 2] (2020 – 2023)			Phase 4[1, 2] (2024 – 2028)		
		High	Medium	Low	High	Medium	Low	High	Medium	Low
BMP Selection	Establish prioritized BMP list and mechanisms for implementation	Review/revise prioritized list (as needed)			Review/revise prioritized list (as needed)			Review/revise prioritized list (as needed)		
Planning	No activity	Complete	Complete	No activity	No activity	No activity	Complete	No activity	No activity	No activity
Design	No activity	Complete	Complete	No activity	No activity	No activity	Complete	No activity	No activity	No activity
Construction	No activity	Complete	Initiate	No activity	No activity	Complete	Initiate	No activity	No activity	Complete
O & M	No activity	Initiate	No activity	No activity	Ongoing	Initiate	No activity	Ongoing	Ongoing	Initiate

1 – Terms "complete", "initiate" or "no activity" are relevant to the end of the phase. For example, for Phase 2, planning, design, and construction activities for all high priority structural BMPs will be complete by end of 2019.

2 - High, medium or low priority designation based on analysis completed under BMP Selection activity to be completed under Phase 1.

Note: Each jurisdiction will select from the phased non-structural BMP program as outlined in Table 5-1 to determine the most beneficial non-structural BMPs to implement for their city.

5.6 Other Implementation Activities

The Reach 2 participating jurisdictions are cooperatively participating in the implementation of the CMP. All jurisdictions subject to this plan will continue to participate in this monitoring program as currently defined in October 2008. Section 8.3 of the TMDL identifies opportunities for special studies the results of which may be used to revise the TMDL at its scheduled reopener in 2011. This Plan's participants may participate in these studies where appropriate and reserve the right to request changes to TMDL requirements based on the outcome of these studies.

Section 6
Compliance Analysis

6.1 Introduction

Using the information and data evaluated in Sections 1 through 5 of this Implementation Plan, an analysis was completed to show how Reach 2 participating jurisdictions will work towards achieving compliance with the Metals TMDL interim and final targets. The following sections outline this analysis.

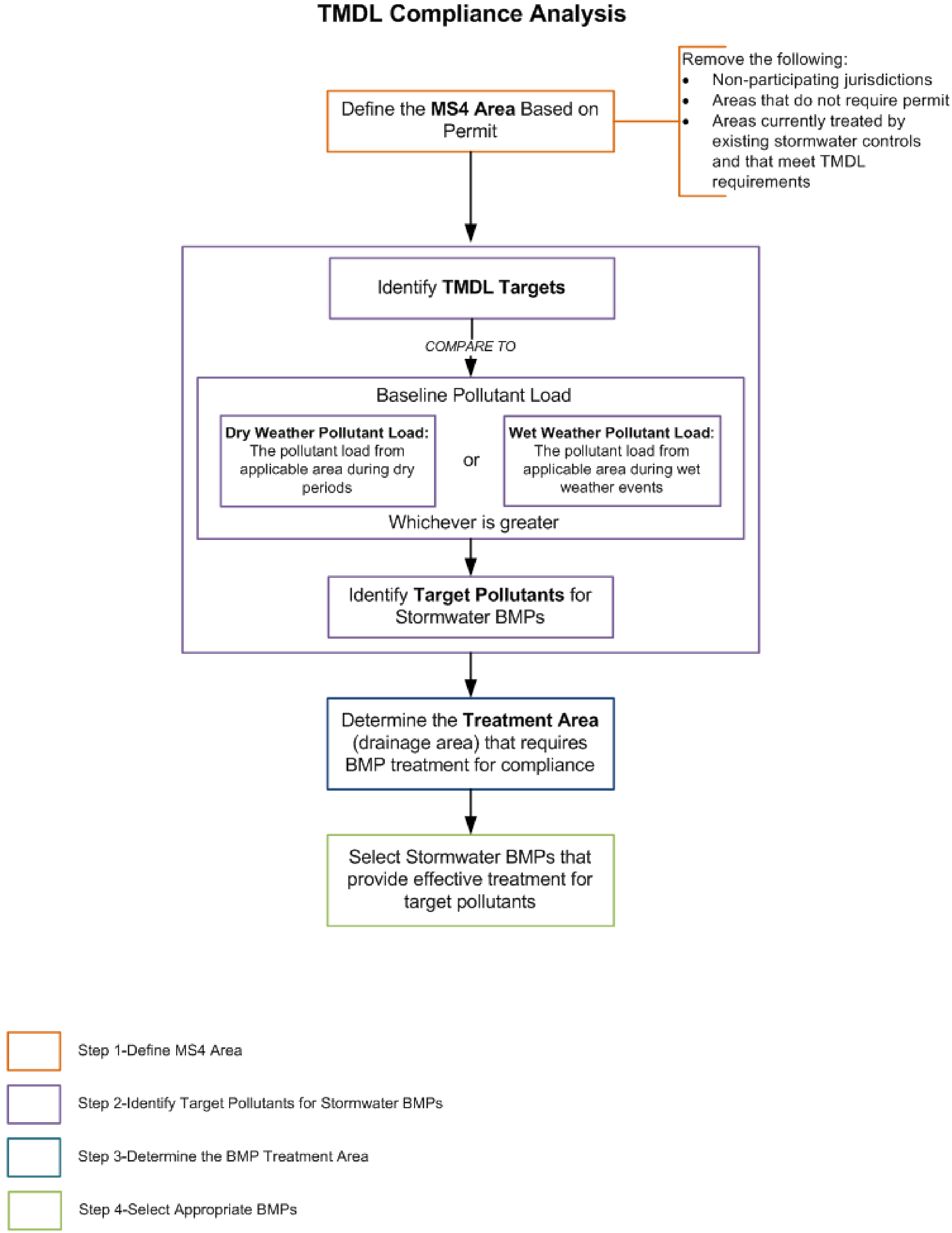
6.2 Procedure

This analysis was conducted to determine the pollutant reduction required to comply with the Metals TMDL targets (see Section 1) and to determine how pollutant reduction will be achieved through the use of both non-structural and structural stormwater BMPs. This analysis provides the basis for estimating the BMP acres required to meet TMDL compliance.

The process includes the following steps (Figure 6-1):

- Define the MS4 area in the Reach 2 watershed;
- Calculate a baseline pollutant load and identify target metals;
- Determine the treatment land area in the Reach 2 watershed;
- Select appropriate BMPs.

Figure 6-1 Compliance Analysis Procedure



6.3 Definition of the MS4 Land Area

The first step is to determine the MS4 area in the Reach 2 watershed. For the purposes of the compliance analysis, the MS4 area is defined as the drainage area to the LAR where the Metals TMDL applies. Factors to consider when defining the MS4 area include jurisdictional limits and land development. Land draining to stormwater controls that assist in treatment to meet the TMDL should also be considered.

For the Reach 2 watershed, the following land areas were omitted for the MS4 land area definition based on these considerations (Table 6-1).

Table 6-1 Definition of MS4 Land Area

Step 1-MS4 Land Area Definition		
Los Angeles River Reach 2 Watershed (study area)	170,000	ac
−Non-participating Jurisdictions	-65,900	ac
−Undeveloped Area	-16,400	ac
−Rio Hondo Spreading Grounds	-49,800	ac
MS4 Land Area in Reach 2	37,900	ac

Non-participating jurisdictions
Section 1 identified the jurisdictions that are participating in this Implementation Plan. Land area within non-participating jurisdictional limits was not considered as contributing drainage area.

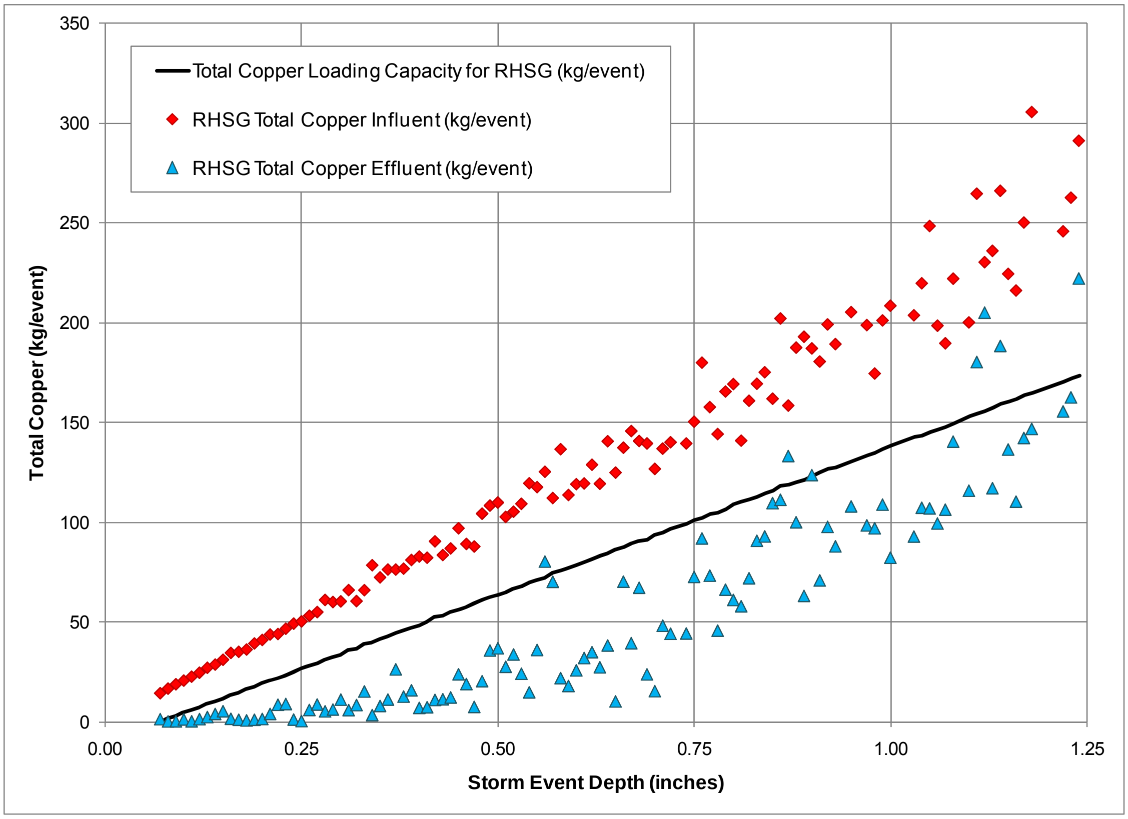
Undeveloped Land
Land area categorized as "undeveloped" was excluded. Developed, urbanized land typically has storm sewer accepting all stormwater runoff and routing directly to a river or stream. Therefore, developed land areas directly influence the Metals TMDL. As discussed in Section 4, land use based EMCs for metals are typically higher in urban areas.

Existing Stormwater Controls that Assist in Meeting the TMDL
For the Reach 2 watershed, the RHSG is an existing feature that ultimately influences metals concentrations in the LAR. The land area upstream of the RHSG receives "treatment", and, thus, is not contributing to the metals exceedances. Therefore, this land area was excluded.

Approximately 50-percent of the Reach 2 watershed drains to the RHSG, as shown in Figure 2-2. While other stormwater treatment may exist in the Reach 2 watershed, the RHSG have the most significant impact on current stormwater treatment in the watershed. The spreading grounds provide natural stormwater treatment via 20 large detention basins totaling 570 acres, with approximately 3,700 acre-feet of available storage and 400 cubic feet per second capacity for groundwater recharge.

To determine the effectiveness of the RHSG, a watershed model was developed to demonstrate pollutant removal. The result is shown in Figure 6-2. This figure shows how influent concentrations (red) are reduced below the total copper loading capacity by treatment in the RHSG.

Figure 6-2 Modeled Load Removal at the RHSG for Varying Rainfall Event Depths from Long Term Hydrologic Simulation



The RHSG has the capacity to treat runoff from rainfall events up to 0.5 inches. Thus, the spreading grounds are capable of treating small rainfall events and will provide capture of the first flush during larger storm events. Small storms generally produce higher metals concentration (see Table 6-3, Section 6.3.3). Currently, there are no water quality sampling data immediately upstream or downstream of the RHSG to determine or verify metals concentrations. The nearest downstream sampling location is located on Rio Hondo Reach 1 near the LAR (LAR-10).

6.4 Calculate Baseline Pollutant Loads and Identify Target Metals

During this step, TMDLs are compared with dry period and wet weather event metals loading data. The wet and dry weather numeric targets for the Reach 2 watershed are defined in Section 1. Compliance activities and BMP selection should focus on the target pollutants that exceed TMDL numeric targets.

6.4.1 Baseline Pollutant Loads-Dry Weather

From October 2008 until October 2009, water quality samples were obtained from three locations within the Reach 2 watershed:

- LAR 1-8: Along the LAR at Washington Boulevard (ST-12)
- LAR 1-9: Along the LAR at 710 Freeway
- LAR 1-10: Along the Rio Hondo River at Garfield Avenue (ST-16)

Data from each monitoring location is indicative of upstream water quality conditions. Drainage areas were considered compliant if the pollutant loads at the sample location were below the TMDL targets. Seven total samples were collected from the LAR and two total samples were collected from the Rio Hondo River during this time frame. Exceedances occurred during dry weather for dissolved copper concentrations in October 2008 (Table 6-2). These samples were collected in the Rio Hondo River Reach 1, near the confluence with the LAR.

Table 6-2 Portion of Reach 2 MS4 Drainage Area Currently in Compliance with Los Angeles River Metals TMDL Based on CMP Monitoring Program

Sample Month	Dissolved Copper	Dissolved Lead	Dissolved Zinc(1)
10/2008	91%	100%	100%
11/2008	100%	100%	100%
12/2008	100%	100%	100%
1/2009	100%	100%	100%
4/2009	100%	100%	100%
5/2009	100%	100%	100%
6/2009	100%	100%	100%
7/2009	100%	100%	100%
8/2009	100%	100%	100%
9/2009	100%	100%	100%
10/2009	100%	100%	100%

1) Numeric targets for Rio Hondo only

6.4.2 Baseline Pollutant Loads- Wet Weather

Wet weather compliance analysis was based on comprehensive wet weather data collected at the Wardlow Road mass emission site on the Los Angeles River in Reach 1. This site is downstream of the Reach 2 watershed. Data from Wardlow Road contain copper concentrations in excess of target TMDLs for a wide range of storm events. Table 6-3 shows the Wardlow monitoring data from October 2000 to October 2008.

Table 6-3 Baseline Copper Concentrations from Wardlow Monitoring Data

Date	Daily Runoff Volume (ac-ft)	Approximate Runoff Depth (in)1	Total Copper Concentration (ug/L)2
10/28/2000	2,300	0.09	11
1/11/2001	25,200	1.00	9
1/25/2001	1,400	0.06	18
3/6/2001	10,100	0.40	8
11/24/2001	9,500	0.38	30
12/20/2001	1,000	0.04	16
1/28/2002	3,300	0.13	15
11/8/2002	12,200	0.49	26
12/16/2002	16,300	0.65	19
2/11/2003	45,000	1.79	13
3/15/2003	36,800	1.46	10
10/28/2003	24,800	0.99	20
10/31/2003	6,200	0.41	295
12/25/2003	23,600	0.94	21
1/1/2004	9,200	0.37	16
10/17/2004	4,500	0.18	42
10/26/2004	17,300	0.69	51
12/6/2004	2,500	0.10	35
1/7/2005	23,400	0.93	31
10/18/2005	2,900	0.12	51
12/31/2005	5,200	0.21	12
1/14/2006	1,000	0.04	16
2/18/2006	2,400	0.10	44
12/9/2006	2,900	0.19	424
2/19/2007	1,400	0.06	77
2/22/2007	2,200	0.09	49
9/22/2007	7,100	0.47	123
10/13/2007	3,300	0.22	255
07-08 Event 29	4,400	0.18	58
07-08 Event 31	2,600	0.10	26
07-08 Event 32	6,700	0.27	44

[1]Runoff Depth (in) = Daily Runoff Volume (ac-ft) * 301,600 acre * 12 in / 1 ft

[2] Numeric target is 17 µg/l

6.4.3 Baseline Pollutant Load Summary

The majority of the Reach 2 watershed is currently in compliance with dry weather targets. Therefore, compliance activities should focus on wet weather target TMDLs. For both wet and dry weather baseline pollutant loads, the only pollutant that exceeds TMDL numeric targets during the most recent monitoring time period is copper. Thus, BMP selection should be geared toward controls that are effective for heavy metal treatment, specifically for copper. Structural and non-structural BMPs necessary for wet weather compliance will also capture any dry weather runoff, which will improve the margin of safety in achieving the dry weather numeric targets in the TMDL.

6.5 Determine Load Reduction

Based on the evaluation of baseline pollutant loads (Section 6.4.3) and the defined MS4 land area (Section 6.3), the total load to achieve compliance with the overall TMDL targets was determined. Metals concentrations shown in Table 6-3 and flow measured at the Wardlow Road mass emission site provide a basis for estimating the load reduction needed to bring each metal to below the wasteload allocation for the entire LAR watershed.

Table 6-3 shows that smaller runoff events in general have higher concentrations of metals, therefore these events will drive the level of implementation needed to achieve compliance. In addition, the magnitude of exceedances of total copper is significantly greater than cadmium, lead, or zinc. To demonstrate the impact of loading from a small runoff event, general calculations to quantify the needed treatment in Reach 2 were calculated using a 0.1-inch runoff event for total copper.

- **Runoff Event = 0.1 inch.** Runoff from this event over the entire LAR watershed MS4 area (~301,600 acres) is approximately 2,500 acre-feet or 3.1 x 10^9 liters.

$$LAR\ Watershed\ Runoff = \mathbf{3.1\ x\ 10^9\ \mathit{Liters}}$$

- **Baseline Load of Total Copper, LAR Watershed.** The product of concentration and runoff volume approximate the baseline load of total copper as summarized in Table 6-4 by runoff event monitored at the Wardlow station (Table 6-3).

Table 6-4 Baseline Copper Loads from Wardlow Monitoring Data

Date	Daily Runoff Volume (ac-ft)	Approximate Runoff Depth (in)[1]	Total Copper Concentration (ug/L)[2]	Baseline Copper Load (kg/day)[3]
10/28/2000	2,300	0.09	11	30
1/11/2001	25,200	1.00	9	294
1/25/2001	1,400	0.06	18	32
3/6/2001	10,100	0.40	8	103
11/24/2001	9,500	0.38	30	351
12/20/2001	1,000	0.04	16	19
1/28/2002	3,300	0.13	15	61
11/8/2002	12,200	0.49	26	390
12/16/2002	16,300	0.65	19	382
2/11/2003	45,000	1.79	13	716
3/15/2003	36,800	1.46	10	434
10/28/2003	24,800	0.99	20	608
10/31/2003	6,200	0.41	295	2,255
12/25/2003	23,600	0.94	21	602
1/1/2004	9,200	0.37	16	184
10/17/2004	4,500	0.18	42	230
10/26/2004	17,300	0.69	51	1,079
12/6/2004	2,500	0.10	35	108
1/7/2005	23,400	0.93	31	897
10/18/2005	2,900	0.12	51	183
12/31/2005	5,200	0.21	12	77
1/14/2006	1,000	0.04	16	20
2/18/2006	2,400	0.10	44	130
12/9/2006	2,900	0.19	424	1,516
2/19/2007	1,400	0.06	77	133
2/22/2007	2,200	0.09	49	132
9/22/2007	7,100	0.47	123	1,077
10/13/2007	3,300	0.22	255	1,037
07-08 Event 29	4,400	0.18	58	312
07-08 Event 31	2,600	0.10	26	83
07-08 Event 32	6,700	0.27	44	362

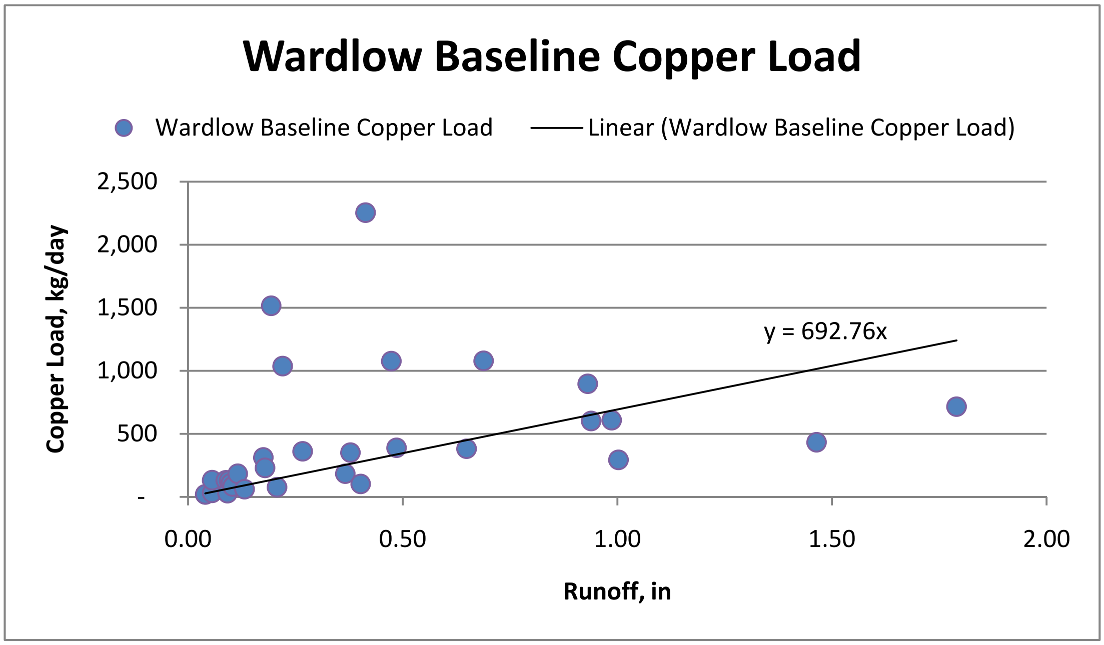
[1]Runoff Depth (in) = Daily Runoff Volume (ac-ft) * 301,600 acre * 12 in / 1 ft

[2] Numeric target is 17 µg/l

[3]Baseline Copper Load (kg) = Total Copper Concentration (µg/L) * Runoff Volume (ac-ft) * (1 kg / $1(10)^9$ µg)* (28.3 ft^3/1 ac-ft)

Figure 6-3 shows the baseline copper loads plotted against runoff depths as calculated in Table 6-4. A linear regression was performed on the data to approximate an average baseline copper load, as represented by “Linear (Wardlow Baseline Copper Load).”

Figure 6-3 Baseline Copper Load versus Runoff Depth at Wardlow



For a 0.1 inch runoff event, the baseline copper load can be calculated using the equation of the linear relationship shown in Figure 6-3.

$$0.1\ inches * 692.7\ = \mathbf{69\ kg}$$

- **Total Allowable Copper, LAR Watershed.** The allowable total copper load for the 0.1 inch runoff event is determined by the wasteload allocation from the TMDL, which is a direct function of runoff volume converted to liters (Table 6-12, TMDL Staff Report). Therefore, the baseline load of 69 kg must be reduced to 42 kg by all stormwater permittees in the LAR watershed.

$$1.7\ x\ 10^{-8} * 3.1\ x\ 10^{9}\ Liters - 10 = \mathbf{42\ kg}$$

- **Required Load Reduction.** Per the TMDL, the proportion of the MS4 drainage area within the Reach 2 watershed contributing to the overall load determines the fraction of the total load reduction to be achieved. This MS4 drainage area for Reach 2 was calculated as 37,900 acres (this does not include the Rio Hondo drainage area upstream of the RHSG), which accounts for approximately 15-percent of the total LAR watershed MS4 area at Wardlow (301,600 acres). Therefore, this Implementation Plan should provide approximately 15-percent of the load reduction needed over the entire LAR watershed. Based on the preceding example for total copper during a 0.1-inch runoff event, the load reduction to be achieved by this Implementation Plan is 4.0 kg.

$$15\% * (69\ kg - 42\ kg) = \mathbf{4.0\ kg}$$

6.6 Selection of Stormwater BMPs for Pollutant Load Removal

Using the quantifications of pollutant load removal for new development and redevelopment projects, non-structural BMPs (Section 3) and structural BMPs (Section 4), the level of implementation effort needed to reduce baseline metals loads from the jurisdictions participating in this TMDL Implementation Plan to meet the total treatment area for compliance can be approximated. It is estimated that development projects and non-structural BMPs would provide approximately 45-percent of the estimated total copper load reduction, and that structural BMPs would provide approximately 55-percent of the estimated total copper load reductions.

Load reductions are expected to occur from redevelopment and new development projects that must comply with stormwater permits. Using the assumed redevelopment rate of 2-percent from SCAG, approximately 500 acres of MS4 drainage area within the participating jurisdictions (outside of the RHSG watershed), will be routed to a structural BMP to control metals, other pollutants, and address downstream effects of increasing imperviousness. An approximate metals load removal expected from BMPs implemented to meet stormwater permit requirements provides some credit toward the reductions goals for the participating jurisdictions within the Reach 2 watershed. This mass removal is estimated by taking modeled load reductions for a hypothetical infiltration BMP and applying per acre removal rates to the 500 acres of redevelopment. The total copper load reduction per acre of MS4 tributary area estimated for a hypothetical infiltration basin during a 0.1-inch runoff depth is 0.00023 kg. Using this approach, it is estimated that load reduction for total copper could be achieved:

$$500\ acres * 0.00023\frac{kg}{acre} = \mathbf{0.1\ kg}$$

Some jurisdictions may opt to take a more stringent approach to managing stormwater runoff through their existing stormwater program. This could provide removals in excess of the estimated 500 acres of larger-scale redevelopment, which could potentially offset the level of implementation for other non-structural and regional structural BMPs included in this Implementation Plan.

Brake pad replacement legislation (Senate Bill 346) was signed into law on September 27, 2010. Implementation of this legislation will provide significant removal effectiveness, as described in Section 3, relative to cost of implementation. Assuming the average copper content in brake pads could be reduced to approximately 5-percent by the 2028 compliance milestone, brake pad replacement could achieve a load reduction of 1.7 kg, or 43-percent of the total copper load reduction needed.

Benefits are expected from other non-structural programs over time, but these benefits are very difficult to quantify. However, non-quantified programs provide a measure of conservatism or margin of safety to the overall implementation program. As implementation proceeds, it is important to periodically re-evaluate water quality in the impaired waters to determine if water quality is better than expected. If so, then the number of structural programs potentially can be reduced, as appropriate.

The portion of load reduction that is planned for control using structural BMPs is 55-percent, or 2.2 kg of total copper. The total copper load reduction per acre of MS4 tributary area estimated for a hypothetical infiltration basin during a 0.1-inch runoff depth is 0.00023 kg. Therefore, an implementation plan that included infiltration BMPs to capture approximately 10,000 acres of MS4 area would provide sufficient load reduction to achieve the 2.2 kg of total copper load reduction that would be needed during this size event.

$$\frac{2.2\ kg}{0.00023\ kg/acre} = \mathbf{10,000}\ \boldsymbol{acres}$$

However, this is not a technically feasible alternative due to the limited set of large, publically owned properties and various infiltration constraints at potential sites. Consequently, implementation of a mix of structural BMP projects that take advantage of existing land use and available publically-owned open space will be needed. Taking into account differences in structural BMP size and the load reduction expected from different types of projects, the total MS4 area that may be directed to a structural BMP will range from 10,000 acres to 22,000 acres. Although classified as a non-structural BMP because of the need to establish a BMP program, for the purposes of the compliance analysis downspout disconnections will be considered as a structural BMP option that would provide treatment to a portion of this MS4 tributary acre target.

Using this information, Reach 2 jurisdictions will identify during Phase 1 specific structural BMPs for construction that provide treatment of at least 10,000 acres. As noted elsewhere, this acreage will be increased or even decreased based on the findings from ongoing water quality monitoring and will be re-evaluated at the major milestones defined in Section 5.

6.7 Sensitivity Analysis

A sensitivity analysis was performed on the parameters used in the compliance analysis to determine copper load reduction and treatment area required for structural BMPs to meet the target copper concentrations. The sensitivity analysis was performed using the Palisades Decision Tools @RISK program. Version 5 of @RISK was used in conjunction with Microsoft Excel to determine the probability of compliance with target copper loads for the range of tributary area (10,000 to 22,000 acres) for treatment with infiltration BMPs.

The sensitivity analysis included the following steps:

- **Step 1 – Rainfall.** Hourly rainfall data was separated into rainfall events.
- **Step 2 – Stormwater Runoff.** Runoff was calculated for the Los Angeles River (LAR) Municipal Separate Storm Sewer System (MS4) area (301,600 acres) for each rainfall event defined in Step 1.
- **Step 3 – Baseline Copper Load.** The baseline copper load for a given runoff event (Step 2) was estimated based on wet weather monitoring data at the Wardlow Station[1].
- **Step 4 – Total Allowable Copper Load.** The total allowable copper load for a given runoff event (Step 2) was estimated using an equation specified in the TMDL Staff Report.
- **Step 5 – Required Copper Load Reduction for Reach 2.** The copper load reduction to be achieved with the construction of structural BMPs to treat the Reach 2 tributary area was estimated based on runoff event depth (Step 2) and estimated baseline copper load (Step 3) for the Reach 2 MS4 area.
- **Step 6 – Estimated Copper Load Treated by Structural BMPs.** The estimated copper load treated by the construction of structural BMPs within the Reach 2 MS4 area was compared to the Reach 2 MS4 area required load reduction (Step 5) to determine compliance.

This process was completed for a range of rainfall depths and baseline copper loads to estimate the sensitivity of the percent compliance achieved by construction of structural BMPs to treat between 10,000 acres and 22,000 acres of the Reach 2 MS4 area. More details on the sensitivity analysis are provided in Appendix B.

The results of the sensitivity analysis show that 10,000 acres of treatment provide a 55-percent probability of compliance with the required copper load reduction for any given runoff event. For 22,000 acres of treated tributary area, 97-percent compliance is achieved for all runoff events.

Based on the results of this sensitivity analysis, the targeted tributary area between 10,000 and 22,000 acres for capture and treatment of stormwater runoff by structural BMPs provides reasonable assurance of compliance, as shown by this conservative estimate. This is, however, a planning level estimate based on a hypothetical structural BMP application. The actual area required for treatment will depend on the baseline copper concentrations (Step 3) and structural BMP performance from specific sites. Therefore, it is recommended that this analysis be revisited periodically during the phased process of structural BMP site selection and implementation.

---

[1] Based on review of all available data, the Wardlow wet weather data remains the best data set for this analysis because both water quality and flow data is available at the location. See discussion in Section 2.3.

Section 7
Program Costs

7.1 Methodology

Planning-level capital and O&M cost estimate ranges were developed based on the non-structural program concepts presented in Section 3, the structural BMP evaluation presented in Section 4, and compliance analysis provided in Section 6. These estimated cost ranges are intended to be used as a planning tool for jurisdictional decision makers in order to anticipate probable costs over the implementation period. These planning level costs are only based on hypothetical BMPs; accordingly, their utility is limited to high level planning only. During Phase 1 of the Implementation Plan, these estimated cost ranges will be re-evaluated based on the final selection of structural BMPs and associated non-structural program implementation.

7.2 Structural BMPs

The Water Environment Research Federation (WERF) BMP and LID Whole Life Cost Models, Version 2.0, was used to develop cost estimate ranges for the hypothetical regional, neighborhood, and lot level structural BMPs evaluated in Section 4. Parameters for the hypothetical structural BMPs developed as part of Section 4 were used to develop a representative cost estimate range for a regional, a neighborhood, and a lot level structural BMP application using the "Simple Cost based on Drainage Area" approach provided in the model. Representative structural BMP applications for cost estimation were selected as follows:

- Regional Structural BMP *(Extended Detention Basin)*
- Neighborhood Structural BMP *(Curb-Contained Bioretention)*
- Lot Level Structural BMP *(Permeable Pavement)*

Though three regional hypothetical structural BMPs were evaluated in Section 4 (infiltration basin, detention system, wetland), the estimated planning level construction costs for each are similar at this planning stage. A detention basin was selected as the representative regional structural BMP for cost estimation. As site specific structural BMP recommendations are defined in Phase 1 of the Implementation Plan, all cost estimates should be re-evaluated for feasibility and engineering issues specific to the site.

Using the planning level cost estimates, an estimated cost range per acre for capital and O&M costs was calculated for each application. The cost per acre was then extrapolated over the Reach 2 watershed. The compliance analysis in Section 6 estimated needed treatment area of 10,000 – 22,000 acres. Costs were based on an estimated treatment projected of 15,000 acres to represent the midpoint of the estimate in Section 6. Actual treatment acreage may be higher. As all cost estimate ranges are planning level, total costs were rounded to two significant digits.

7.2.1 Structural BMP Capital Costs

Table 7-1 summarizes the cost estimate ranges for each hypothetical structural BMP application. Total estimated facility capital costs and annual O&M costs are provided. The drainage area used for these estimates is also provided, and correlates to the modeled drainage area from Section 4. Table 7-2 takes these estimated costs and divides them by the treated drainage area to provide a "per acre" cost for each BMP application. These costs were applied across the Reach 2 watershed to estimate the total structural BMP costs based on the currently estimated number of acres requiring treatment (Section 4).

Table 7-1 Estimated Total Cost Range per Hypothetical BMP

Planning Level Costs	Potential Range of Facility Capital Costs			Potential Range of Annual O&M Cost			Acres Treated
Regional	$750,000	to	$4,700,000	$3,800	to	$71,000	200
Neighborhood	$610,000	to	$1,600,000	$7,200	to	$110,000	20
Lot Level	$58,000	to	$240,000	$1,100	to	$8,400	1

Table 7-2 Estimated Cost Range/Acre Per Hypothetical BMP

Planning Level Costs	Facility Capital Cost Range per Acre			Annual O&M Cost Range per Acre		
Regional	$3,750	to	$23,500	$19	to	$355
Neighborhood	$30,500	to	$80,000	$360	to	$5,500
Lot Level	$58,000	to	$240,000	$1,100	to	$8,400

Facility cost ranges were estimated using conservative assumptions in the model. Actual costs could vary significantly, depending on a specific project site.

Land acquisition costs were not included in the low end of the range cost estimate because of the site selection requirement that the property be owned by a public entity. For the high end of the range cost estimate, a factor of 30 percent of the base construction cost of the facility was estimated to account for needed land acquisition or complications created by having to locate a BMP below ground in order to maintain the functionality of the site on the surface. This latter scenario is likely for many structural BMPs given the highly urbanized nature of the watershed.

7.2.2 Structural BMP O&M Costs

O&M costs as summarized in Tables 7-1 and 7-2 were estimated in the model assuming a "low" level of maintenance for the low end of the range and a "high" level of maintenance for the high end of the range. O&M costs were estimated for routine maintenance activities (inspections, vegetation management, etc.) and corrective and infrequent maintenance activities (unplanned activities and/or greater than 3 years between events). Using the treated drainage area, the estimated O&M cost "per acre" was calculated. These estimated costs were applied across the Reach 2 watershed to estimate the total structural BMP O&M costs based on the estimated number of acres needed for treatment (Section 6).

7.3 Non-Structural BMPs

Non-structural BMP program costs are very difficult to estimate for several reasons:

- Many programs already exist and for some BMPs it may be possible to redirect existing budgets to new priority activities, e.g., revision of education materials to target metals.
- For existing programs, additional costs are incremental, meaning that a base budget already exists, but additional funds are needed to expand the BMP activity. How much additional budget is needed will often be jurisdiction-specific.
- Some BMPs require participation from agencies or departments outside of the stormwater program. For example, developing a local ordinance or updating the City's General Plan will require resources beyond the stormwater program. The budgetary impact will again be jurisdiction-specific.
- Non-structural BMPs will have varying levels of activity depending on the phase, e.g., the legislative support activities are needed only in the short-term.

Given these uncertainties, Table 7-3 was developed to identify cost considerations for each of the non-structural BMPs. With the exception of the downspout disconnection program, which can have fairly high costs associated with it depending on level of effort, many of these activities will require only incremental increases in existing budgets. This is especially true if activities are appropriately phased and costs are shared among jurisdictions. Section 7.4 provides an estimate of overall non-structural BMP costs for the entire Reach 2 watershed.

Table 7-3 Non-Structural Cost Considerations

BMP	Cost Considerations
Vehicle Brake Pad Replacement	Legislation signed into law on September 27, 2010; no additional funding required
Tire Wheel Weight Replacement	Similar to brake pad replacement BMP, but at this time no concerted effort underway to secure funding support. Until such a request is made there is no need to identify funds for this BMP. Phase 1 only; once legislation adopted, no additional funding required
Pesticide Use	This is a low priority BMP; evaluation may require funding for a study to evaluate potential to reduce metals through a pesticide replacement program. Cost can be shared with all participating jurisdictions. No activity in Phase 1. Any implementation would occur during Phases 2 and 3 which provides opportunity to spread out costs.
Vehicle Tire Wear Reduction	This is a low priority BMP; evaluation may require funding for a study to evaluate potential to reduce metals through a pesticide replacement program. Cost can be shared with all participating jurisdictions. No activity in Phase 1. Any implementation would occur during Phases 2 and 3 which provides opportunity to spread out costs.
Roof Materials Control	Additional budget recommended. Initial activities are planning in nature and can be done area-wide providing opportunity for cost-sharing. In addition, later activities such as model ordinance or building specification development can largely be done jointly allowing costs to be shared
Street Sweeping	During Phase I, no additional cost as program is to be maintained at current levels. During Phase 2 and following additional budget should be considered to evaluate how to enhance program and if necessary purchase (or support if sweeping contracted out) better, more efficient equipment.
Catch Basin Cleaning	During Phase I, no additional cost as program is to be maintained at current levels. During Phase 2 and following additional budget should be considered to evaluate how to enhance program and if appropriate increase catch-basin cleaning activities
Public Education & Outreach	Additional budget may be needed in Phase 1 to evaluate existing materials and update to better target metals. May also be possible to re-allocate portion of existing education budget to address this need. Revisions of materials can also be done jointly by all participating jurisdictions to share costs. After Phase 1, no additional budget anticipated.
Water Conservation	Development of model ordinance can be done jointly at minimal cost. Additional budget may be needed to provide resources for ordinance development within each jurisdiction.
Development Practices	Development of model requirements can be done jointly at minimal cost. Additional budget may be needed to provide resources for modifying jurisdiction specific documents (if any).
Downspout Disconnect Program	This BMP is the most costly program over the long term. In the short term, development of the program components can be relatively low cost and the costs shared among jurisdictions by developing model program requirements based on similar programs implemented elsewhere. Costs during implementation will rise but total cost depends on extent of implementation, i.e., number of retrofitted properties and means of implementation, e.g., use of fees or incentives. City of Los Angeles is estimating a cost of $1,700/residential retrofit (based on City's Water Quality Compliance Master Plan, City of Los Angeles 2008)
General Plan Update	This is a relatively low cost activity that would be spread out over many years and completed by departments not associated with stormwater.
Watershed Coordination	This is a relatively low cost activity that can likely be absorbed into existing program activities

7.4 Implementation Plan Costs

Table 7-4 summarizes the potential estimated cost ranges of BMP implementation in the Reach 2 watershed.

Structural BMP implementation costs were calculated by extrapolating the estimated cost per acre developed for each type of application in Table 7-2 over the area needed for treatment as defined in Section 6. These cost ranges may increase if actual treatment acreage increases beyond the projected 15,000 acres. This cost range assumes that only one type of structural BMP is chosen for implementation. In reality, a combination of regional, neighborhood, and lot level solutions will be implemented to treat the projected 15,000 acres. Clearly, regional solutions are the most cost effective. However, given the high level of urbanization, regional BMP projects will have to be greatly supplemented by neighborhood and lot level projects. The result will be higher costs for compliance.

For planning level non-structural BMP implementation cost ranges, a conservative assumption of 15-percent of total capital costs of regional BMP facility costs was assumed for budgeting purposes as exact non-structural BMP costs are difficult to approximate without specific plans in place.

As these are planning level cost ranges, both structural and non-structural implementation plan cost estimate ranges should be re-evaluated during all phases of the Implementation Plan, as specific details on the both of these programs are evaluated and coordinated between the participating jurisdictions.

Table 7-4 Implementation Plan Reach 2 Metals TMDL – Planning Level Cost Ranges

				Implementation Plan Planning Level Costs	
Planning Level Costs	**MS4 Treated Area (acres)[2]**	**Facility Capital Cost Range per Acre**	**Annual O&M Cost Range per Acre**	**Range of Capital Cost**	**Range of Annual O&M Cost**
Structural BMPs					
Regional	15,000	\$3,800 to \$24,000	\$19 to \$360	\$57,000,000 to \$360,000,000	\$285,000 to \$5,400,000
Neighborhood	15,000	\$31,000 to \$80,000	\$360 to \$5,500	\$465,000,000 to \$1,200,000,000	\$5,400,000 to \$82,500,000
Lot Level	15,000	\$58,000 to \$240,000	\$1,100 to \$8,400	\$870,000,000 to \$3,600,000,000	\$16,500,000 to \$126,000,000
Non-Structural BMPs[1]				\$8,550,000 to \$54,000,000	*NA* to *NA*

(1) As a placeholder, planning level cost estimated as 15-percent of the total regional BMP capital cost, includes cost of downspout disconnection program.
(2) Based on projected treatment of 10,000 – 22,000 acres. Actual treatment acreage may be higher.

Section 8
Implementation Challenges

The purpose of this section is to describe three significant challenges associated with implementation of the Metals TMDL in the Reach 2 watershed. How these challenges are addressed will affect TMDL implementation throughout the watershed. The following sections describe these challenges more fully.

8.1 Control of Indirect Metals Sources – Air Deposition

A common source of metals and other potentially toxic pollutants is dry deposition of particulates from urban sources, e.g., highways and industry (e.g., Sabin et al. 2005; Sabin et al. 2006a, b; Lim et al. 2006). For example, in a small impervious catchment in an urbanized area of Los Angeles Sabin et al. (2005) demonstrated that 57- to 100-percent of the trace metal loads in stormwater in the study area were potentially attributable to air deposition. In the LAR Metals TMDL, the LARWQCB addressed metals loadings from air deposition by including them in the MS4 wasteload allocations (LARWQCB 2005). Much of this load is not derived from the MS4, but from other sources over which the MS4 permittees have no control.

The transference of responsibility of air deposition sources to the MS4 creates a significant challenge for achieving compliance with final wet weather targets. In its resolution to adopt the LAR Metals TMDL into the Basin Plan for the Los Angeles Region the SWRCB acknowledged the following in the (SWRCB Resolution #2008-0046):

> Finding #10:
>
> "To the extent that pollutant loadings from indirect atmospheric deposition over land are being conveyed to stormwater discharges, these loadings are included in the stormwater waste load allocations. One study has shown that atmospheric deposition of particulates containing trace metals in the urban areas of the Los Angeles Region is an important source of metals contaminants on land surfaces (Sabin et al., 2005). The Los Angeles Water Board met with the South Coast Air Quality Management District (SCAQMD) and the California Air Resources Board (CARB) to discuss the findings of the study. It appears that larger particulates are responsible for the highest loadings of metals in atmospheric deposition, and therefore pose the greatest risk to water quality. The two agencies have identified the need to (1) expand monitoring of larger particulates in atmospheric deposition to better gauge the impact to water quality, and (2) investigate the sources of these metals in order to design a control strategy. The Los Angeles Water Board and the State Water Board will continue to meet with the SCAQMD and CARB to pursue further studies and to assist in developing appropriate controls."

Finding #11:

> "The State Water Board encourages local municipalities within the urban watersheds in the Los Angeles Region and Los Angeles County also to work with SCAQMD and CARB to further identify and control sources of trace metals in atmospheric deposition. If necessary, the State Water Board and Los Angeles Water Board shall enforce compliance with the adopted plans by the SCAQMD and CARB as appropriate under Water Code sections 13146 and 13247, and all other relevant statutes and regulations."

The proposed Reach 2 Metals TMDL Implementation Plan includes a number of non-structural BMPs that support reduction of metals loadings that are derived from particulate sources such as industrial activity or re-suspension of particulates from roadways. For example, vehicle brake pad replacement legislation signed into law on September 27, 2010 will greatly reduce an important source of re-suspended particulates from roadways. In addition, while roofing materials contain metals that can be leached by rainwater, roof surfaces receive a significant amount of air deposited particulates. Implementation of a downspout disconnection program to retain roof runoff onsite will greatly reduce this air deposited source.

Regardless of progress made by Plan participants towards reducing pollutant loads from indirect sources, the participating jurisdictions expect the LARWQCB and SWRCB to fulfill its commitments to addressing this issue as stated in Findings #10 and #11 of SWRCB Resolution #2008-0046.

8.2 Implementation Costs

Section 7 provided the expected range of costs associated with the implementation of this Plan. Given the highly urbanized nature of the Reach 2 watershed, it is expected that actual costs will fall on the higher end of the range because of land use/acquisition issues. Given the many participating jurisdictions in this watershed, opportunities exist for cost-sharing. However, even with cost-sharing budget limitations may affect BMP implementation, in particular structural BMP implementation. While participating jurisdictions are committed to the principles of this Plan, the ability to implement required BMPs will depend on the availability of sufficient funds. Action by the state to address indirect sources, over which participating jurisdictions have no ability to control, will increase the likelihood of achieving compliance with all TMDL targets.

8.3 Multi-Jurisdictional Coordination

Many jurisdictions make up the Reach 2 watershed. This fact creates significant challenges for the siting, design and implementation of BMPs, especially structural BMPs. Successful implementation requires that significant coordination occurs among jurisdictions. For example, 29 jurisdictions (28 cities and Caltrans) are participating in the development of this Implementation Plan. The City of Los Angeles and Los Angeles County also have responsibilities within the Reach 2 watershed, but are submitting their own metals TMDL Implementation Plans. In addition, there are several cities in Reach 2 that have not participated in the development of this Plan.

During Phase 1 of implementation, the participating jurisdictions in this Plan will identify prioritized locations for the implementation of structural BMPs. Issues regarding how to share implementation responsibilities including costs will need to be addressed prior to moving into design and construction. In addition, issues regarding long-term operation and maintenance responsibilities will also need to be addressed. These issues will not only involve the participants of this Plan, but may also involve other jurisdictions, e.g., City of Los Angeles or Los Angeles County, if the planned BMP includes drainage from any of their jurisdictions. To resolve this challenge, discussion will need to be initiated early in the Phase 1 period to develop the best mechanisms for multi-jurisdictional implementation.

Section 9
References

AquaTerra. *Modeling the Contribution of Copper from Brake Pad Wear Debris to the San Francisco Bay*. October 2007.

California Stormwater Quality Association (CASQA). *California Stormwater Quality Association Stormwater Best Management Practice Handbook.* 2003.

California Department of Forestry and Fire Protection. *Fire and resource assessment program: GIS data.* (2008)Available at http://frap.cdf.ca.gov/data/frapgisdata/select.asp.

California Department of Transportation (Caltrans). *Statewide Storm Water Management Plan*, CTSW-RT-02-008. Division of Environmental Analysis. May 2003.

City of Los Angeles. *Water Quality Compliance Master Plan for Urban Runoff.* 2009.Watershed Protection Division, Bureau of Sanitation, Department of Public Works.

City of Pasadena. 2003. *Arroyo Seco Master Plans: Central Arroyo Master Plan.* Prepared by City of Pasadena, adopted September 2003. (a)

City of Pasadena. 2003. *Arroyo Seco Master Plans: Hahamongna Watershed Park Master Plan.* Prepared by City of Pasadena, adopted September 2003. (b)

City of Pasadena. 2003. *Arroyo Seco Master Plans: Lower Arroyo Master Plan.* Prepared by City of Pasadena, adopted September 2003. (c)

Davis, A.P., Shokouhian, M., Sharma, H., Minami, C., and Winogradoff, D. *Water Quality Improvement through Bioretention: Lead, Copper, and Zinc, Water Environ.* Res. 75(1), 73-82. (2003).

Green Topeka. Available at http://greentopeka.org/. 2009.

Hunt, W., Jarrett, A., Smith, J., and Sharkley, L. *Evaluation Bioretention Hydrology and Nutrient Removal at Three Field Sites in North Carolina. J. of Irrigation and Drainage Engineering.* 132: 600-608. (2006)

International Stormwater BMP Database. Available at www.bmpdatabase.org. 2010.

Los Angeles Regional Water Quality Control Board (LARWQCB). *Total Maximum Daily Loads for Metals, Los Angeles River and Tributaries.* Staff Report, Los Angeles Regional Water Quality Control Board prepared in coordination with Environmental Protection Agency Region 9. June 2, 2005.

Lim J.H., Sabin L.D., Schiff K., and Stolzenbach, K.D. *Concentration, size distribution, and dry deposition rate of particle-associated metals in the Los Angeles region.* Atmospheric Environment 40, 7810-7823. 2006.

Mid-America Regional Council (MARC) and American Public Works Association. *Manual of Best Management Practices for Stormwater Quality.* 2009. Available at www.marc.org/environment/Water/bmp_manual.htm.

MARC. *Sustainable Skylines Kansas City*. 2009. Available at http://www.sustainableskylineskc.org/.

Muthukrishnan, S., Field, R., and Sullivan, D. *Extended Wet Detention Basins. In Field*, R.,.Tafuri, A., Muthukrishnan, S., Acquisto, B., and Selvakumar, A. (Eds.), *The use of best management practices (BMPs) in urban watersheds* (ed. 1, 118-124) Pennsylvania, United States: Destech Publications. (2006)

North Carolina Department of Environment & Natural Resources (NCDENR). *NCDENR Stormwater BMP Manual, Chapter 17.* June 1, 2009. Available at http://h2o.enr.state.nc.us/su/documents/Ch17-DryExtendedDetentionBasin.pdf.

Office of Water, United States Environmental Protection Agency. *Stormwater Technology Fact Sheet.* 1999.

Rosselot, K. *Copper Released from Brake Pad Lining Wear in the San Francisco Bay Area.* Report prepared for the Brake Pad Partnership. January 2006.

Sabin, L.D, Lim, J.H, Stolzenbach, K.D, Schiff, K. *Atmospheric dry deposition of trace metals in the coastal region of Los Angeles, California, USA.* Environmental Toxicology and Chemistry 25: 2334–2341. 2006.

Sabin, L.D., Lim, J.H., Stolzenbach, K.D, Schiff, K. *Contribution of trace metals from atmospheric deposition to stormwater runoff in a small impervious urban catchment.* Water Research 39 (2005) 3929–3937. 2005.

Sabin L.D., Lim J.H., Venezia M.T., Winer A.M., Schiff K., and Stolzenbach, K.D. *The dry deposition and resuspension of particle-associated trace metals near a freeway in Los Angeles.* Atmospheric Environment 40: 7528-7538. 2006.

San Gabriel and Lower Los Angeles Rivers and Mountains Conservancy. *Rio Hondo Watershed Management Plan,* October 2004.

Santa Clara Valley Urban Runoff Program (SCVURP). *Metals Control Measures Plan and Evaluation of Nine Metals of Concern*, Volume I. February 1997.

Southern California Association of Governments (SCAG). *The regional comprehensive plan: making the connections.* (2009). Available at http://www.scag.ca.gov/rtp2008/index.htm.

Southern California Association of Governments (SCAG). *The regional transportation plan: helping communities achieve a sustainable future.* (2008). Available at http://www.scag.ca.gov/rcp/index.htm.

State Water Resources Control Board (SWRCB). *Approving an amendment to the water quality control plan for the Los Angeles Region (Basin Plan) to establish a total maximum daily load for metals in the Los Angeles River.* SWRCB Resolution #2008-0046. 2008.

Stenstrom M.K., and Kayhanian M. *First Flush Phenomenon.* California Department of Transportation, Report No. CTSW-RT-05-73-02.6, Sacramento, California. (2005).

Tetra Tech. *Modeling Analysis for Development of TMDL for Metals in the Los Angeles River and Tributaries*. Prepared for LARWQCB and EPA Region 9. 2004.

University of New Hampshire. *University of New Hampshire Stormwater Center 2007 Annual Report.* UNH Stormwater Center in partnership with the UNH/NOAA Cooperative Institute for Coastal and Estuarine Environmental Technology. 2007. Available at http://ciceet.unh.edu/unh_stormwater_report_2007/treatments/gravel_wetland/index.php.

Urban Drainage and Flood Control District. *Urban Storm Drainage Criteria Manual – Volume 3: Best Management Practices.* Denver, Colorado. 2005.

Urban Drainage and Flood Control District. *Urban Storm Drainage Criteria Manual – Volume 3: Best Management Practices.* Denver, Colorado. 2008.

US Census Bureau. *Topologically integrated geographic encoding and reference system (TIGER).* (2007). Available at http://www.census.gov/geo/www/tiger/.

Appendix A

Figure A-1 Cadmium Dissolved Wet Weather Sample Results

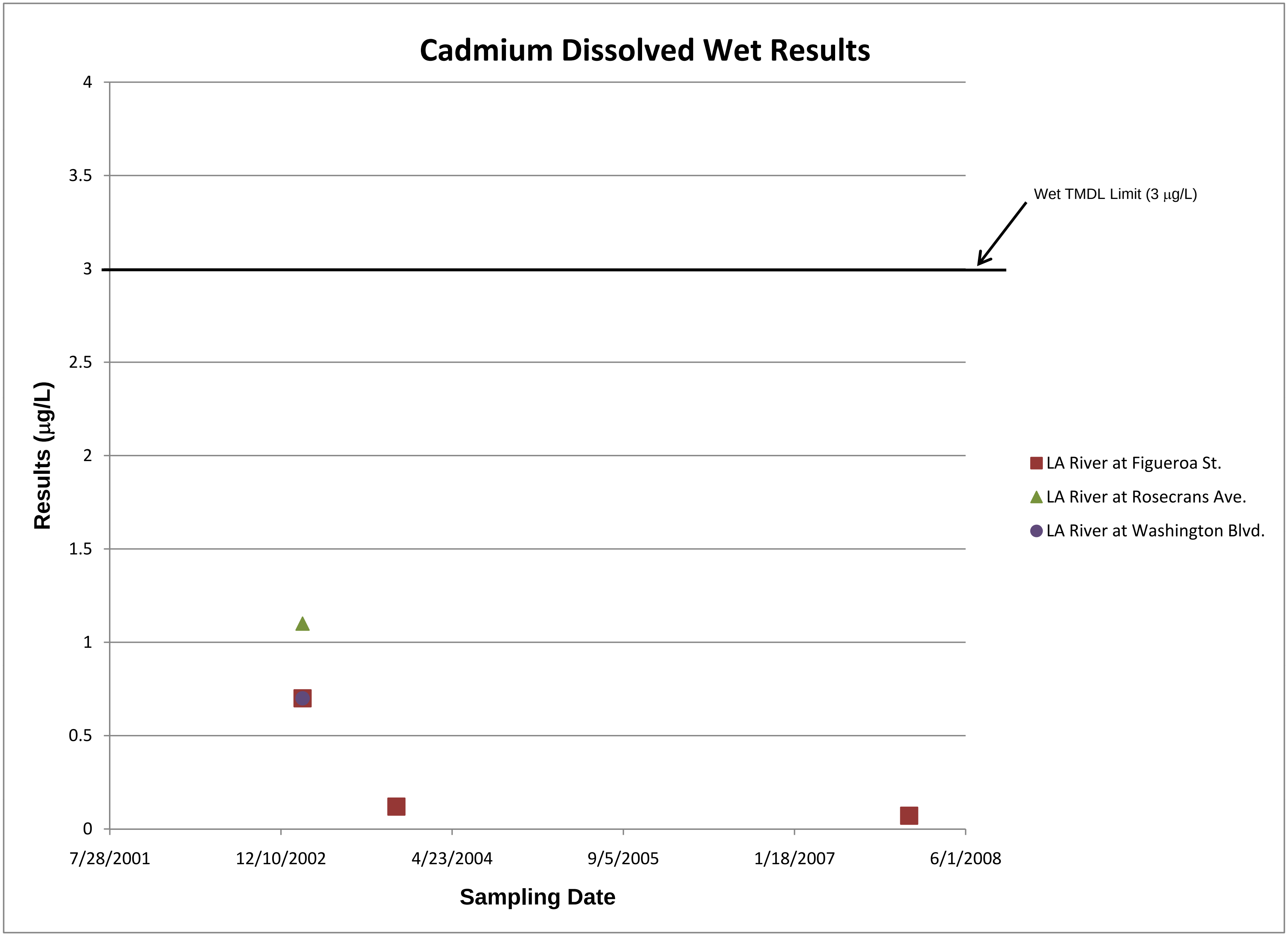


Figure A-2 Cadmium Total Wet Weather Sample Results

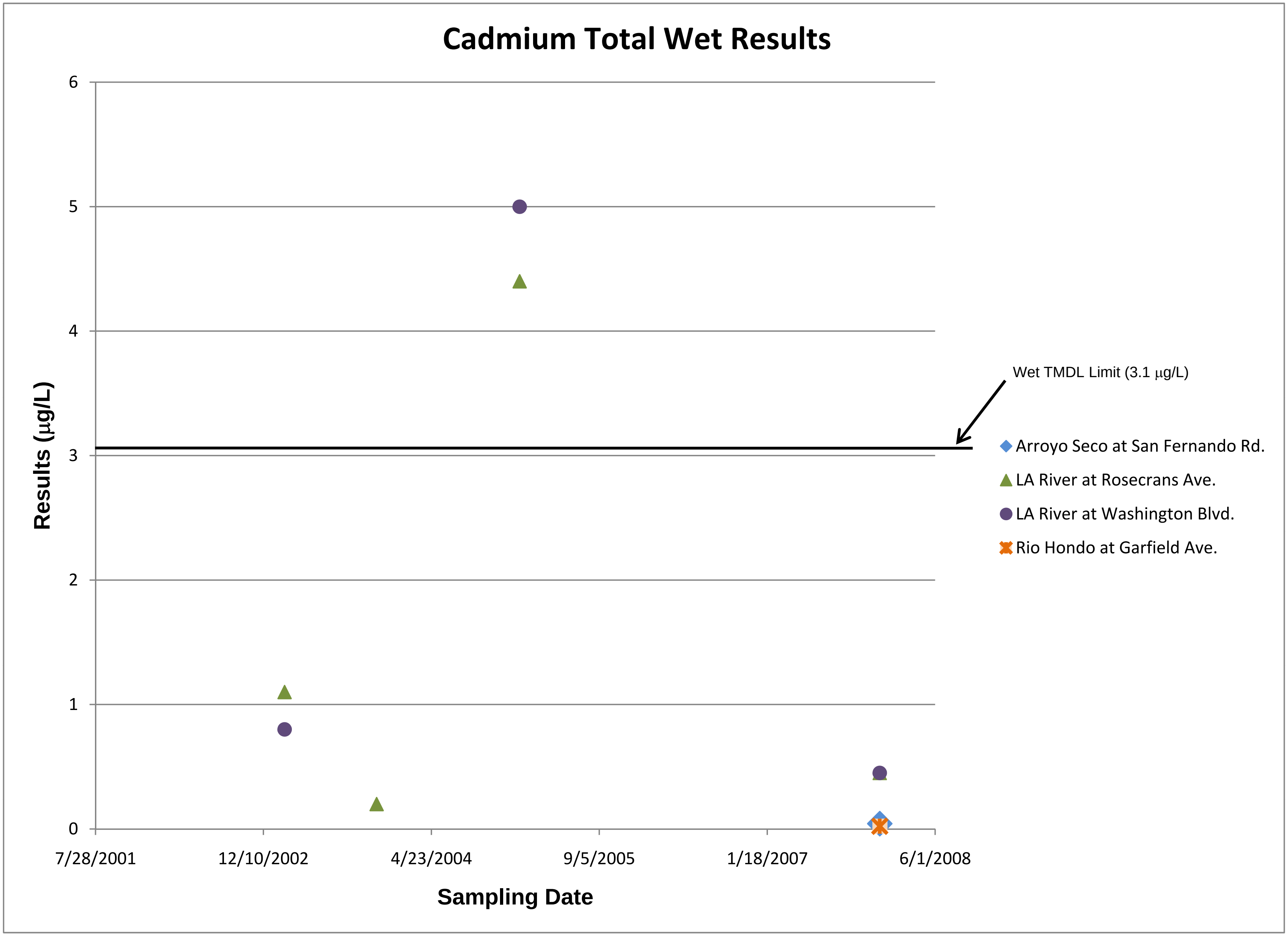


Figure A-3 Copper Dissolved Wet Weather Sample Results for Arroyo Seco

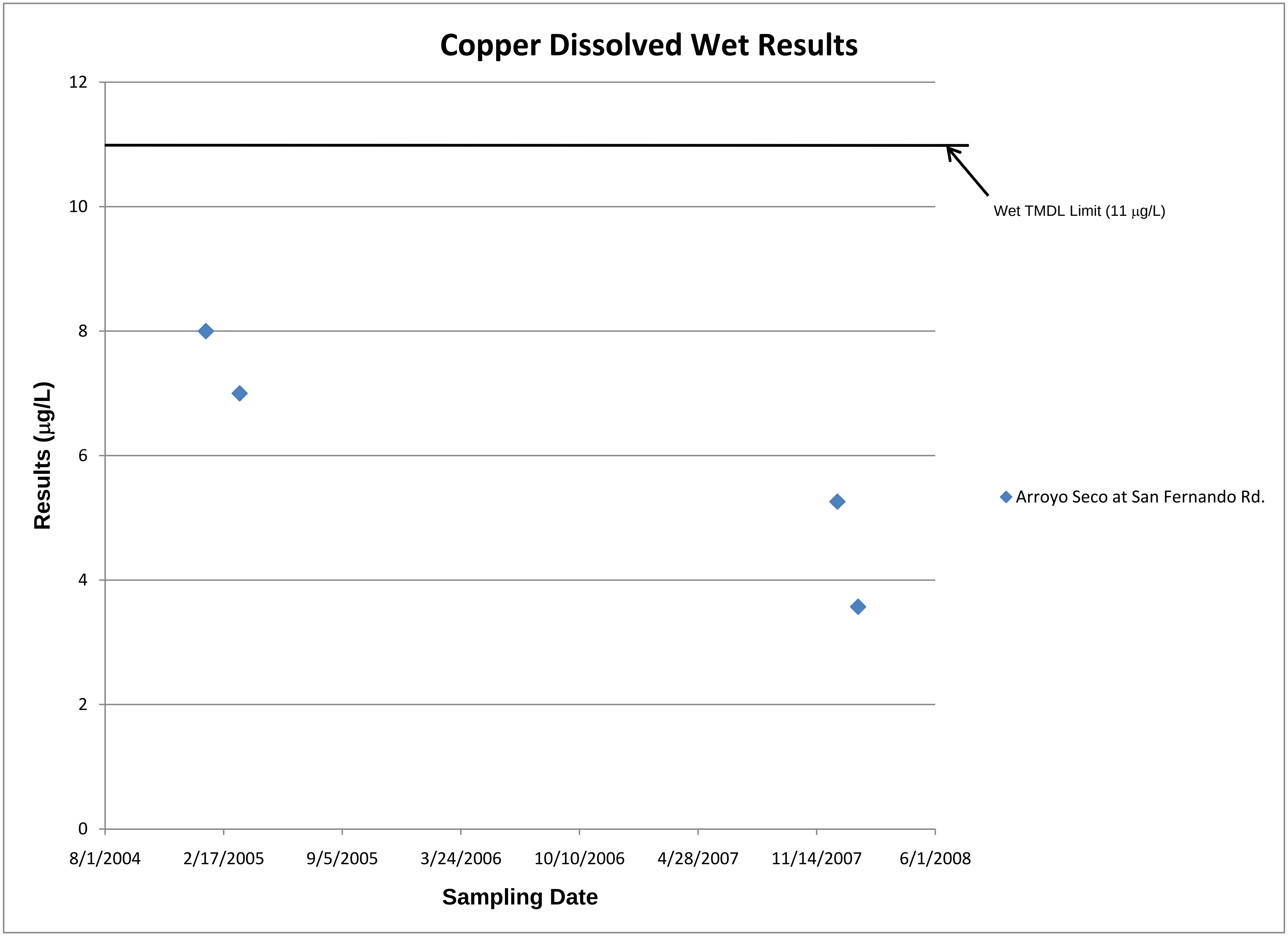


Figure A-4 Copper Dissolved Wet Weather Sample Results for LA River at Rosecrans Ave. and Washington Blvd. (Reach 2)

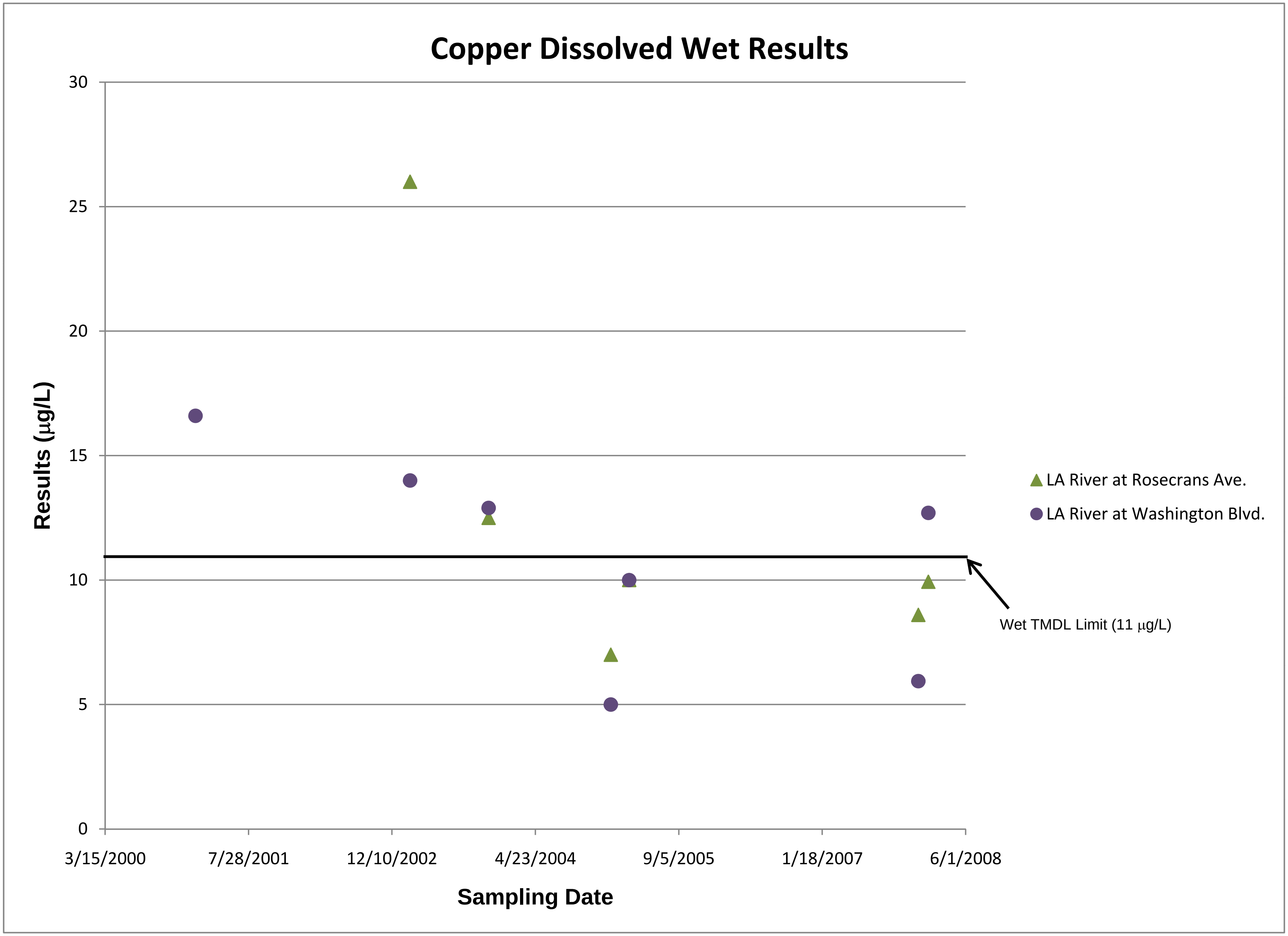


Figure A-5 Copper Dissolved Wet Weather Sample Results for Rio Hondo at Garfield Avenue

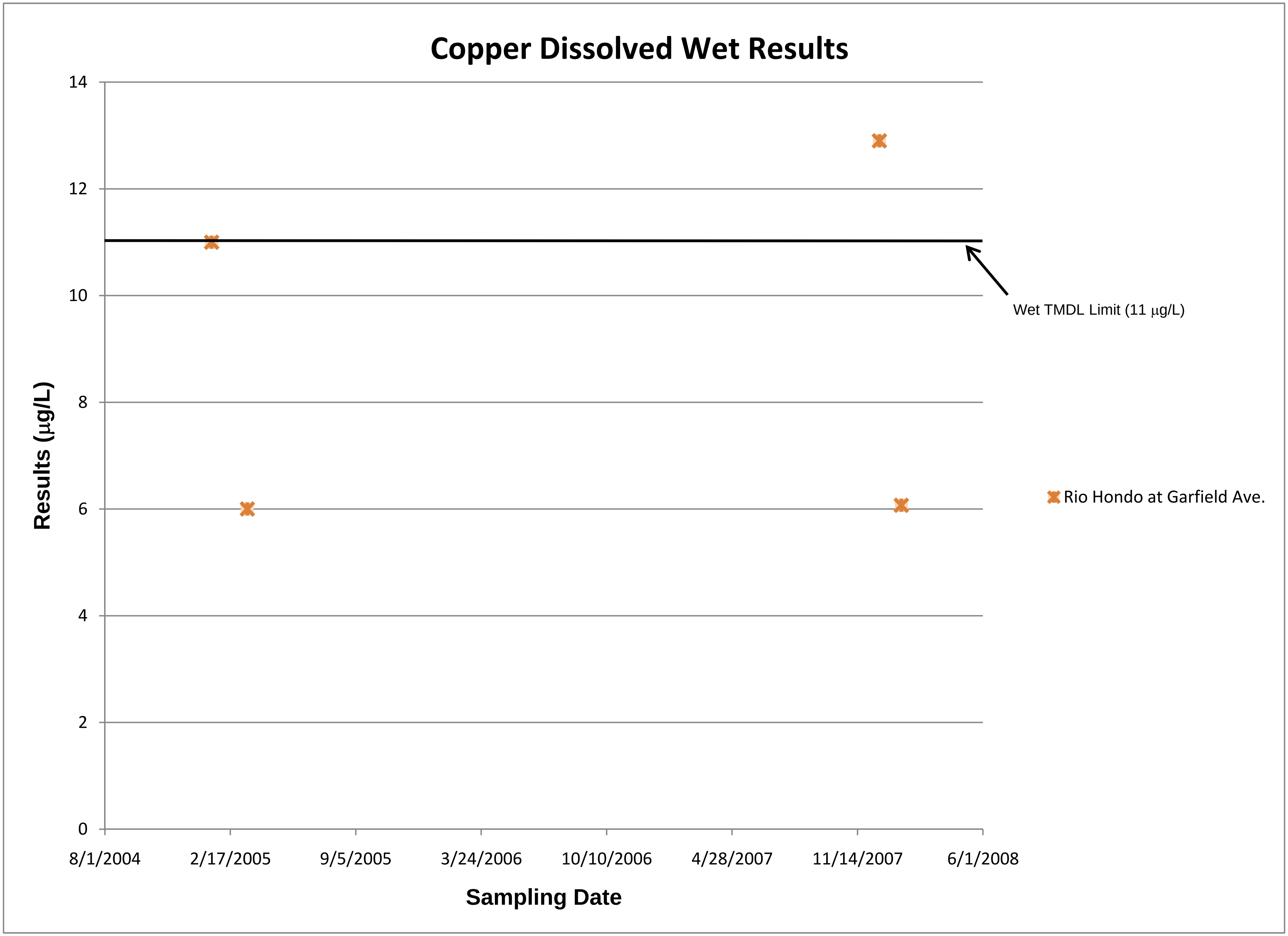


Figure A-6 Copper Dissolved Wet Weather Sample Results for LA River at Figueroa Street (Reach 3)

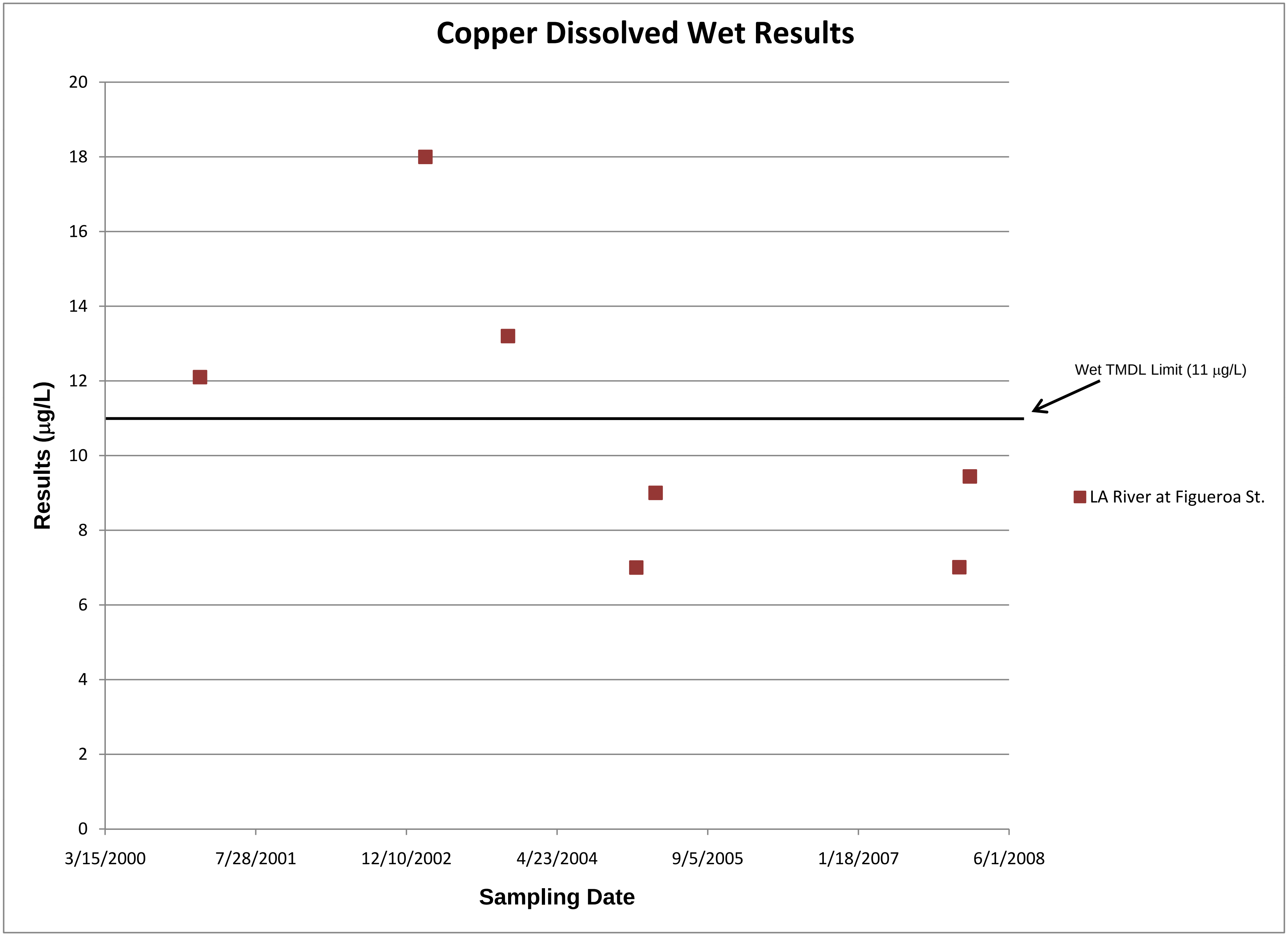


Figure A-7 Copper Total Wet Weather Sample Results for Arroyo Seco

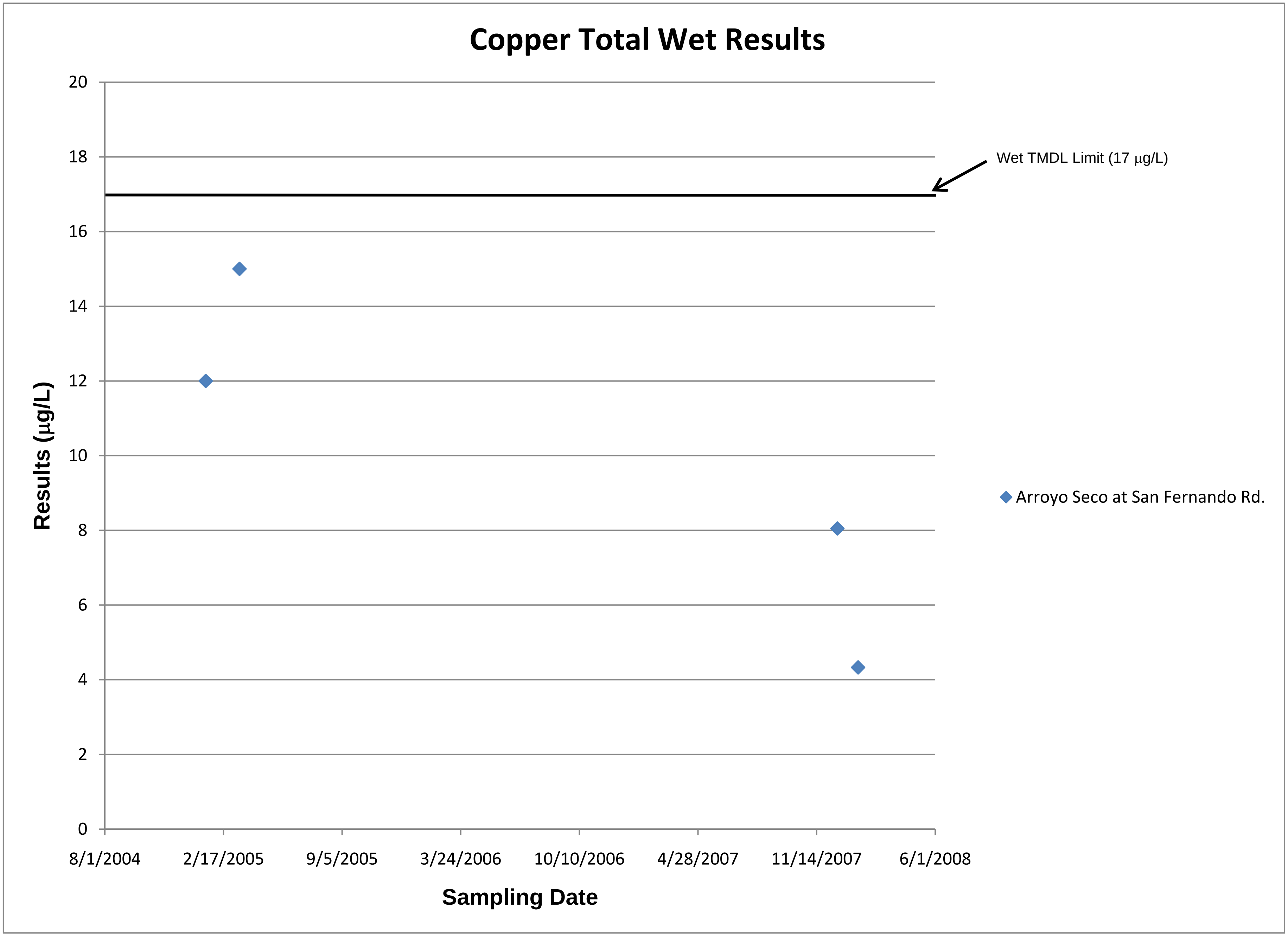


Figure A-8 Copper Total Wet Weather Sample Results for LA River at Rosecrans Ave. and Washington Blvd. (Reach 2)

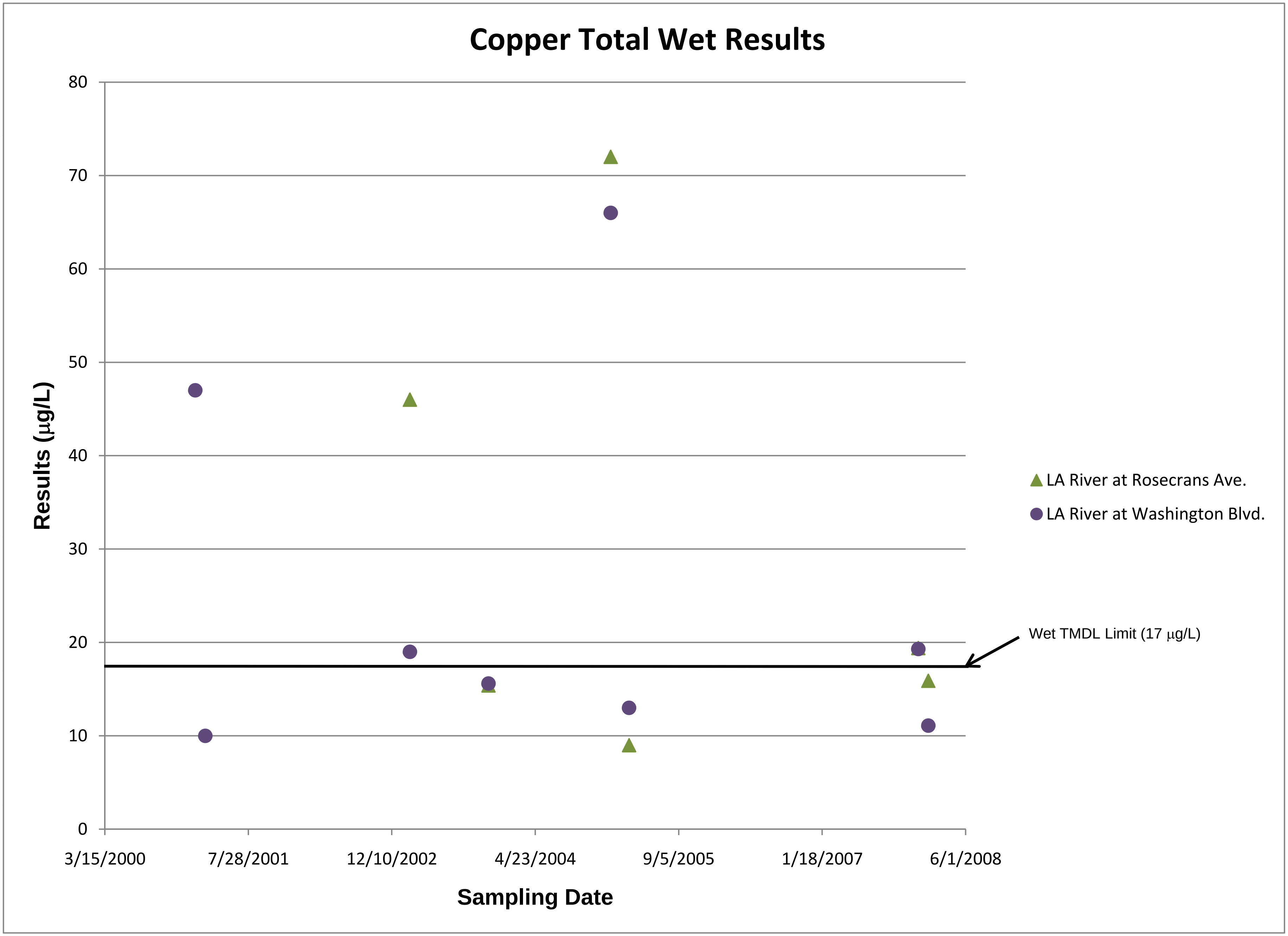


Figure A-9 Copper Total Wet Weather Sample Results for Rio Hondo at Garfield Avenue

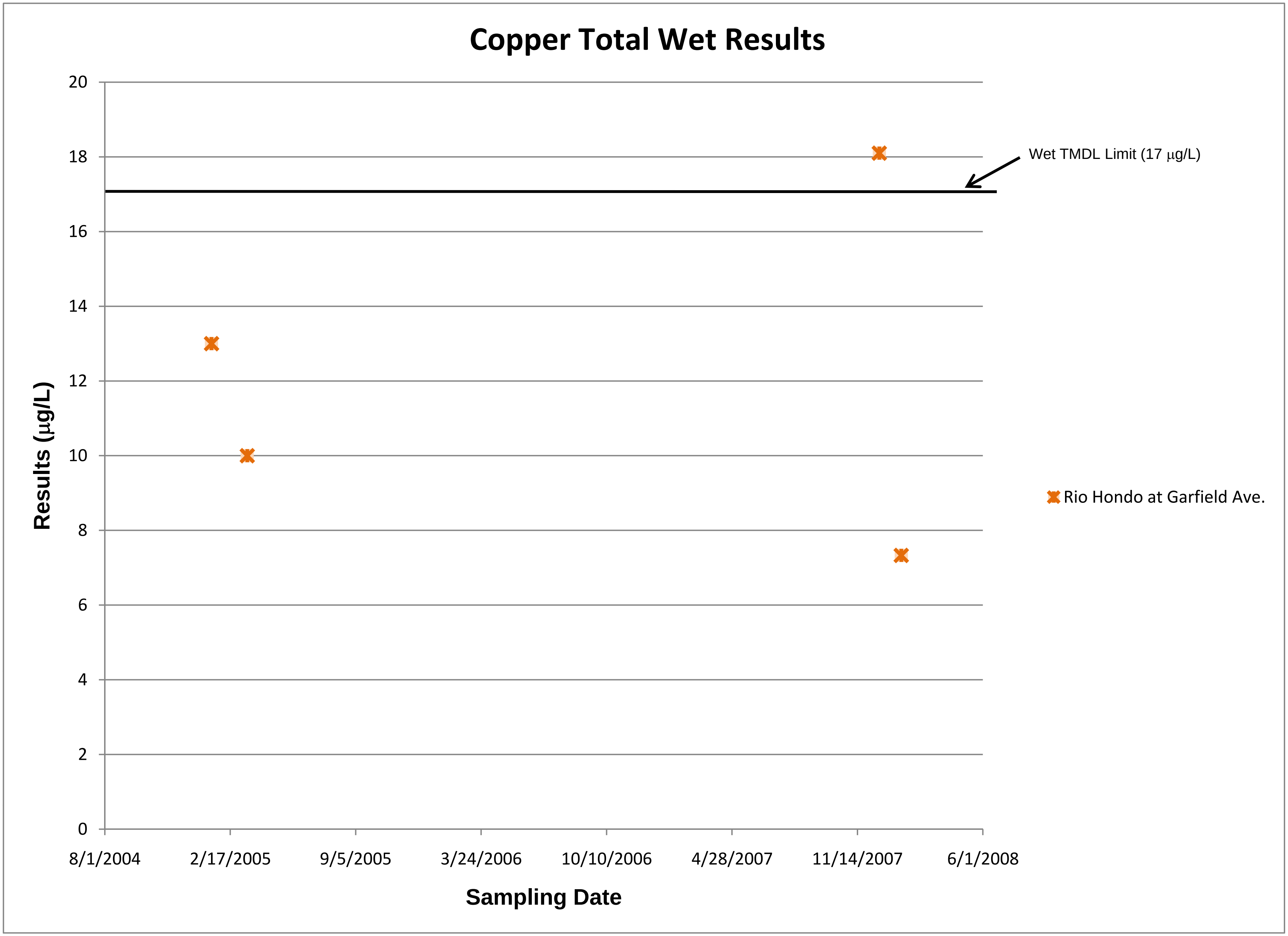


Figure A-10 Copper Total Wet Weather Sample Results for LA River at Figueroa Street (Reach 3)

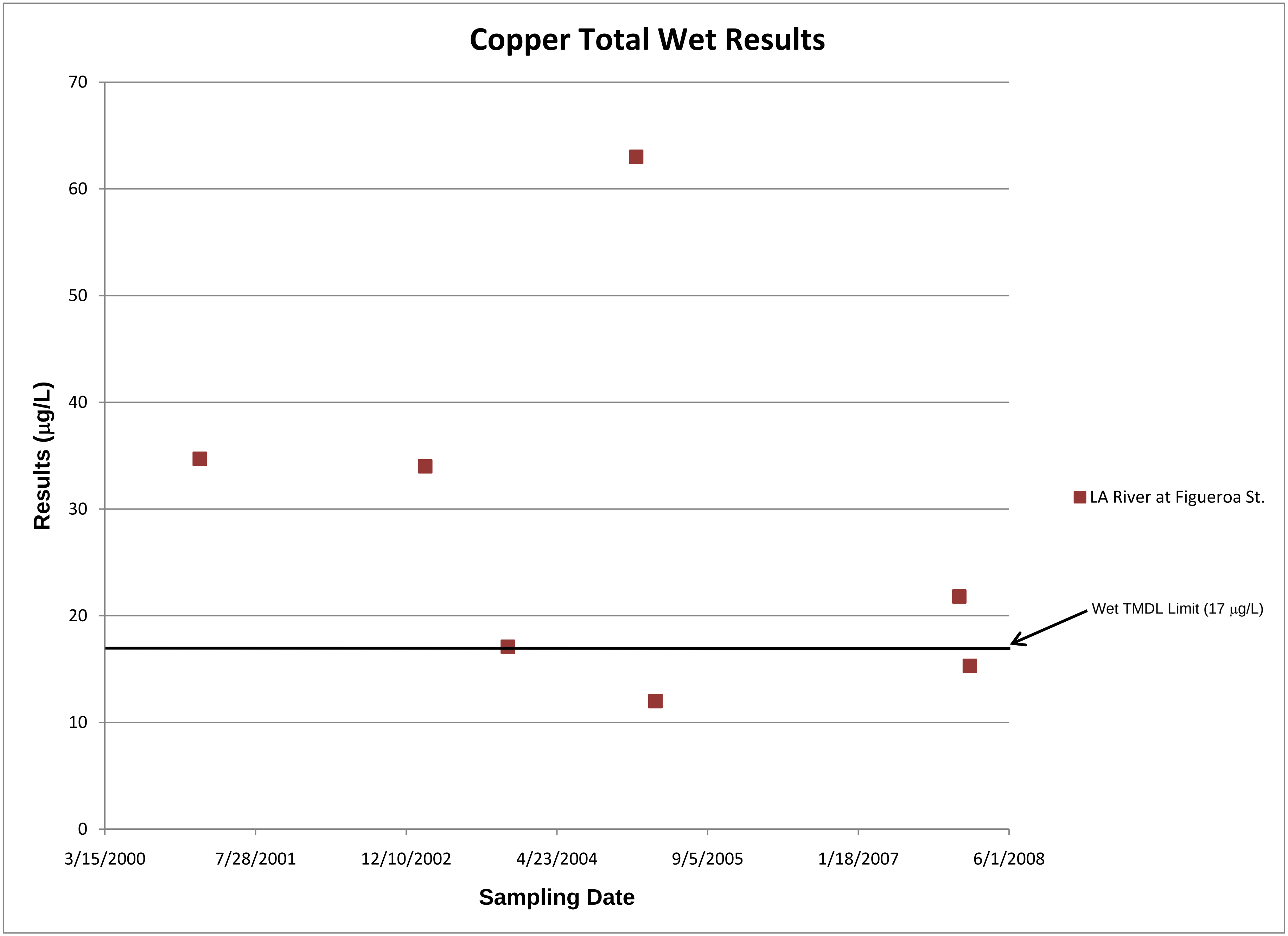


Figure A-11 Lead Dissolved Wet Weather Sample Results

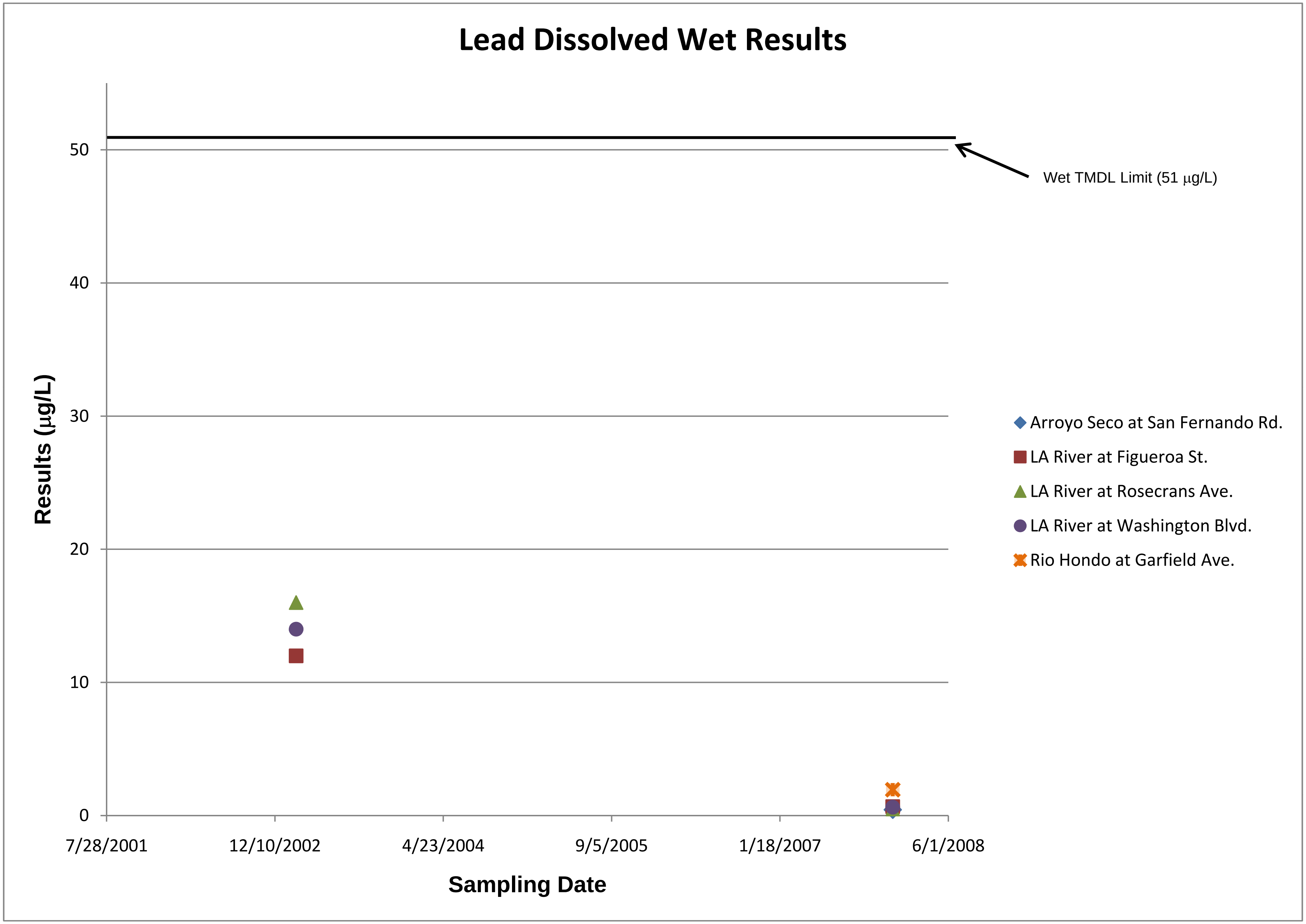


Figure A-12 Lead Total Wet Weather Sample Results

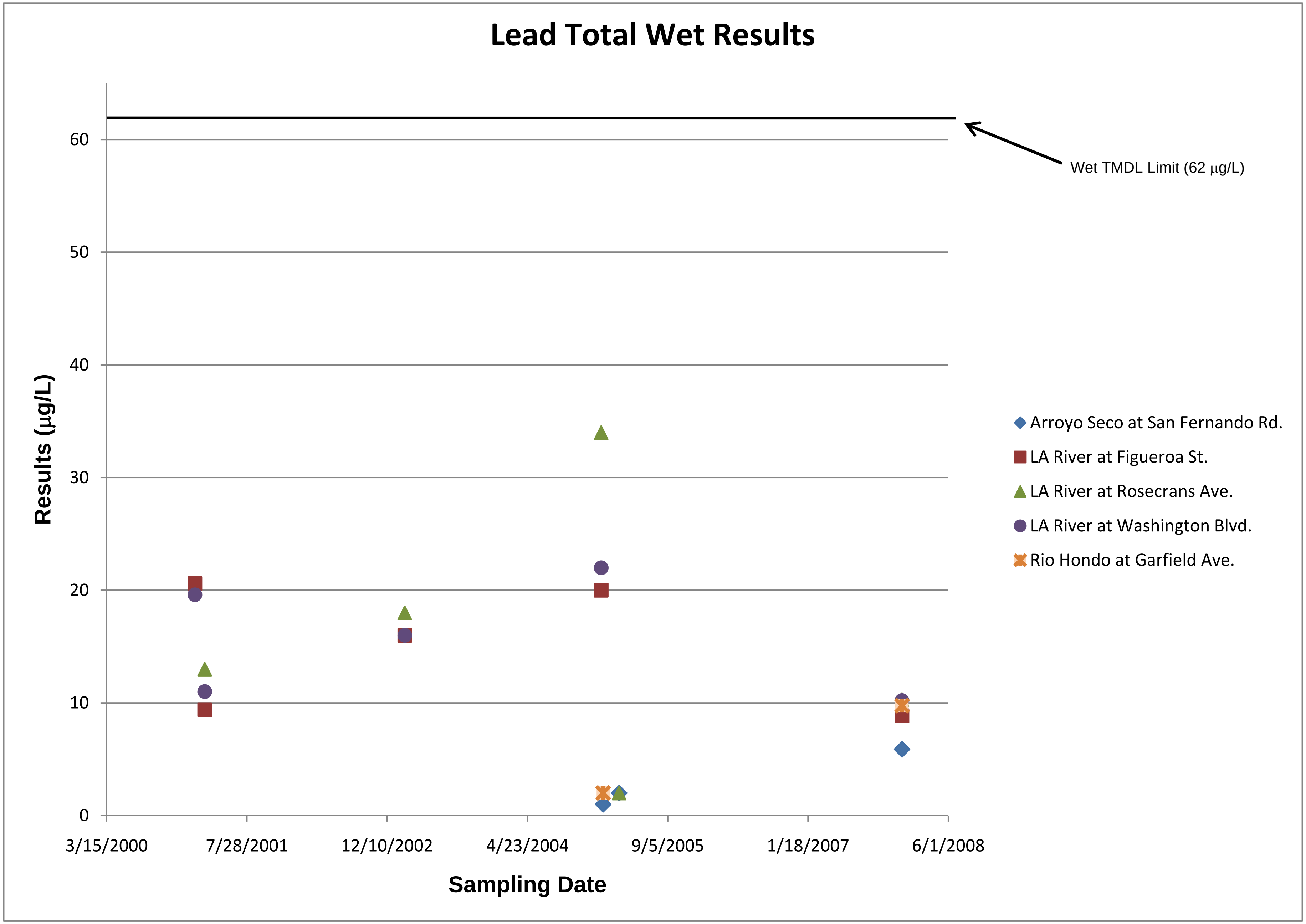


Figure A-13 Zinc Dissolved Wet Weather Sample Results

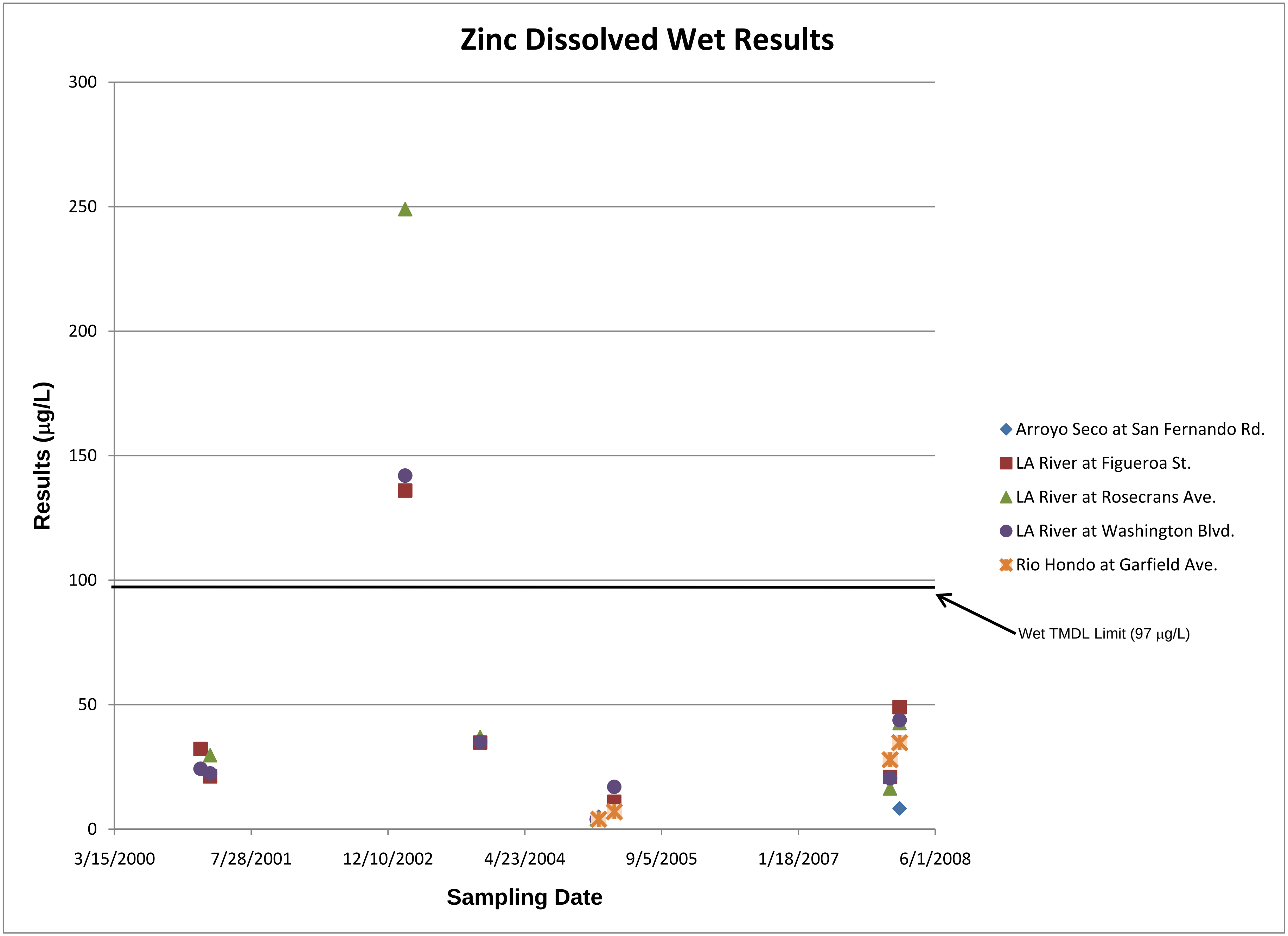


Figure A-14 Zinc Total Wet Weather Sample Results

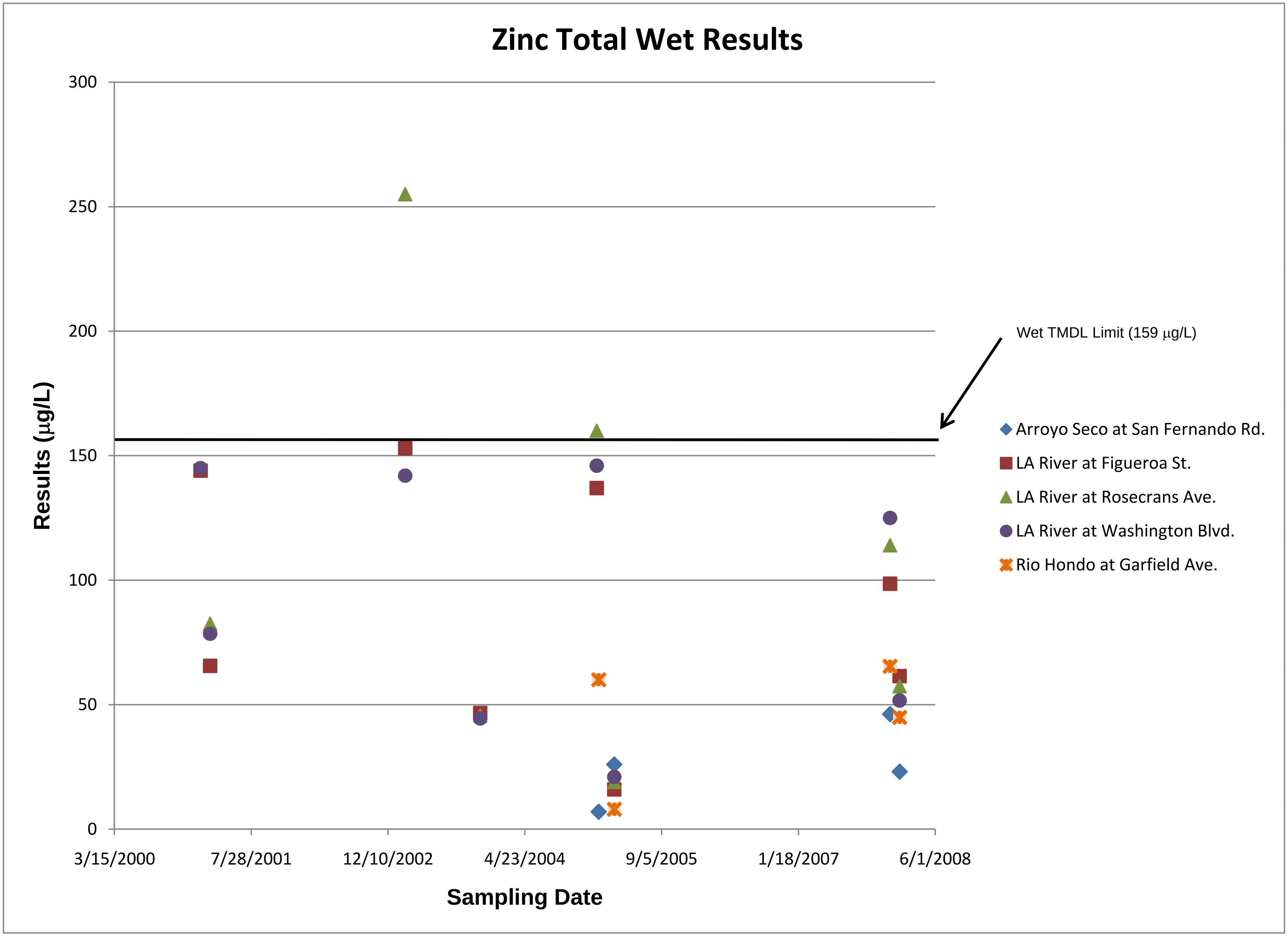


Figure A-15 Cadmium Dissolved Dry Weather Sample Results

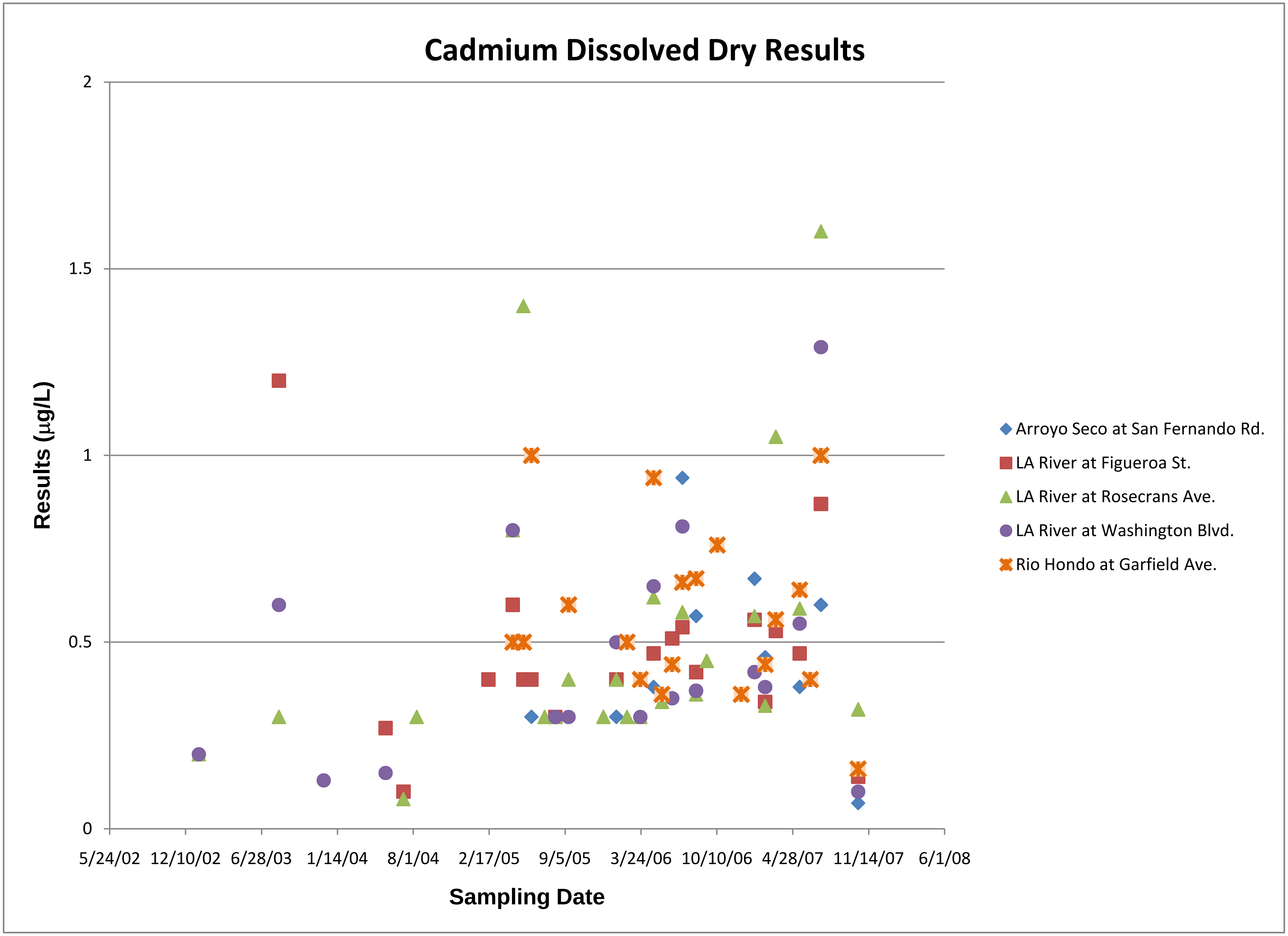


Figure A-16 Cadmium Total Dry Weather Sample Results

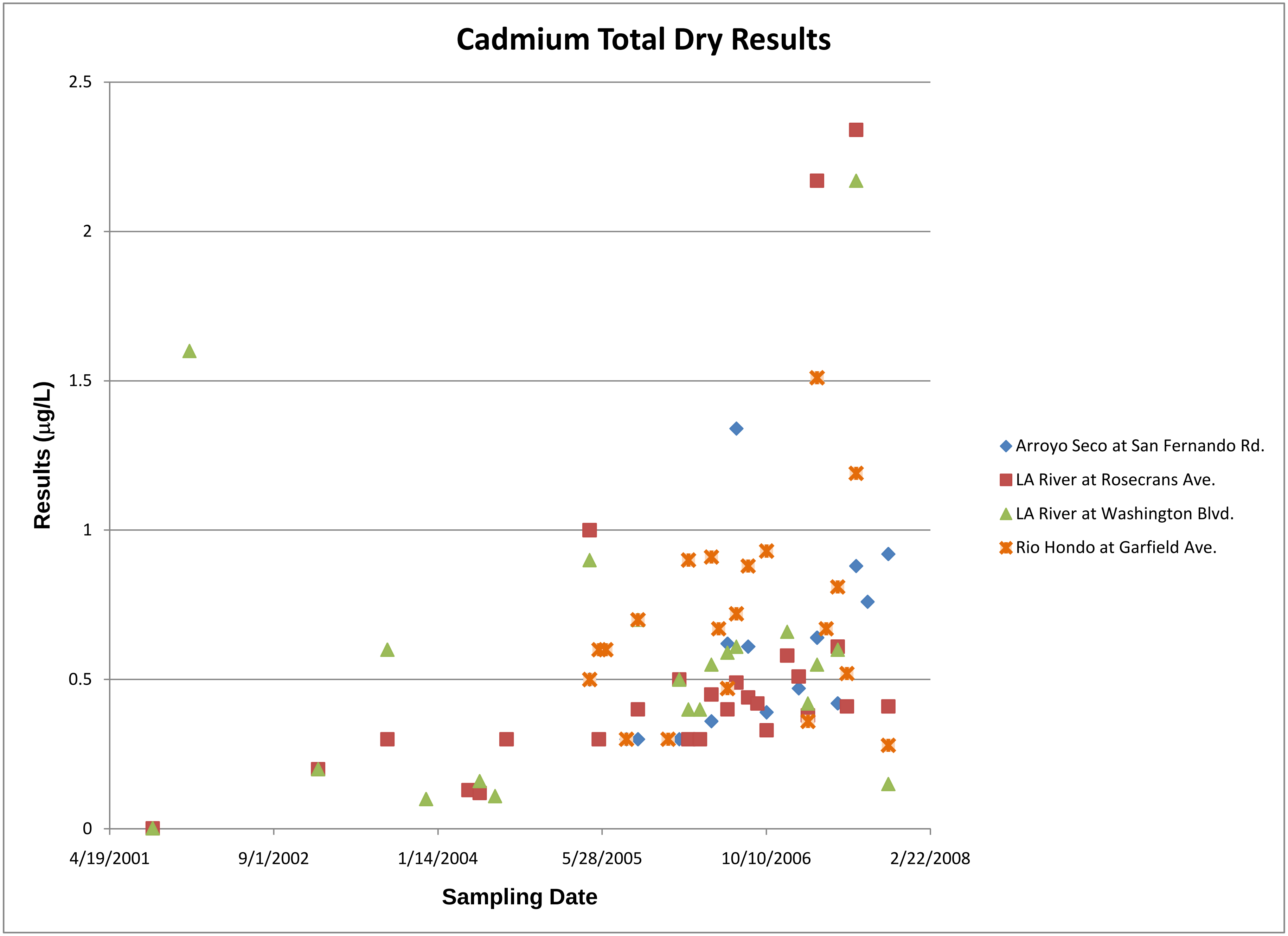


Figure A-17 Copper Dissolved Dry Weather Sample Results for Arroyo Seco

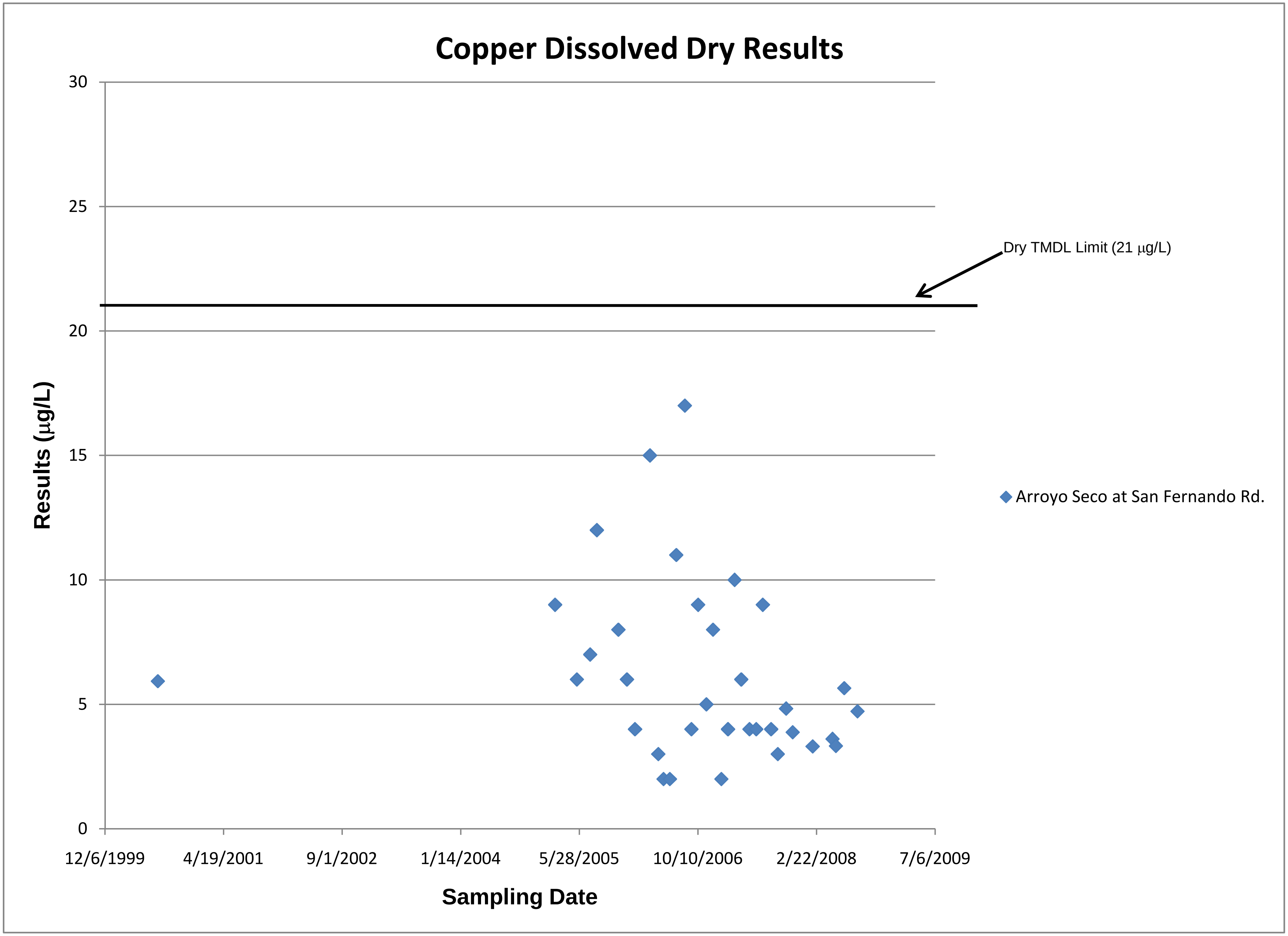


Figure A-18 Copper Dissolved Dry Weather Sample Results for LA River at Rosecrans Ave. and Washington Blvd. (Reach 2)

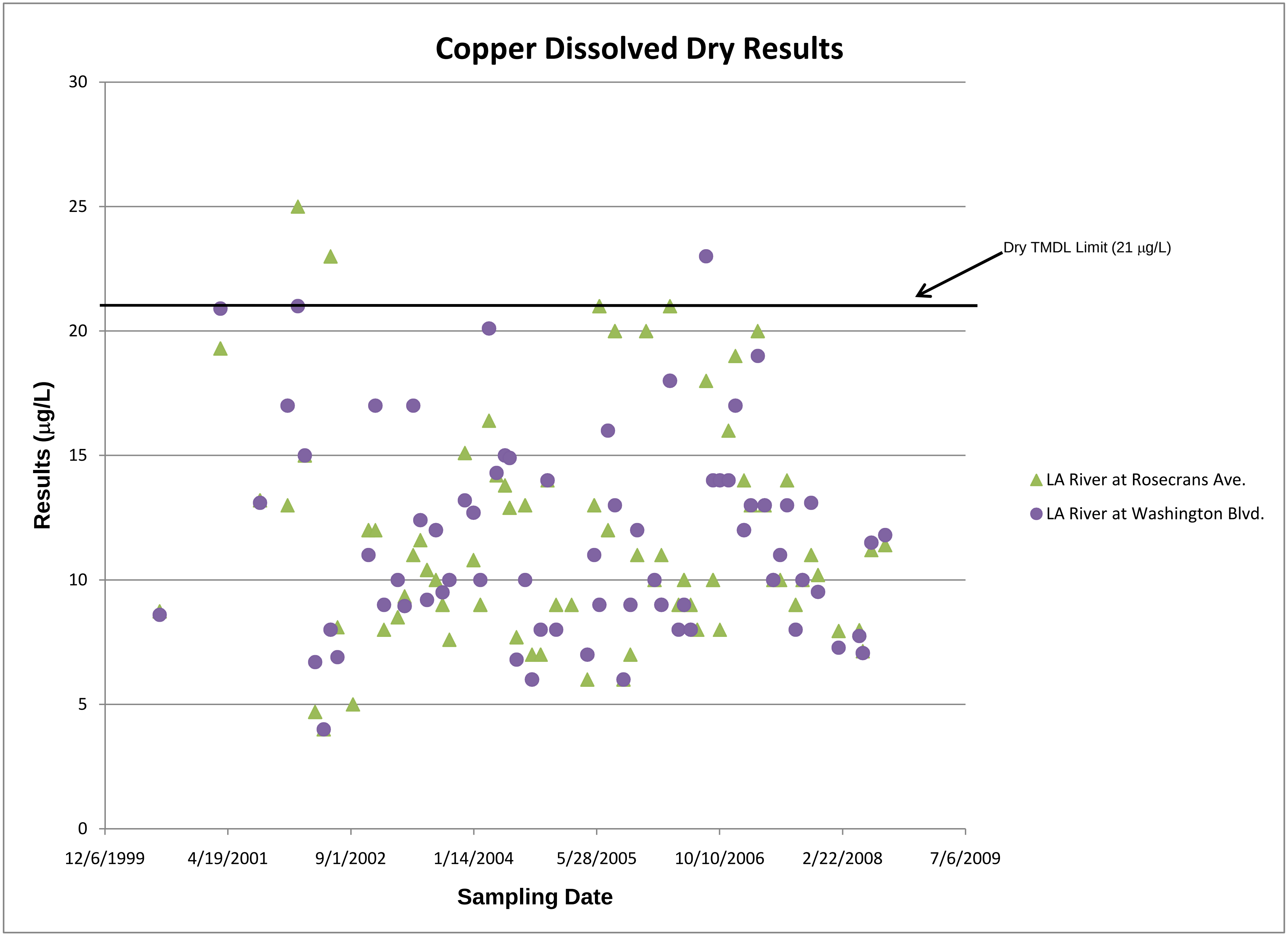
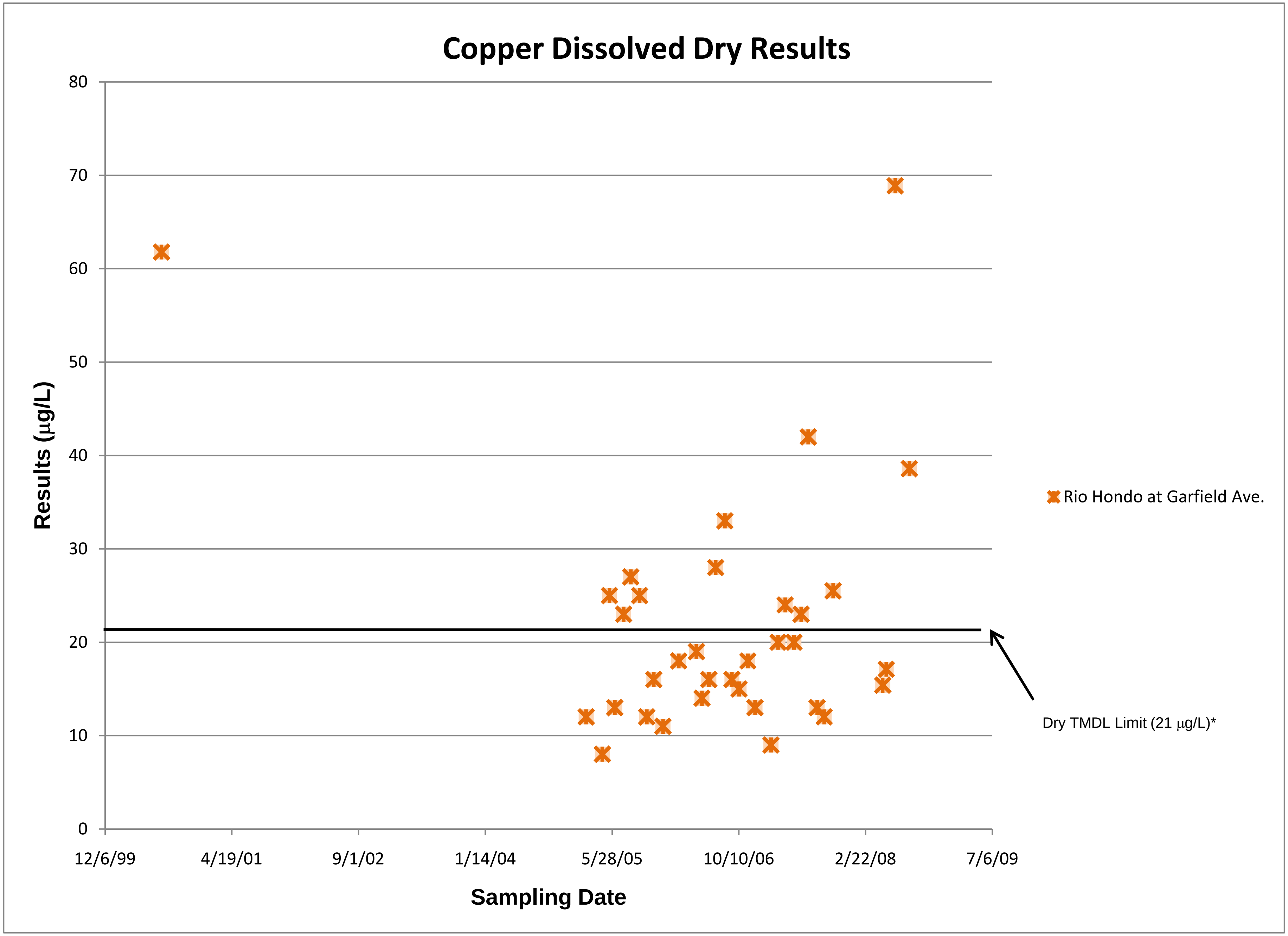


Figure A-19 Copper Dissolved Dry Weather Sample Results for Rio Hondo at Garfield Avenue



**Note: California Toxics Rule (CTR) criteria recomplied using recent dry weather hardness measurements.*

Figure A-20 Copper Dissolved Dry Weather Sample Results for LA River at Figueroa Street (Reach 3)

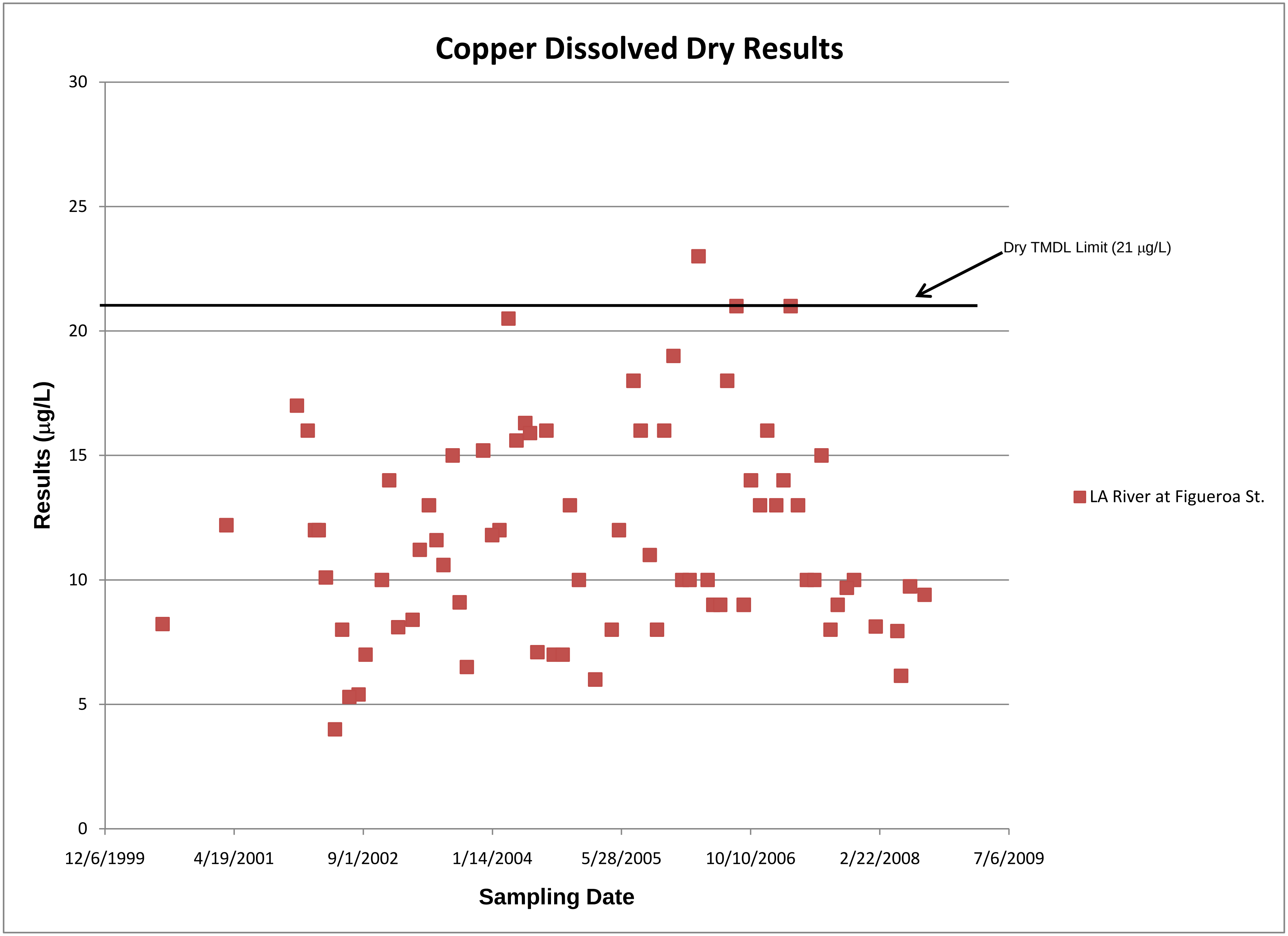


Figure A-21 Copper Total Dry Weather Sample Results for LA River at Rosecrans Ave. and Washington Blvd. (Reach 2)

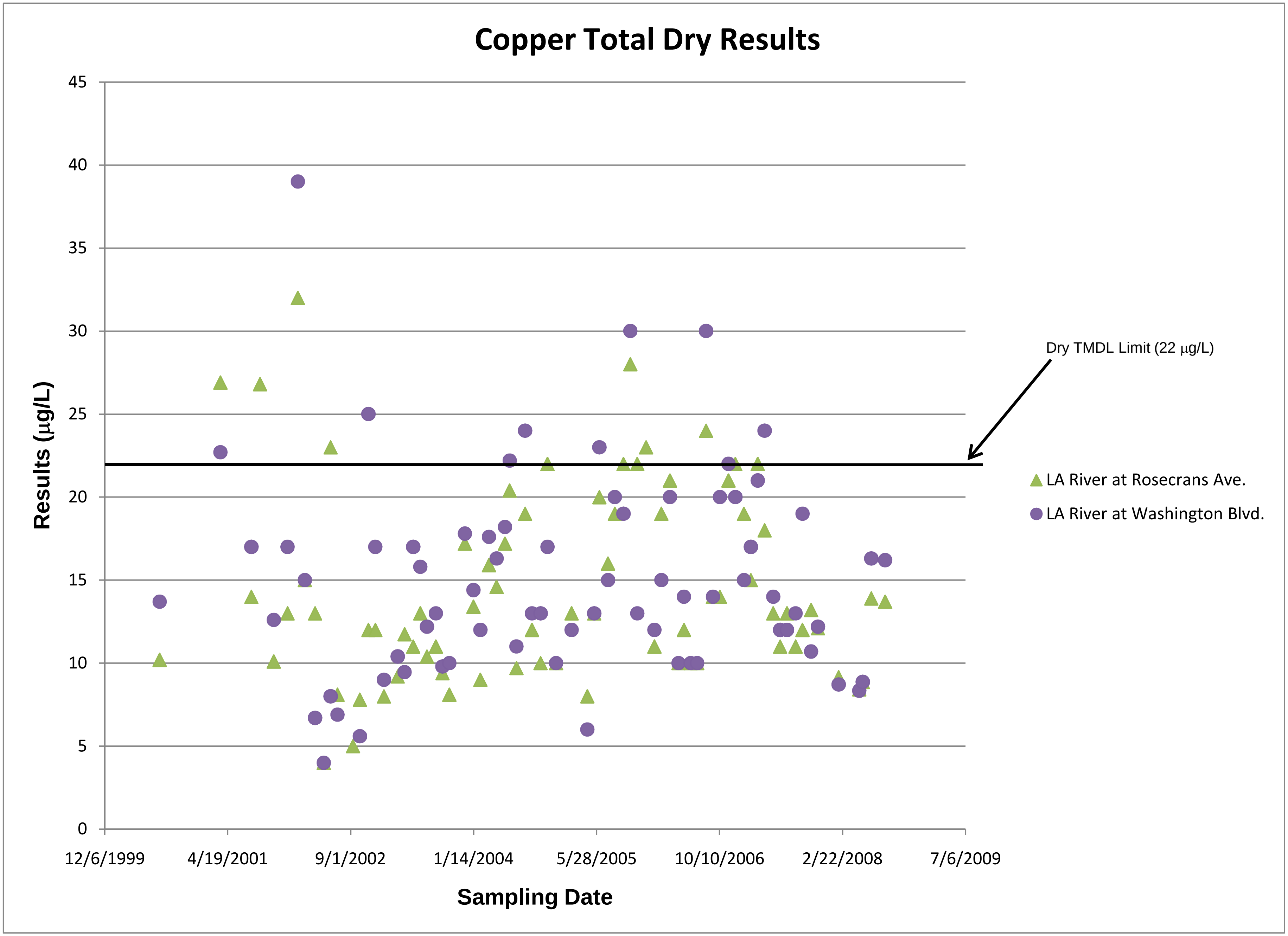
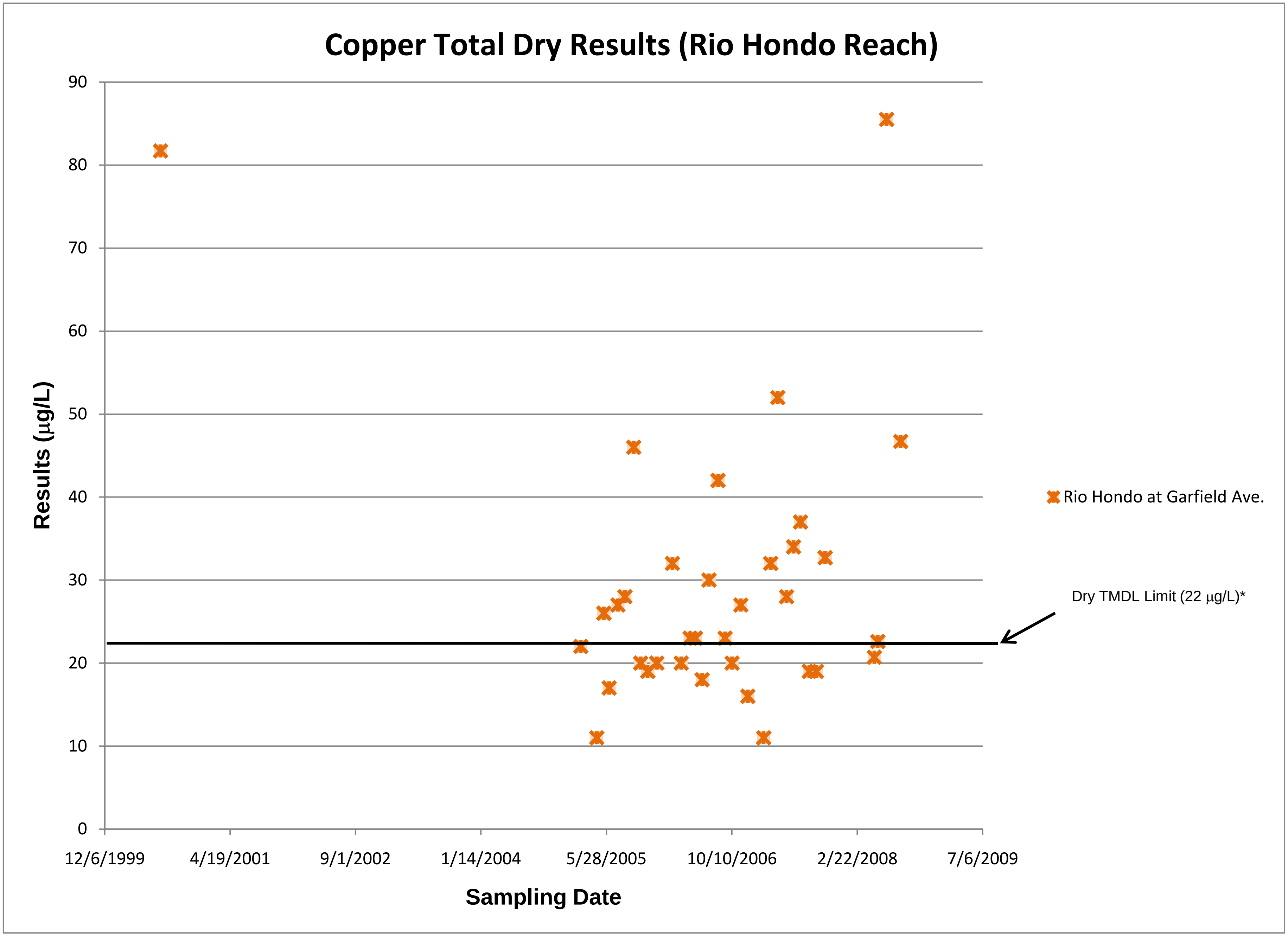


Figure A-22 Copper Total Dry Weather Sample Results for Rio Hondo at Garfield Avenue



**Note: California Toxics Rule (CTR) criteria recomplied using recent dry weather hardness measurements.*

Figure A-23 Copper Total Dry Weather Sample Results for LA River at Figueroa Street (Reach 3)

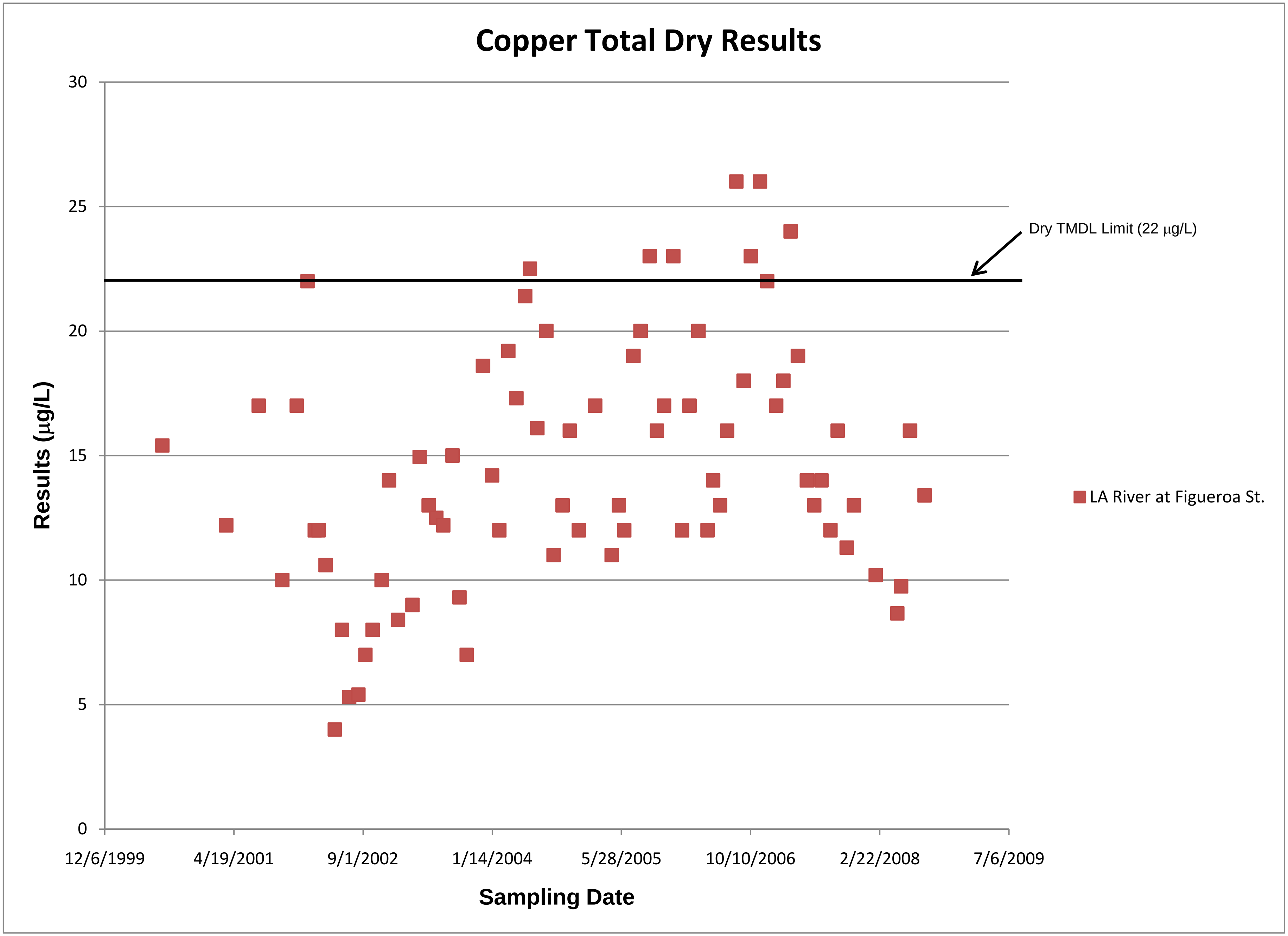


Figure A-24 Lead Dissolved Dry Weather Sample Results for Arroyo Seco

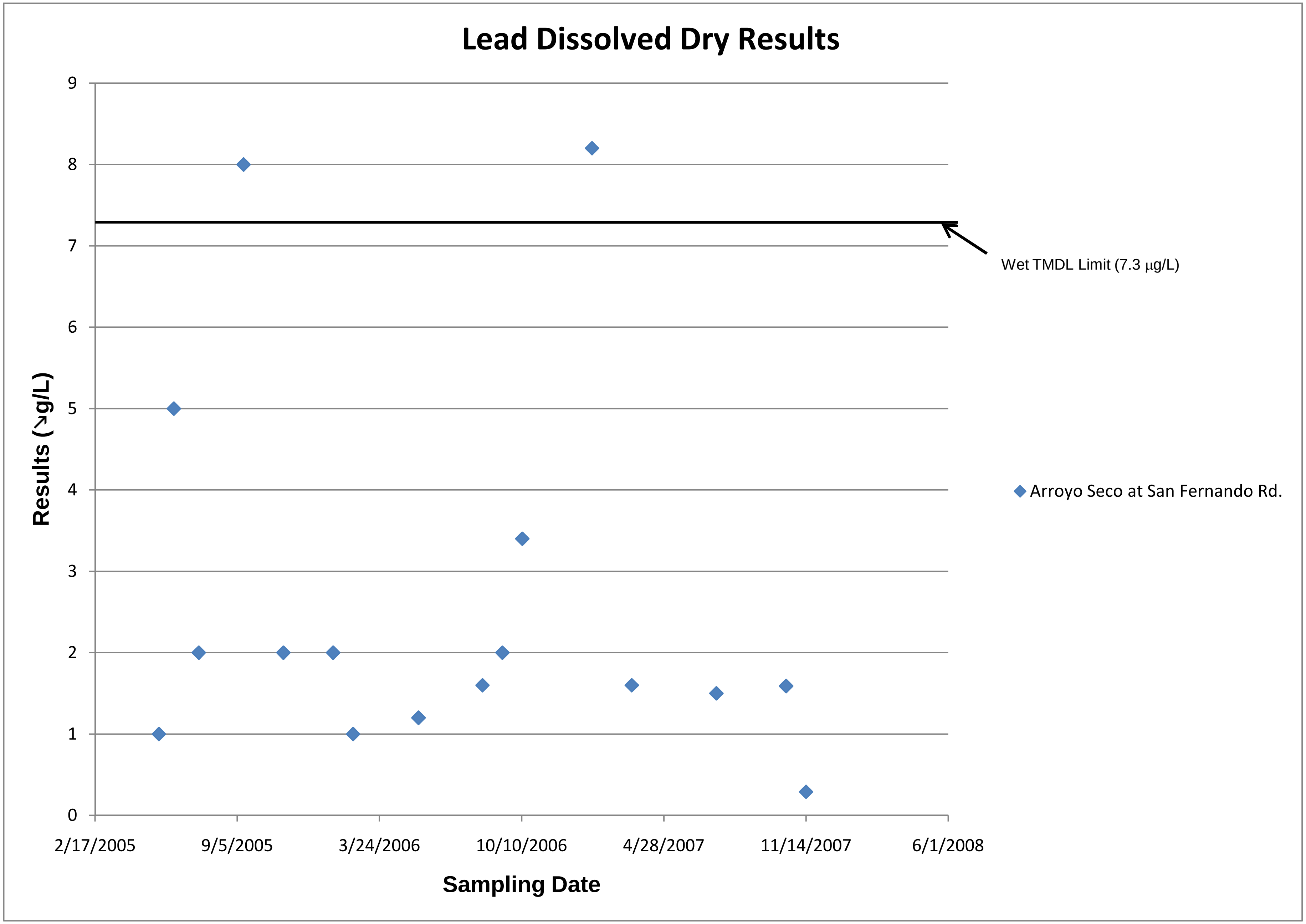


Figure A-25 Lead Dissolved Dry Weather Sample Results for LA River at Rosecrans Ave. and Washington Blvd. (Reach 2)

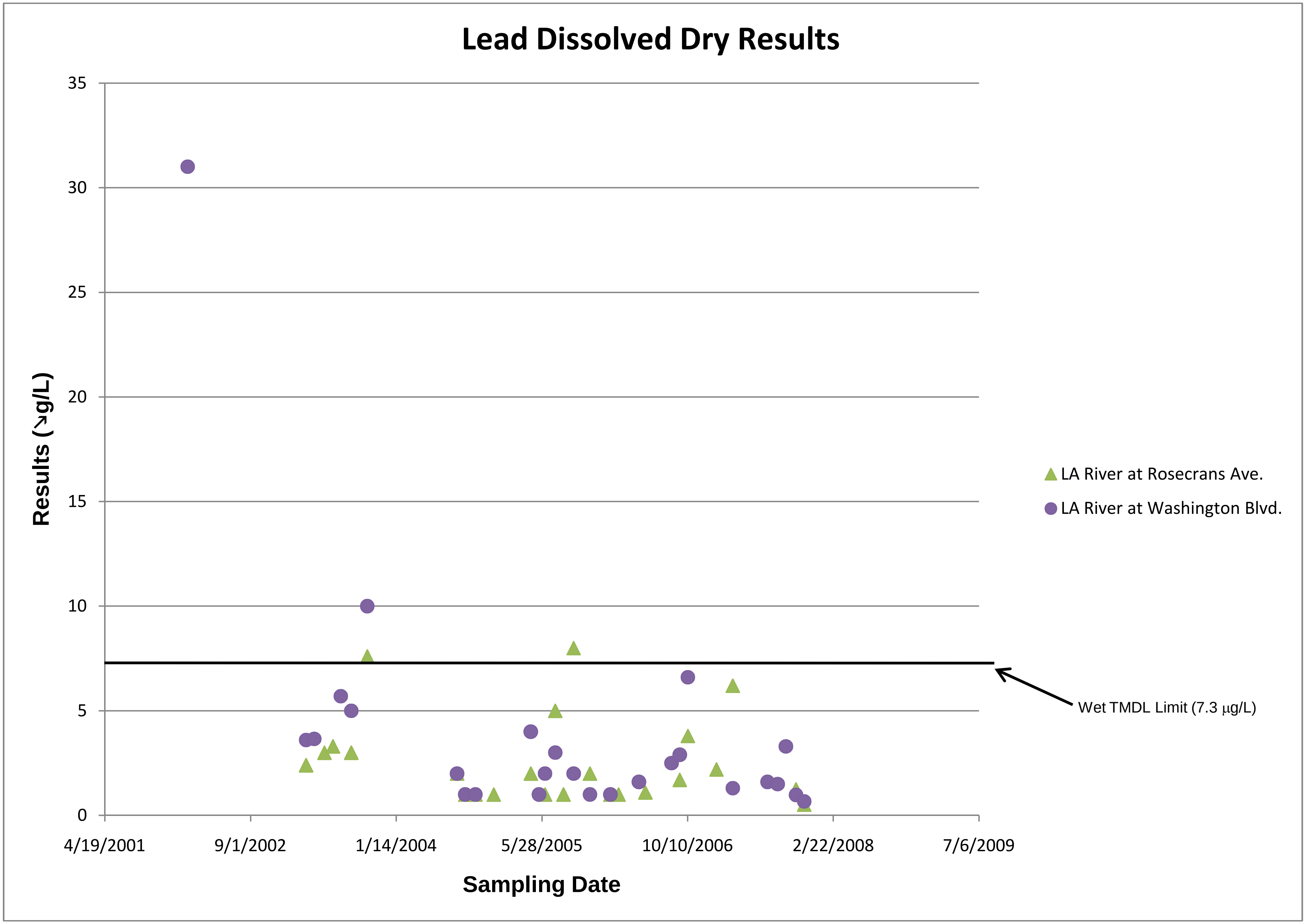
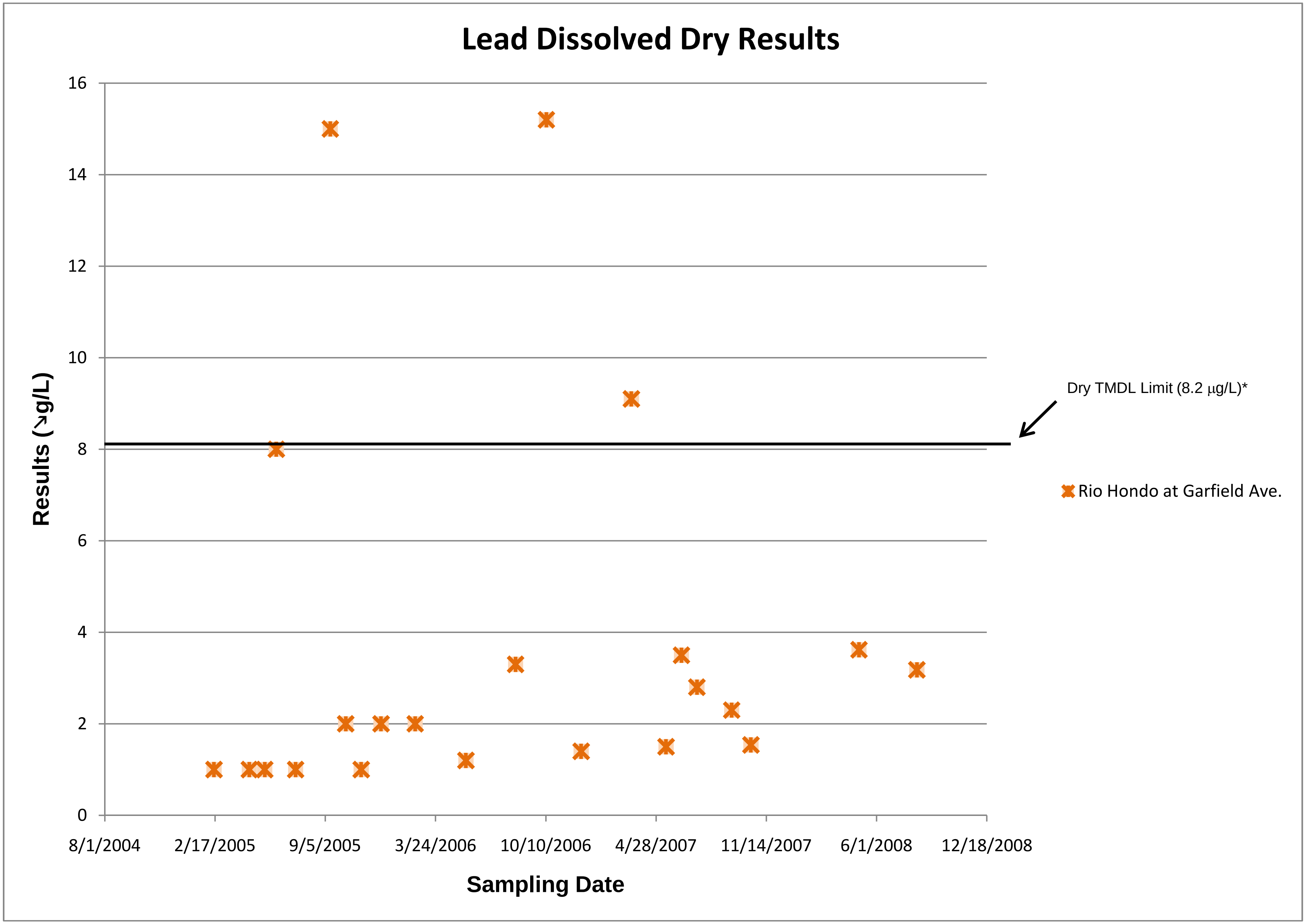


Figure A-26 Lead Dissolved Dry Weather Sample Results for Rio Hondo Reach



**Note: California Toxics Rule (CTR) criteria recomplied using recent dry weather hardness measurements.*

Figure A-27 Lead Dissolved Dry Weather Sample Results for LA River at Figueroa (Reach 3)

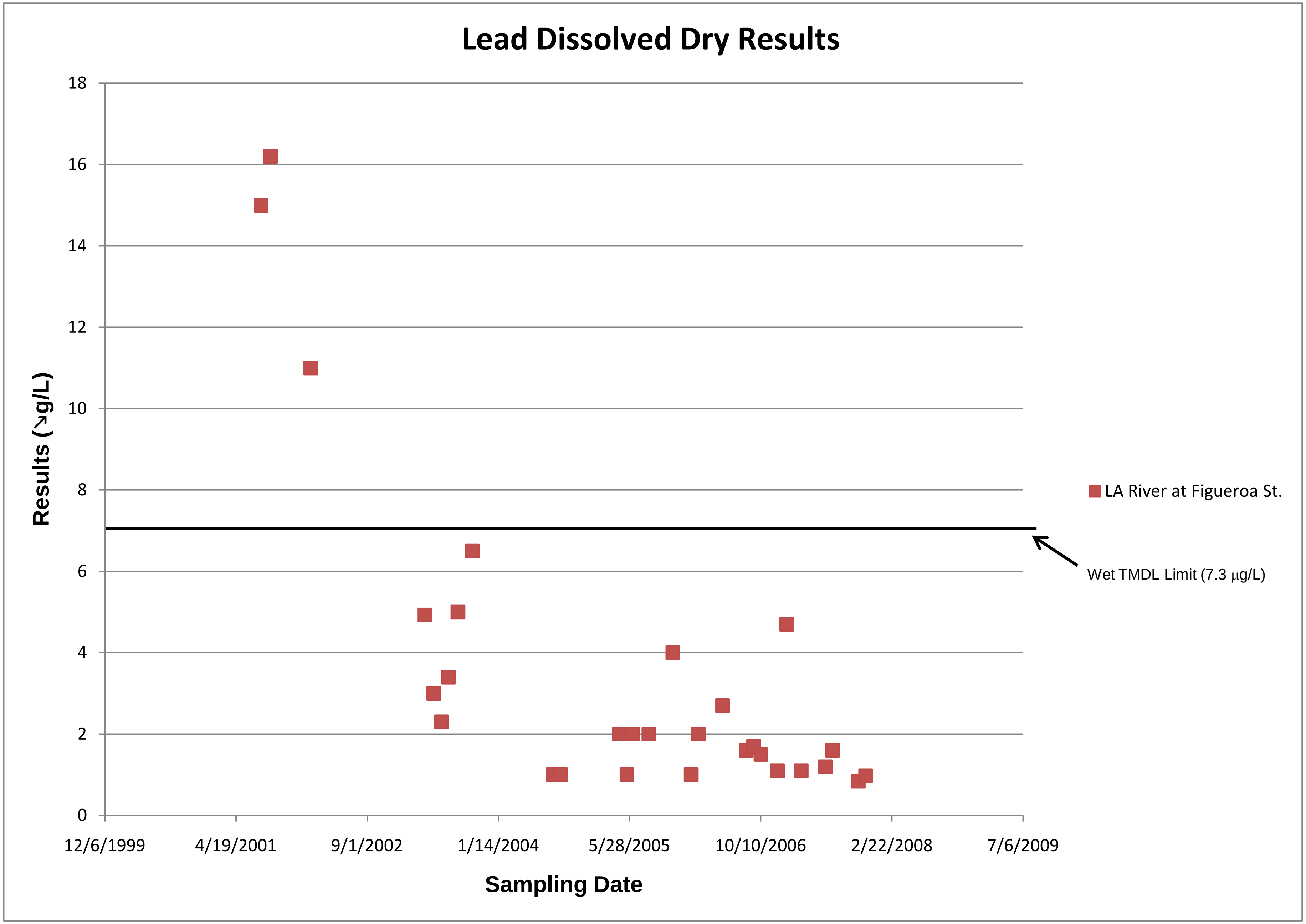


Figure A-28 Lead Total Dry Weather Sample Results for Arroyo Seco

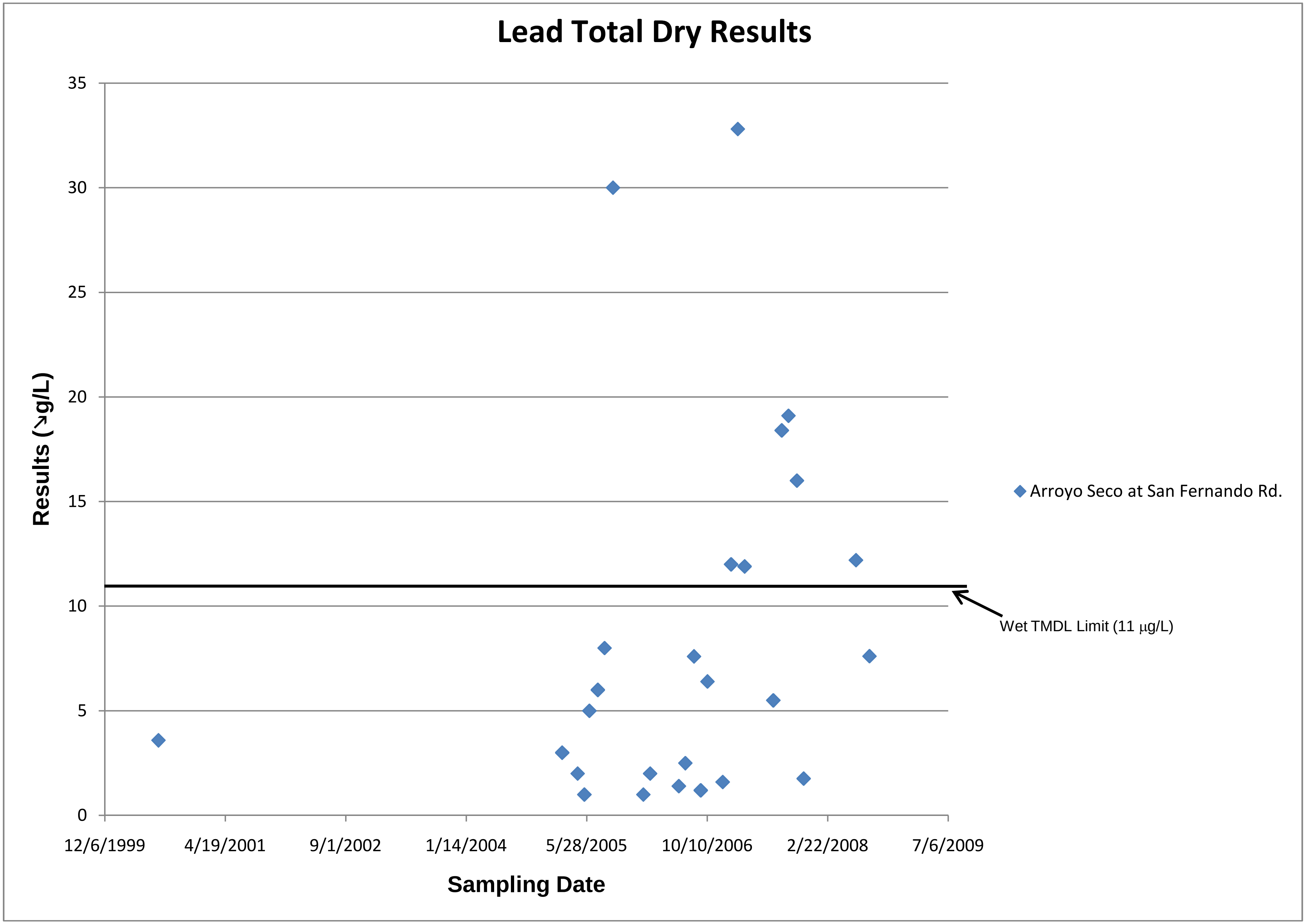


Figure A-29 Lead Total Dry Weather Sample Results for LA River at Rosecrans Ave. and Washington Blvd. (Reach 2)

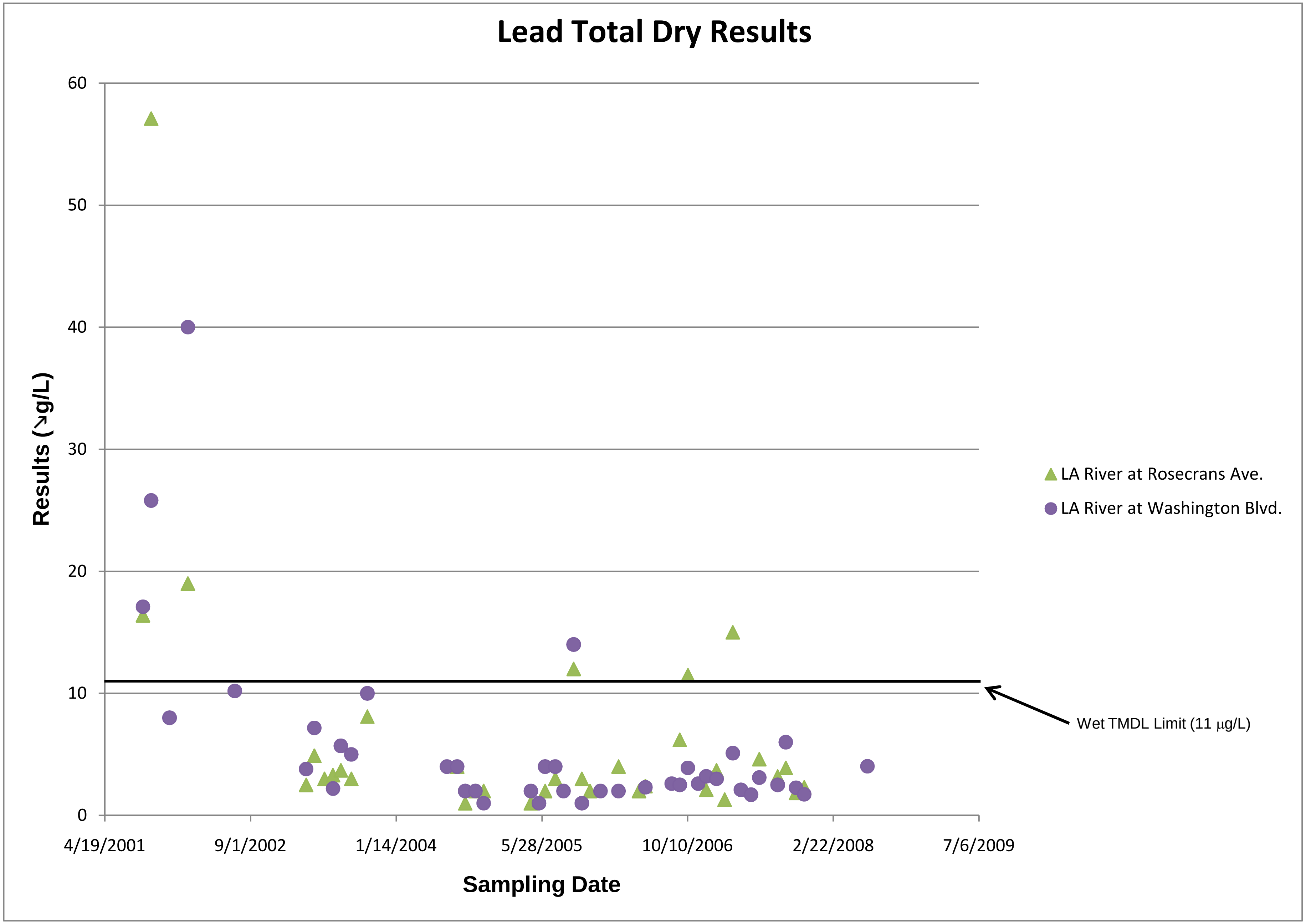
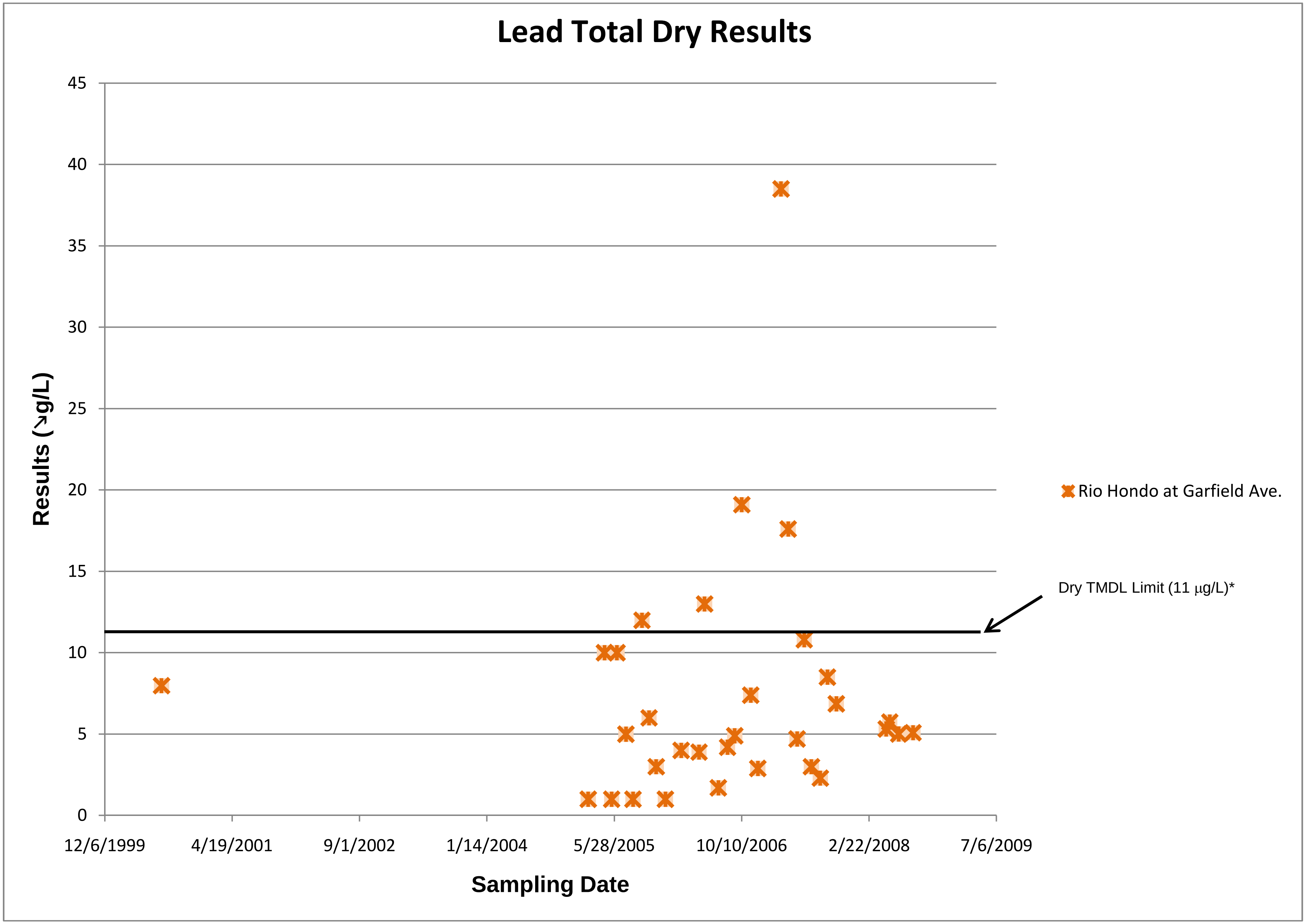


Figure A-30 Lead Total Dry Weather Sample Results for Rio Hondo Reach



**Note: California Toxics Rule (CTR) criteria recomplied using recent dry weather hardness measurements.*

Figure A-31 Lead Total Dry Weather Sample Results for LA River at Figueroa (Reach 3)

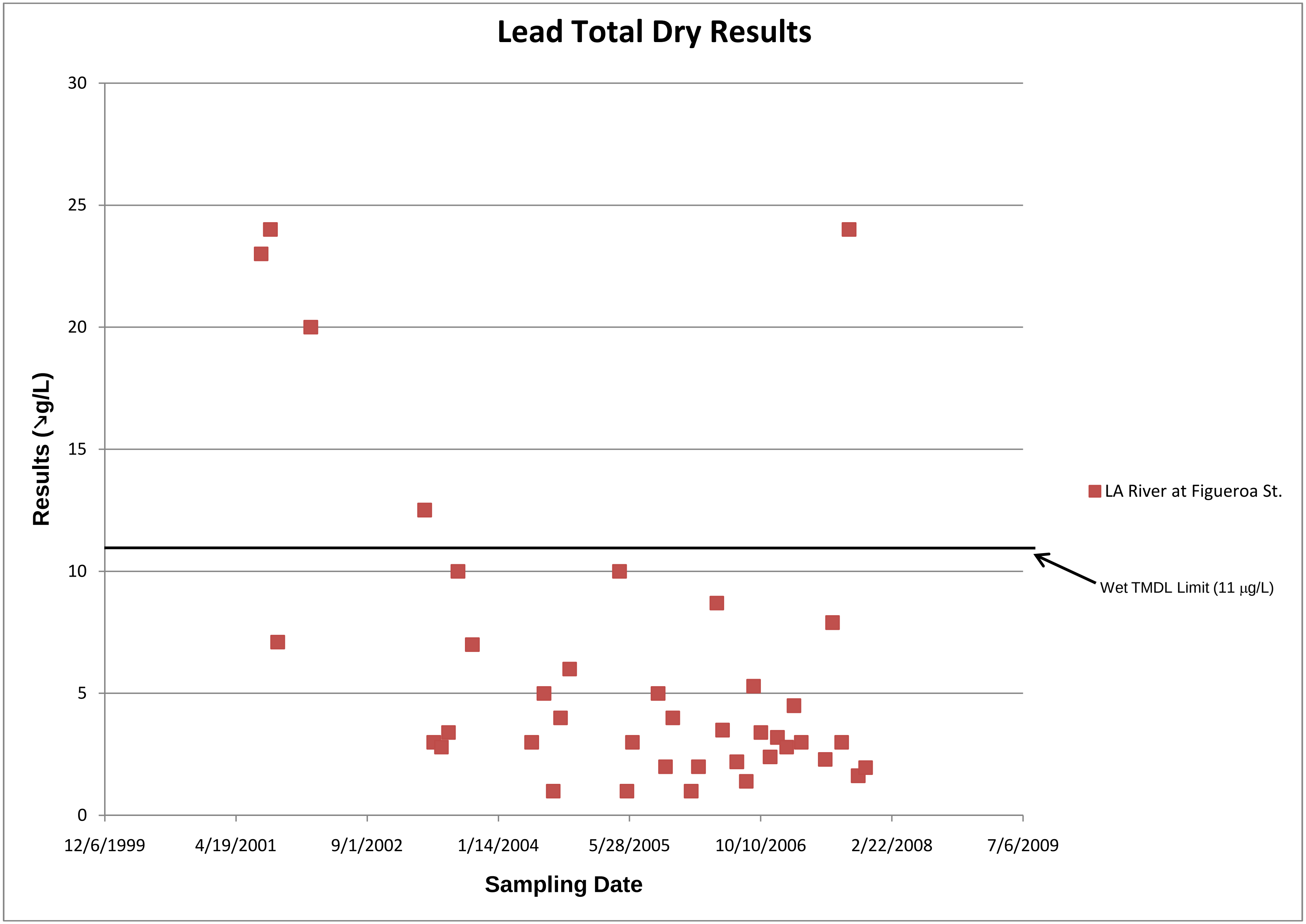


Figure A-32 Zinc Dissolved Dry Weather Sample Results (without Rio Hondo)

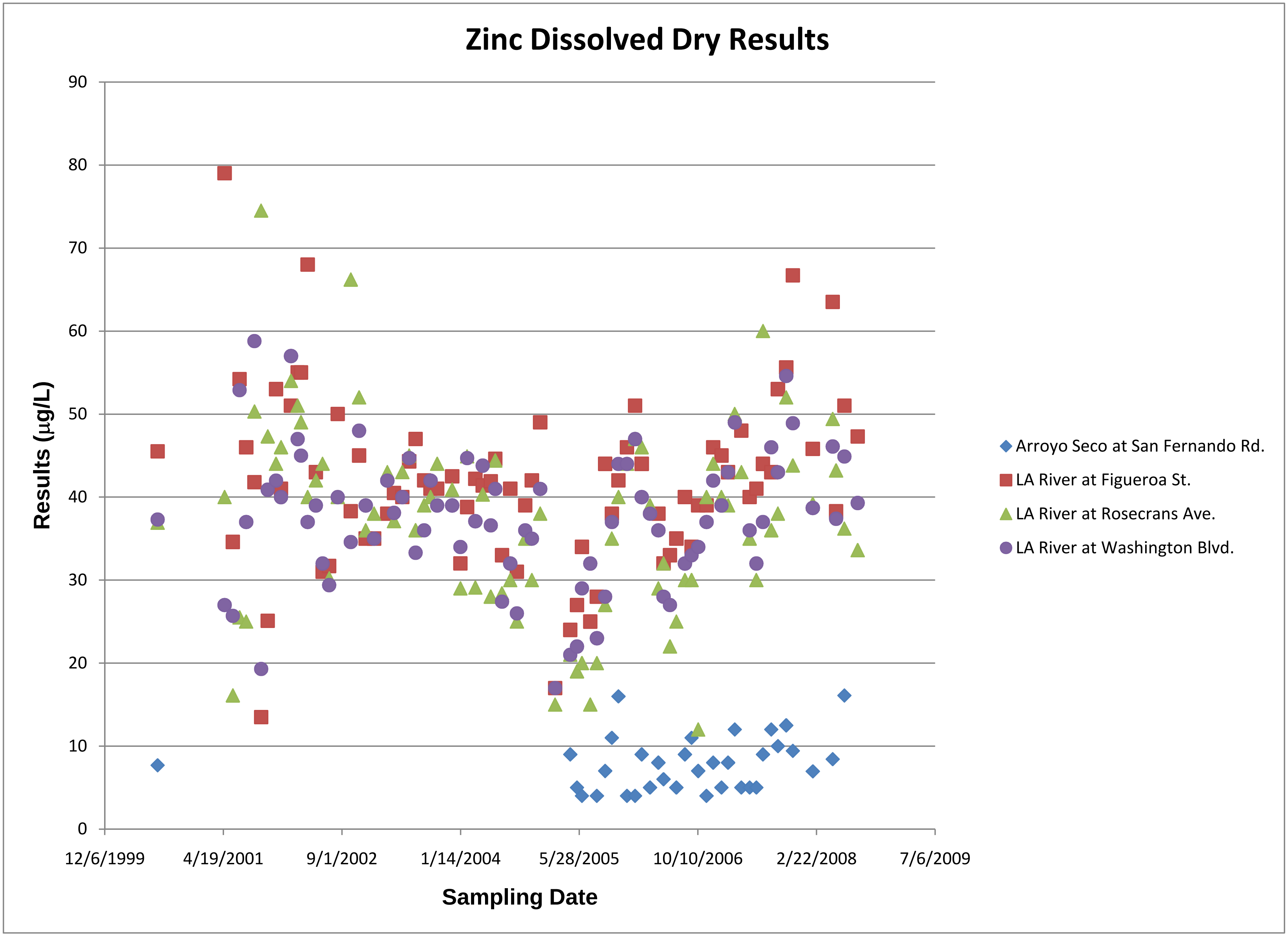
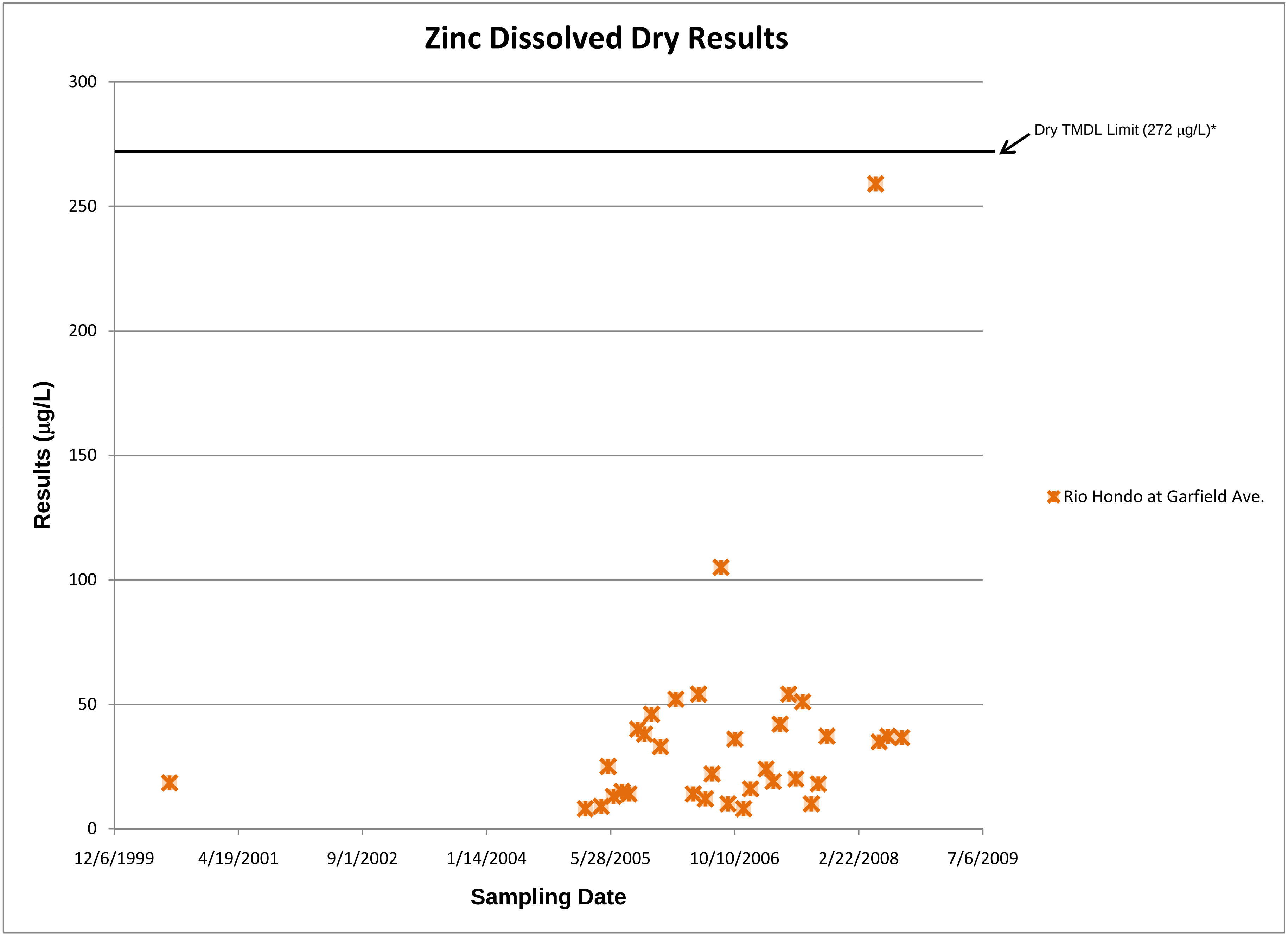


Figure A-33 Zinc Dissolved Dry Weather Sample Results for Rio Hondo



**Note: California Toxics Rule (CTR) criteria recomplied using recent dry weather hardness measurements.*

Figure A-34 Zinc Total Dry Weather Sample Results (without Rio Hondo)

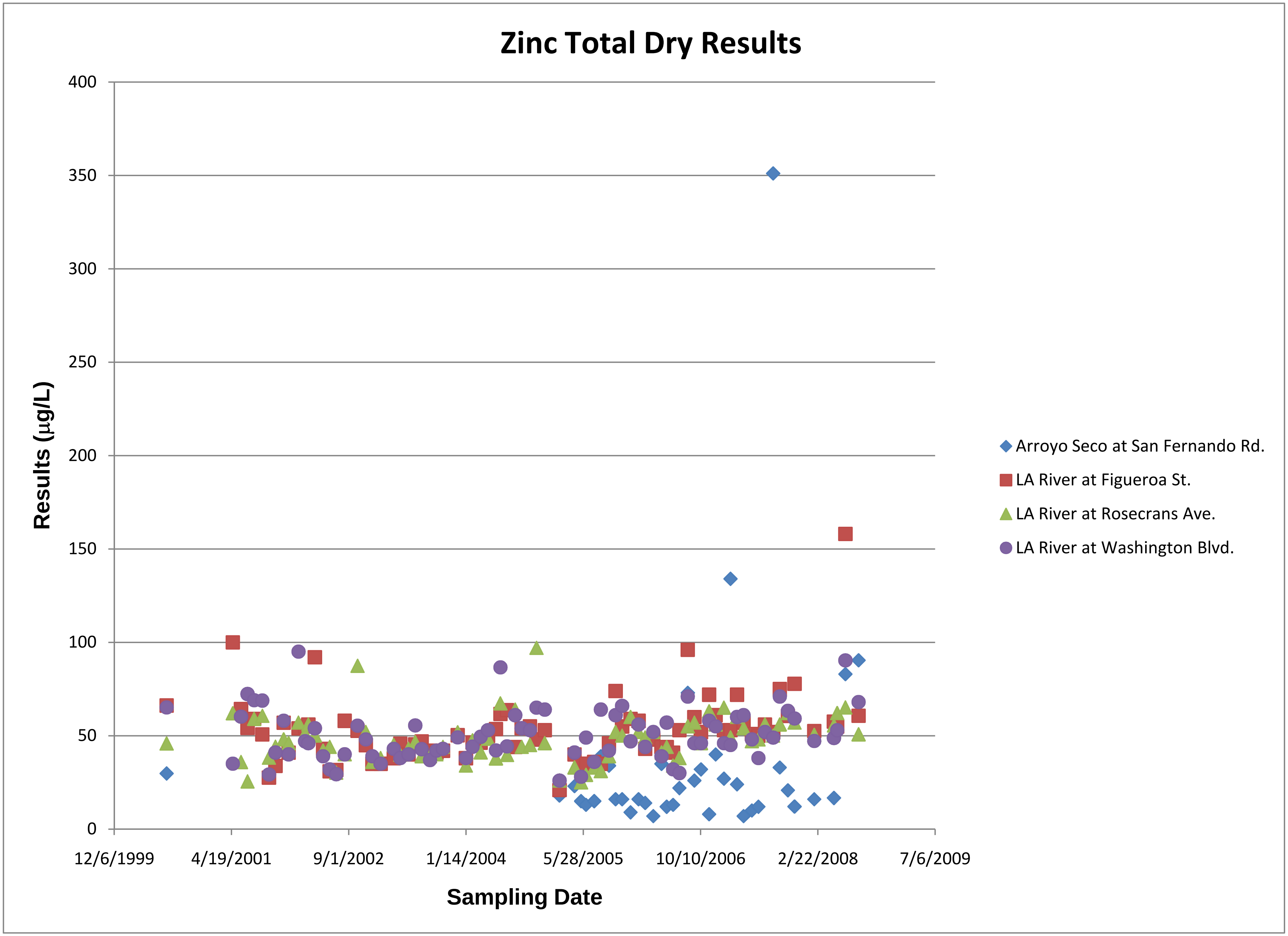
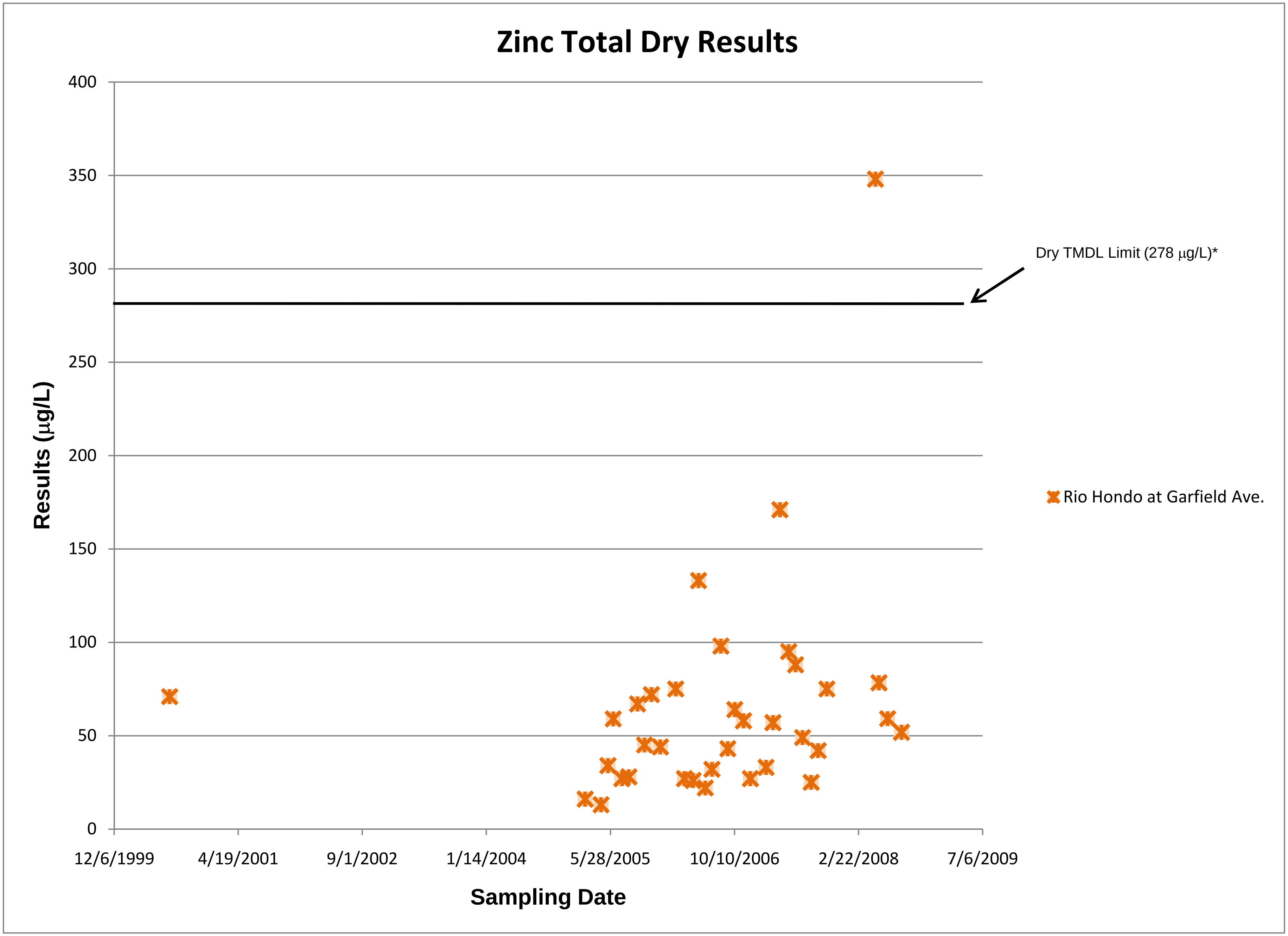


Figure A-35 Zinc Total Dry Weather Sample Results for Rio Hondo



**Note: California Toxics Rule (CTR) criteria recomplied using recent dry weather hardness measurements.*

Appendix B

Appendix B Compliance Analysis

CDM performed a sensitivity analysis on the parameters used in the compliance analysis to determine copper load reduction and treatment area required for structural Best Management Practices (BMPs) to meet the target copper concentrations as outlined in the TMDL.

Procedure and Equations

The sensitivity analysis was performed using the Palisades Decision Tools @RISK program. Version 5 of @RISK was used in conjunction with Microsoft Excel to determine the probability of compliance with target copper loads for the range of tributary area (10,000 to 22,000 acres) for treatment with infiltration BMPs published in Section 6 of the *Los Angeles River and Tributaries Total Maximum Daily Load (TMDL) for Metals Implementation Plan for Reach 2 Participating Jurisdictions*.

The sensitivity analysis included the following steps:

- **Step 1 – Rainfall.** Hourly rainfall data was separated into rainfall events.

- **Step 2 – Stormwater Runoff.** Runoff was calculated for the Los Angeles River (LAR) Municipal Separate Storm Sewer System (MS4) area (301,600 acres) for each rainfall event defined in Step 1.

- **Step 3 – Baseline Copper Load.** The baseline copper load for a given runoff event (Step 2) was estimated based on wet weather monitoring data at the Wardlow Station[1].

- **Step 4 – Total Allowable Copper Load.** The total allowable copper load for a given runoff event (Step 2) was estimated using an equation specified in the TMDL Staff Report.

- **Step 5 – Required Copper Load Reduction for Reach 2.** The copper load reduction to be achieved with the construction of structural BMPs to treat the Reach 2 tributary area was estimated based on runoff event depth (Step 2) and estimated baseline copper load (Step 3) for the Reach 2 MS4 area.

- **Step 6 – Estimated Copper Load Treated by Structural BMPs.** The estimated copper load treated by the construction of structural BMPs within the Reach 2 MS4 area was compared to the Reach 2 MS4 area required load reduction (Step 5) to determine percent compliance.

This process was completed for a range of rainfall depths and baseline copper loads to estimate the sensitivity of the percent compliance achieved by construction of structural BMPs to treat between 10,000 acres and 22,000 acres of the Reach 2 MS4 area. The following paragraphs describe in detail each step used in this sensitivity analysis.

[1] Based on review of all available data, the Wardlow wet weather data remains the best data set for this analysis.

Step 1 – Rainfall

Rainfall data from the National Climatic Data Center (NCDC) Station CA5115 (LADWTN) for the period of October 17, 1948 to December 20, 2007 was used to separate hourly rainfall depths into rainfall events with a 12-hour inter-event time. The CA5115 rainfall gauge is located less than three miles west of the Reach 2 subwatershed. Figure 2-7 in Section 2 shows the location of the rainfall gauge with respect to the study area.

Each rainfall event was input into the @RISK program and a probability distribution was assigned based on the dataset. The closest fit was an inverse Gaussian distribution. Figure 1 shows the inverse Gaussian distribution plotted along with the event dataset. The probability density plotted on the Y-axis of Figure 1 describes the likelihood that a rainfall event will occur and is used by the @Risk program to guide the selection of rainfall events for the analysis.

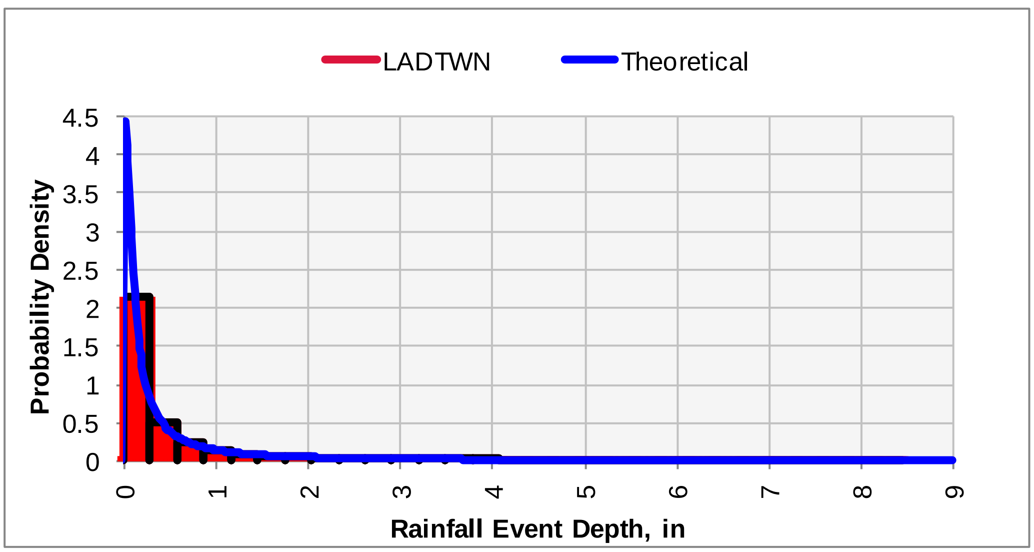


Figure 1
Probability Density of Rainfall Event Depth for NCDC Data and Applied Distribution

Step 2 – Stormwater Runoff

In Section 6, a runoff event depth of 0.1 inches was used in the compliance analysis to estimate a minimum treatment area required for compliance with copper load targets. To address the Regional Board's comments, the compliance analysis was revised to calculate a range of runoff event depths using a range of rainfall events (Step 1) and a runoff coefficient (C) as shown in Equation 1. An area weighted runoff coefficient of 0.4 for the LAR MS4 area was derived using land use information and associated runoff coefficients presented in Section 4, Table 4-1.

Equation 1
*Runoff Event Depth (in) = Rainfall Event Depth (in) * C*

Stormwater runoff volume (Equation 2) was calculated by multiplying the runoff event depth (Equation 1) by the total tributary area for the LAR MS4 area (301,600 acres). This area is used because it is the total tributary area to the Wardlow monitoring station where there is wet weather copper concentration data available for use in Step 3.

Equation 2
*Runoff Event Volume (L) = (Equation 1) * (301,600 acres) * (1 ft / 12 in) *(1,233,481.84 L /1 ac-ft)*

Step 3 – Baseline Copper Load

The measured total copper concentration multiplied by the runoff volume approximate the baseline load of total copper per runoff event, as summarized in Table 1.

Figure 2 shows the baseline copper loads plotted against runoff depths. A linear regression was performed on the data to approximate an average baseline copper load for use in the sensitivity analysis, as represented by "Linear (Wardlow Baseline Copper Load)."

Table 1 Baseline Copper Load Calculations from Wardlow Monitoring Data

Date	Daily Runoff Volume (ac-ft)	Approximate Runoff Depth (in)[1]	Total Copper Concentration (ug/L)[2]	Baseline Copper Load (kg/day)[3]
10/28/2000	2,300	0.09	11	30
1/11/2001	25,200	1.00	9	294
1/25/2001	1,400	0.06	18	32
3/6/2001	10,100	0.40	8	103
11/24/2001	9,500	0.38	30	351
12/20/2001	1,000	0.04	16	19
1/28/2002	3,300	0.13	15	61
11/8/2002	12,200	0.49	26	390
12/16/2002	16,300	0.65	19	382
2/11/2003	45,000	1.79	13	716
3/15/2003	36,800	1.46	10	434
10/28/2003	24,800	0.99	20	608
10/31/2003	6,200	0.41	295	2,255
12/25/2003	23,600	0.94	21	602
1/1/2004	9,200	0.37	16	184
10/17/2004	4,500	0.18	42	230
10/26/2004	17,300	0.69	51	1,079
12/6/2004	2,500	0.10	35	108
1/7/2005	23,400	0.93	31	897
10/18/2005	2,900	0.12	51	183
12/31/2005	5,200	0.21	12	77
1/14/2006	1,000	0.04	16	20
2/18/2006	2,400	0.10	44	130
12/9/2006	2,900	0.19	424	1,516
2/19/2007	1,400	0.06	77	133
2/22/2007	2,200	0.09	49	132
9/22/2007	7,100	0.47	123	1,077
10/13/2007	3,300	0.22	255	1,037
07-08 Event 29	4,400	0.18	58	312
07-08 Event 31	2,600	0.10	26	83
07-08 Event 32	6,700	0.27	44	362

[1]Runoff Depth (in) = Runoff Volume (ac-ft) * 301,600 acre * 12 in / 1 ft
[2] Numeric target is 17 µg/l
[3]*Baseline Copper Load (kg) = Total Copper Concentration (µg/L) * Daily Runoff Volume (ac-ft) * (1 kg / 1(10)^9 µg)* (28.3 ft^3/1 ac-ft)*

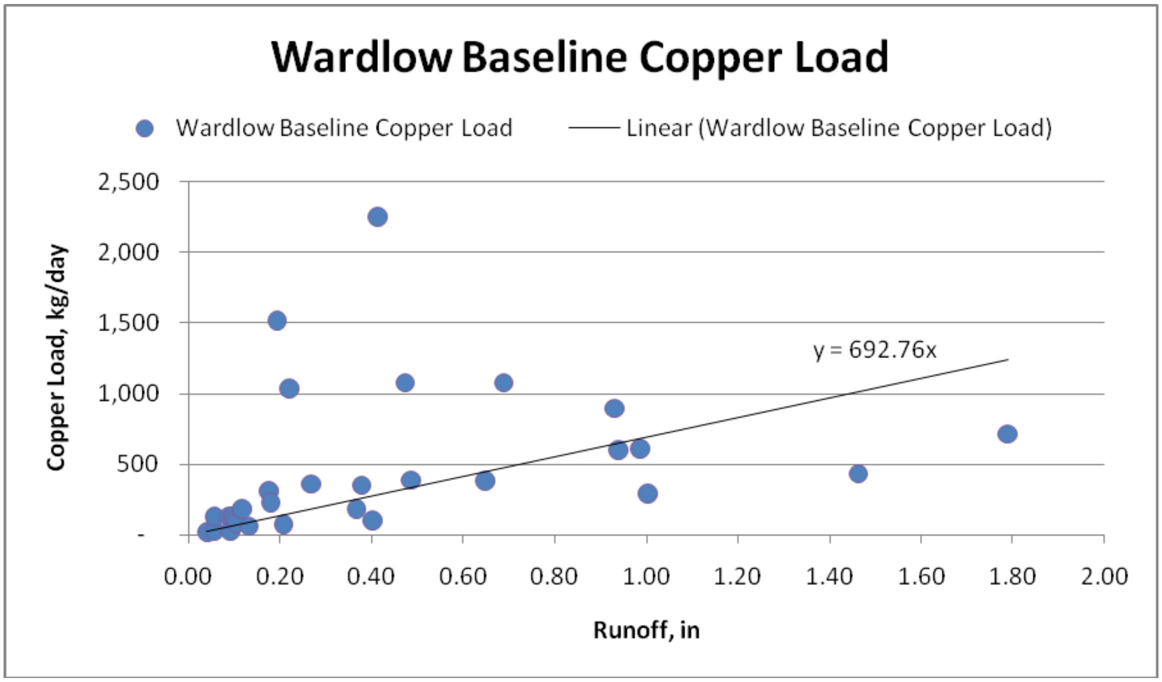


Figure 2
Baseline Copper Load versus Runoff Depth at Wardlow

Step 4 – Total Allowable Copper Load

The allowable total copper load for a given runoff event (Step 2) is determined by the wasteload allocation from the TMDL, which is a direct function of runoff volume (Table 6-12, TMDL Staff Report). Therefore, the allowable copper load is:

Equation 3
Allowable Copper Load (kg) = $1.7(10)^{-8}$ ** Runoff Volume (L) – 10.*

The analysis disregarded runoff volumes below 0.02 inches to avoid a negative allowable copper load.

Step 5 – Required Copper Load Reduction for Reach 2

The required copper load reduction at Wardlow for the LAR tributary area is the difference between the baseline copper load (Step 3) and total allowable copper load (Step 4).

Equation 4
Required Copper Load Reduction at Wardlow (kg) = Baseline Copper Load (kg) – (Equation 3)

The MS4 drainage area for Reach 2, excluding the area upstream of the Rio Hondo Spreading Grounds, (37,900 acres) accounts for approximately 15-percent of the total LAR MS4 area draining to Wardlow Road. Therefore, the implementation plan for participating jurisdictions in Reach 2 should provide approximately 15-percent of the load reduction needed at Wardlow.

Equation 5
*Required Copper Load Reduction for Reach 2 (kg) = 0.15 * (Equation 4)*

As was stated in Section 6, 45-percent of the required load reduction for the Reach 2 participating jurisdictions is expected to be met by non-structural BMPs. Structural BMPs are expected to provide 55-percent of the required load reduction, as calculated in Equation 6.

Equation 6
*Required Copper Load Reduction for Structural BMPs (kg) = 0.55 * (Equation 5)*

Step 6 – Estimated Copper Load Treated by Structural BMPs

As was stated in the Section 6, hypothetically constructed structural BMPs in Reach 2 were assumed to be infiltration BMPs. The expected load reductions for infiltration BMPs were estimated based on a design capture volume of 0.5 inches of runoff and 2-day drawdown time. Section provides a discussion of the infiltration BMP design parameters. This design standard is expected to capture 58-percent of the average annual runoff volume. The California Stormwater Quality Association (CASQA) *New Development and Redevelopment Handbook* recommends capturing 85-percent of the annual runoff volume; therefore, the load reductions presented here conservatively estimate expected load reductions from future BMP implementation should structural BMPs, such as infiltration basins, be designed to the recommended standard.

CDM's NetSTORM program determined inches of overflow, or untreated runoff, from a hypothetical infiltration BMP for the rainfall period analyzed. The estimated copper load released from this untreated runoff per acre of tributary area was plotted versus runoff event depth (Figure 3). For runoff events of 0.5 inches or less, the hypothetical infiltration BMP treats all of the runoff. For runoff events greater than 0.5 inches, the logarithmic equation shown in Figure 3 was used to approximate the copper load released by hypothetical infiltration BMPs during overflow events.

Estimated Copper Load by Reach 2 to LAR with Implementation of Structural BMPs
The copper load released from Reach 2 participating jurisdictions is the sum of the copper load released from acreage treated with structural BMPs and the copper load released from untreated acreage. The copper load released was calculated as:

Equation 7
*Copper Load Released by Reach 2 (kg) = [[Baseline Load (kg)/ (301,600 acres)] * [(37,900 acres) – Structural BMP Treatment Area (acres)]] * Copper Load Released by Structural BMP (kg/acre)*

In Equation 7, the 301,600 acres is the total LAR MS4 area and the 37,900 acres is the Reach 2 MS4 area minus the area upstream of the Rio Hondo Spreading Grounds.

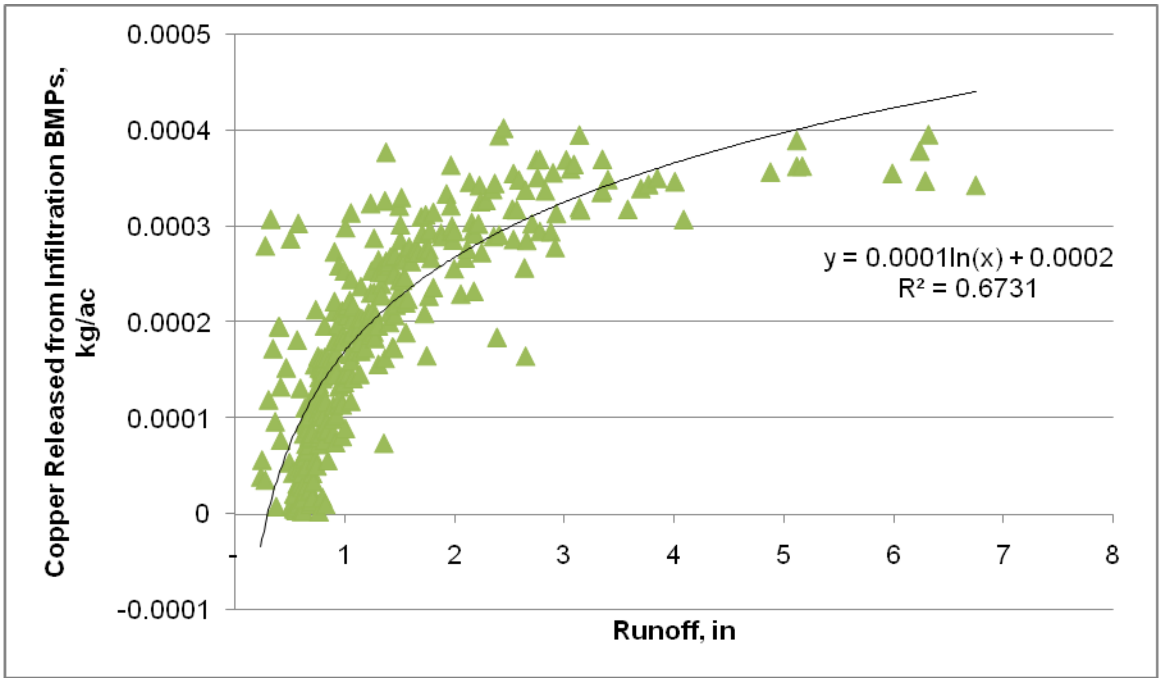


Figure 3
Copper Load Released per Acre Treated by Hypothetical Infiltration BMP

Estimated Copper Load Treated by Structural BMPs
The copper load retained, or treated, by the structural BMPs is equal to the baseline copper load from the participating jurisdictions minus the copper load released.

Equation 8
*Copper Load in Reach 2 Treated by Structural BMPs (kg) = [[Baseline Load (kg)/ (301,600 acres)] * (37,900 acres)] – (Equation 7)*

Compliance with Copper Reduction Target
Compliance with the TMDL wasteload allocation is achieved if the copper load in Reach 2 treated by structural BMPs (Equation 8) is greater than or equal to the required copper load reduction by BMPs (Equation 6).

Simulation

Palisades @RISK was used to simulate the required copper load reduction (Equation 6) and compliance by structural BMPs treating between 10,000 and 22,000 acres. The program chose

1,000 rainfall events according to the distribution shown in Figure 1 and performed the compliance calculations for each rainfall depth. The simulation was performed to estimate the probability of compliance for the minimum and maximum estimated treatment areas (10,000 acres and 22,000 acres, respectively) for an average baseline copper load.

Results and Conclusion

The sensitivity analysis based on the construction of hypothetical infiltration BMPs shows that 10,000 acres of treatment (Section 6) provides a 55-percent probability of compliance for any given runoff event with the required copper load reduction as calculated in Equation 6. For 22,000 acres of treated tributary area (Section 6), a 97-percent compliance is achieved for all runoff events.

Based on the results of this sensitivity analysis, the targeted tributary area between 10,000 and 22,000 acres for capture and treatment of stormwater runoff by structural BMPs provides reasonable assurance of compliance, as shown by this conservative estimate. This is, however, a planning level estimate based on a hypothetical structural BMP application. The actual area required for treatment will depend on the baseline copper concentrations (Step 3) and structural BMP performance from specific sites. Therefore, it is recommended that this analysis be revisited periodically during the phased process of structural BMP site selection and implementation.