Memorandum

To: *Rick Whetsel, SAWPA*

From: *CDM*

Date: *September 30, 2011*

Subject: *Final Submittal - Source Evaluation Project Activities for Middle Santa Ana River, TMDL Program Support 2010-2011*

In 2010, the Middle Santa Ana River (MSAR) Task Force identified five source evaluation project activities for execution during the 2010-2011 fiscal year. As directed by the Task Force, CDM prepared a scope of work for each proposed study activity so that they could be further evaluated for implementation. Following review by the Task Force and concurrence by the Santa Ana Regional Water Quality Control Board (letter dated December 7, 2010), the Task Force directed CDM to proceed with the planned source evaluation activities in spring/early summer 2011.The results of these studies are presented in the following technical memoranda organized as follows:

- *Attachment A, Box Springs Channel Follow-up Study (Task 2.1)* - Short-term bacterial indicator study at the Box Springs Channel site originally sampled as part of the Urban Source Evaluation Plan (USEP) Monitoring Program in 2007- 2008. During that sample period, human source bacteria were regularly detected and high bacterial indicator concentrations were present. Following a local investigation in 2008, a sanitary/storm sewer cross connection was identified and corrected. The purpose of the task was to conduct follow-up sampling activity to evaluate current bacterial indicator levels and verify that human source bacteria are no longer present.

- *Attachment B, Preliminary Characterization of Bacteria Loading from MS4 in Pomona and Claremont (Task 2.2)* - When the USEP program was implemented in 2007-2008 no samples were collected from sites representing the Cities of Pomona and Claremont. The purpose of this task was to gather dry weather condition bacterial indicator data during the dry season to provide a preliminary characterization of potential bacteria loading and presence/absence of human sources of bacteria from this portion of the MSAR watershed.

- *Attachment C, Survey of Dry Weather Flows from MS4 Outfalls to Major Tributaries (Task 2.3)* - The purpose of this source evaluation study was to gain additional information regarding the

variability of dry weather flows in stormwater channels/outfalls in the MSAR watershed. The information gained from this effort, combined with other available dry weather flow data, support characterizations of typical dry weather flows in the area and support compliance analyses in the Comprehensive Bacteria Reduction Plan (CBRP).

- *Attachment D, Calculate Mass Balance for Dry Weather Conditions (Task 2.4)* - The purpose of this task is to quantify, to the extent possible, the mass balance of bacterial indicators under dry weather conditions based on known dry weather hydrology, source of flow, and available bacteria concentration data. Mass balance characterizations are an important element of the compliance analysis contained within the CBRP.

- *Attachment E, Calculate Site-Specific Log Standard Deviation at Monitoring Sites (Task 2.5)* - The EPA uses a default log standard deviation (LSD) of 0.4 for *E. coli* when calculating single sample maximum criteria. A site-specific LSD may be substituted for the default value where such data exist, which would result in different single sample maximum criteria. The potential to use site-specific LSD to establish site-specific single sample criteria has been incorporated into the Basin Plan amendment under development by the Stormwater Quality Standards Task Force. The purpose of this task was to calculate LSD values for the USEP and Watershed-wide Compliance monitoring sites.

Attachment A

Box Springs Channel Follow-up Study (Task 2.1)

Memorandum

To: *Rick Whetsel, SAWPA*

From: *Richard Meyerhoff, CDM*
Thomas Lo, CDM

Date: *September 30, 2011*

Subject: *Technical Memorandum - Box Springs Channel Follow-up Study, 2011 Dry Season*

Purpose

The Box Springs Channel site was originally sampled as part of the Urban Source Evaluation Plan (USEP) Monitoring Program in 2007-2008. During that sample period, human source bacteria were regularly detected and high bacterial indicator concentrations were present. Following a local investigation in 2008, a sanitary/storm sewer cross connection was identified and corrected. During the 2011 dry season, Riverside County Flood Control & Watershed Conservation District (RCFCWCD) staff in coordination with CDM conducted a 5-week follow-up study to evaluate current bacterial indicator levels and verify that human source bacteria are no longer present. This technical memorandum reviews past USEP sample results and presents the results from recent sampling during the 2011 dry season.

Description of Box Springs Channel Site

Box Springs Channel drains a 31 square mile urbanized subwatershed in the City of Riverside. Dry weather flows measured in this channel are approximately 3.2 cfs (average of USEP field measurements in dry season 2007) and may consist of a combination of nuisance flow from urban drainages in the City of Riverside and de minimus water from Riverside Public Utilities (RPU). This channel may be divided into two segments:

- Upstream channel – Engineered section with 0.15 mile vertical-wall concrete-lined channel; 0.10 mile trapezoidal rock-lined slope with natural bottom

- Downstream Channel – 0.4 mile natural segment that confluences with the Middle Santa Ana River.

The Box Springs Channel USEP site was identified very early in the 2007-2008 USEP Monitoring period as having elevated fecal coliform and *E. coli* concentrations and strong indications of

possible contamination from human sources. RCFCWCD initiated an IC/ID investigation in January 2008 to attempt to identify the source of the bacteria.

Coincidentally, during the same time, the City of Riverside was also reviewing plans to replace a sewer line running near Box Springs Channel. While performing dye tests on lateral sewer lines, the City discovered a single restroom toilet, located in the Sam Evans Sports Complex on the Riverside Community College (RCC) Riverside Campus, was inadvertently connected to a storm drain pipe rather than a sewer line. To correct the problem, the cross-connected toilet was removed in May of 2008 and the sewer lateral was later capped to prevent any recurrence.

On May 6 and June 30, 2008, two separate samples analyzed by the Orange County Water District were both negative for the presence of human source bacteria. However, in September of 2008, a sample collected from Box Springs Channel indicated the probable presence of low levels of human bacteria.

Previous USEP Monitoring Results

The 2007-2008 USEP results indicated elevated geomean bacterial indicator concentrations and the common presence of human source bacteria (Table 1). The observed concentrations exceeded existing Basin Plan fecal coliform objectives and proposed *E. coli* objectives.

Table 1. Bacterial Indicator Data Summary for Box Springs Channel, 2007 Dry Season

Parameter	Geometric Mean Dry Season 2007	
	Week of 7/14 to Week of 8/11	Week of 9/1 to Week of 9/29
Fecal coliform	12,990	23,077
E. coli	1,149	4,793
Human Source *Bacteroides*	Present 5 of 5 samples	Present 5 of 5 samples

Box Springs Channel Follow-up Study Results

From April 19 to June 24, 2011, RCFCWCD staff in coordination with CDM sampled Box Springs Channel, collecting data for field parameters, bacterial indicator concentrations, and presence/absence of human source bacteria (Tables 2, 3 and 4). Water quality parameters were collected five consecutive weeks. Flow data were gathered for five additional weeks[1].

[1] Additional flow data were gathered to support other ongoing source evaluation studies to improve dry weather flow estimates in the area.

Table 2. Water Quality Parameters and Flow Results

Sample Date	Temp (°C)	Turbidity (NTU)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	pH	Flow (cfs)
04/19/2011	17.08	59.20[1]	520	9.41	7.90	3.2
04/27/2011	17.92	1.10	569	9.06	7.75	0.5
05/03/2011	18.57	0.87	562	9.06	7.87	1.2
05/11/2011	17.7	0.9	680	9.45	8.02	1.5
05/19/2011	15.8	35.1[1]	748	9.45	8.03	3.3
5/24/2011						1.17
6/2/2011						NR[2]
6/9/2011						3.66
6/14/2011						2.70
6/24/2011						0.50
					Mean Flow	2.2

[1] Pipeline construction activity near Box Springs channel may be source of elevated turbidity readings.
[2] NR (no reading) due to flow meter equipment malfunction

Table 3. Box Springs Channel Bacterial indicator Results

Date	Fecal Coliform (cfu/100 mL)	*E. coli* (cfu/100 mL)
4/19/2011	540	780
4/27/2011	770	990
5/3/2011	3,900	2,100
5/11/2011	2,400	2,000
5/19/2011	900	1,400
Geomean	1,285	1,353

Table 4. Results of Analyses for Presence/Absence of *Bacteroides* at Box Springs Channel

Sample Date	Human Marker: (Presence/Absence of *Bacteroides*)
4/19/11	Absent
4/27/11	Absent
5/3/11	Absent
5/11/11	Absent
5/19/11	Absent

Study Findings

Sample results indicate significant reductions in the geometric mean of fecal coliform observed in summer 2007 as compared to what was observed in 2011. *E. coli* concentrations were similar when compared to one 2007 sample period (July-August 2007), but lower when compared to the other (September 2007) (see Table 1). Regardless, the observed geometric mean concentrations in 2011 are well above existing or proposed Basin Plan water quality objectives for bacterial indicators.

Results from *Bacteroide*s analyses indicate that no human bacteria were present in the water samples collected in 2011. This finding further supports the presumption that the cross-connection discovered during the IC/ID investigation in January 2008 was the source of the human bacteria detected during 2007-2008 USEP monitoring.

Attachment B

Preliminary Characterization of Bacteria Loading from MS4 in Pomona and Claremont (Task 2.2)

Memorandum

To: *Rick Whetsel, SAWPA*

From: *Richard Meyerhoff, CDM*
Thomas Lo, CDM

Date: *August 12, 2011*

Subject: *Preliminary Characterization of Bacteria Loading from MS4 in Pomona and Claremont*

Background

The Santa Ana Regional Water Quality Control Board (RWQCB) adopted and the State Water Resources Control Board (SWRCB) approved the Middle Santa Ana River (MSAR) Bacterial Indicator TMDL to address fecal indicator bacteria (FIB) impairments in 1995. After EPA Region 9 approval, the MSAR Bacteria TMDL took effect on May 16, 2007. The MSAR Bacterial Indicator TMDL required urban and agricultural dischargers to implement a watershed-wide bacterial indicator monitoring program by November 2007.

The MSAR dischargers worked collaboratively through the MSAR Watershed TMDL Task Force (TMDL Task Force) to develop this program. As part of the MSAR Bacteria TMDL implementation, five Watershed-wide compliance monitoring program locations have been monitored since July 2007 for bacterial indicators.

In addition, the SWRCB funded a 2006 Proposition 40 Grant for San Bernardino County and Riverside County MS4 Permittees to support implementation of TMDL requirements. With this Grant 40 funding, the Permittees, in collaboration with SAWPA and the MSAR TMDL Task Force, implemented an Urban Source Evaluation Plan (USEP) Monitoring Program in 2007 to characterize urban bacteria sources within the MSAR watershed.

It was recognized at the time of the 2007 USEP Monitoring that the Chino Basin subwatershed portion of the MSAR watershed included potential MS4 discharges from jurisdictions outside of the San Bernardino County MS4. These jurisdictions include the Cities of Claremont and Pomona, which are located within Los Angeles County and thus not under the jurisdiction of the Santa Ana RWQCB. Since the completion of the USEP Monitoring Program, the Cities of Claremont and Pomona have since joined and participated in the TDML Task Force.

Based on monitoring data from the Watershed-wide Compliance Monitoring Program and USEP Monitoring Program, San Bernardino and Riverside County MS4 Permittees have each developed a long term dry weather Comprehensive Bacteria Reduction Plan (CBRP) designed to achieve TMDL compliance under dry weather conditions.

Purpose

When the USEP program was implemented in 2007-2008, no samples were collected from sites representing the Cities of Pomona and Claremont. This memorandum summarizes the steps taken by CDM and the TMDL Task Force in Spring 2011 to identify new urban source evaluation sample sites specifically representing potential dry weather MS4 discharges from Pomona and Claremont. This monitoring effort collected bacterial indicator data as well as analyzed for presence/absence of human source bacteria (*Bacteroides*). Newly gathered data provide a preliminary characterization of bacteria loading in dry weather conditions from this Chino Creek portion of the MSAR watershed and will further guide implementation of the CBRP.

Site Identification Process

CDM collaborated with staff from the Cities of Claremont and Pomona to identify MS4 outfalls to collect dry weather flow samples representing runoff from each City's jurisdiction. The following section describes the steps taken with both City staff to identify potential outfalls for monitoring during the 2011 dry season.

Figure 1 shows the Chino Creek watershed-wide compliance drainage area and identifies the locations where there has been past and ongoing sampling within the Chino Creek watershed-wide drainage area. Figure 1 also shows the location of the Cities of Claremont and Pomona in relation to the Chino Creek watershed-wide compliance drainage area.

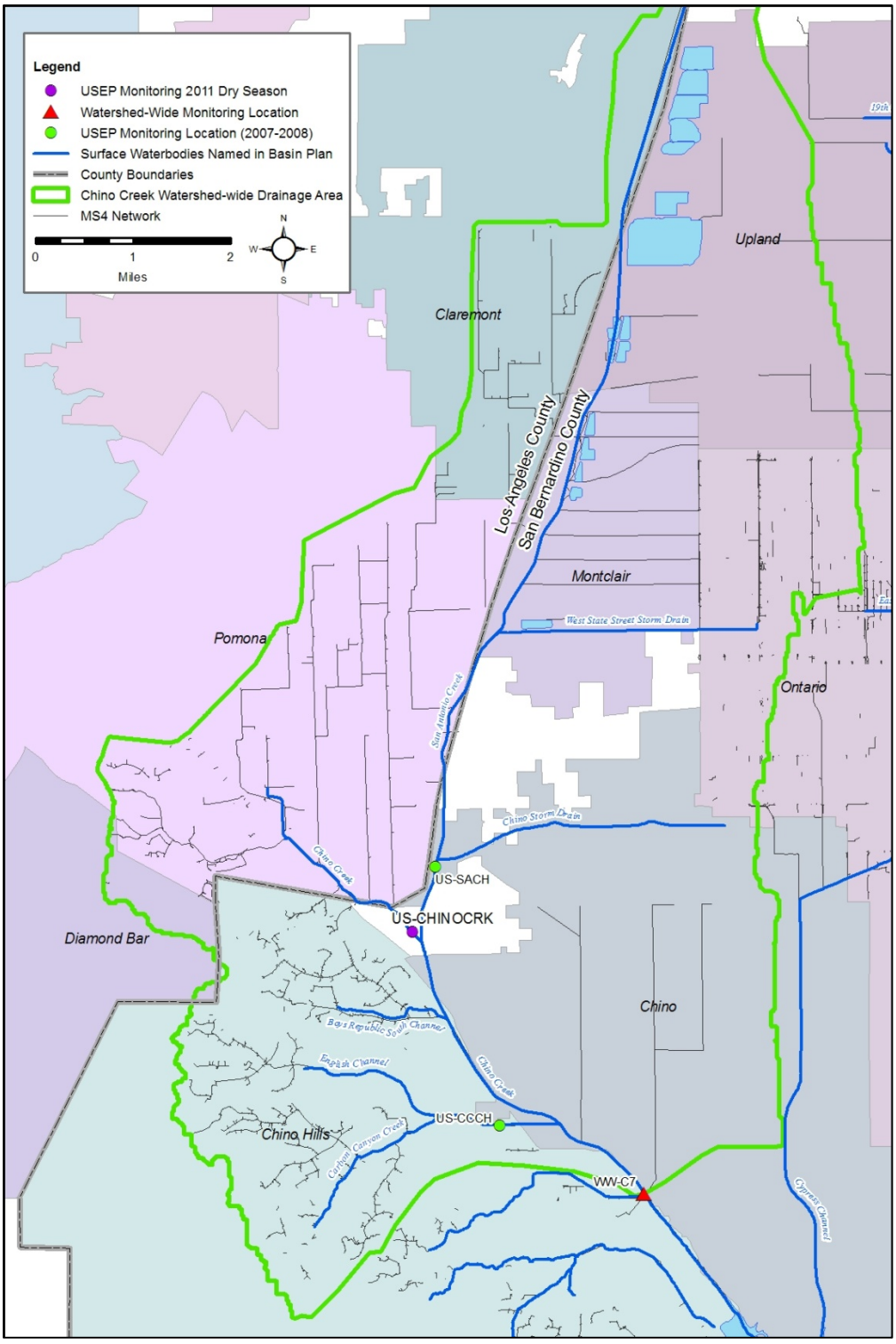

Figure 1
Chino Creek Watershed-wide Drainage Area

Claremont MS4 Sample Location

CDM contacted Craig Bradshaw, City of Claremont City Engineer, to identify MS4 outfalls discharging to the San Antonio Channel, which is tributary to Chino Creek. The City of Claremont reviewed their MS4 drainage system and identified a single storm drain line routing predominantly through Claremont before connecting to San Antonio Channel, located just south of Arrow Highway at San Antonio Channel. Figure 2 shows an aerial view of the location of this potential MS4 outfall in relation to San Antonio Channel and Montclair Basin, located east of San Antonio Channel. Montclair Basin No. 1 is one of a series of four basins owned by Chino Basin Water Conservation District and maintained and operated by Inland Empire Utilities Agency (IEUA) and Chino Basin Watermaster (CBWM). IEUA and CBWM are co-permit holders for the Chino Basin Recycled Water Groundwater Recharge Program.

CDM conducted field verification at San Antonio Channel and observed that the storm drain outfall (see Figures 3 and 4) at Arrow Highway is not directly connected with an outlet to San Antonio Channel but rather has a permanent structural diversion to Montclair Basin No. 1 (see Figure 5). All dry and wet weather flows are diverted completely to Montclair Basin No.1 and bypasses San Antonio Channel.

In addition to this outfall diversion at Arrow Highway, San Antonio Channel also has an in-channel automated inlet located just south of Arrow Highway (see Figure 6), which also diverts dry and wet weather flows to Montclair Basin No. 1. A second automated inlet is also constructed within San Antonio Channel and is located approximately 3 miles south of Arrow Highway, between Brook Street and State Street. This second automated inlet diverts all dry and wet weather flows within San Antonio Channel to Brooks Street Basin (Brooks Basin). Brooks Basin is also part of the Chino Basin Recycled Water Groundwater Recharge Program and is located approximately 0.15 miles east of San Antonio Channel and south of Brooks Street.[1]

With installation of an outfall flow diversion and two in-channel automated inlets within San Antonio Channel as part of the Chino Basin Recycled Water Groundwater Recharge Program, all dry and wet weather flows within San Antonio Channel from Arrow Highway south to State Street are diverted completely to either Montclair Basins or Brooks Basins. In discussions with Andy Campbell, IEUA Groundwater Recharge Coordinator, CDM confirmed that any water transfers that utilize San Antonio Channel as a conveyance are coordinated with IEUA for closure of automated inlets within San Antonio Channel.[2]

[1] Conversation with Ben Pak, Senior Engineer, Chino Basin Watermaster, March 28, 2011.
[2] Conversation with Andy Campbell, IEUA Groundwater Recharge Coordinator, July 28, 2011.

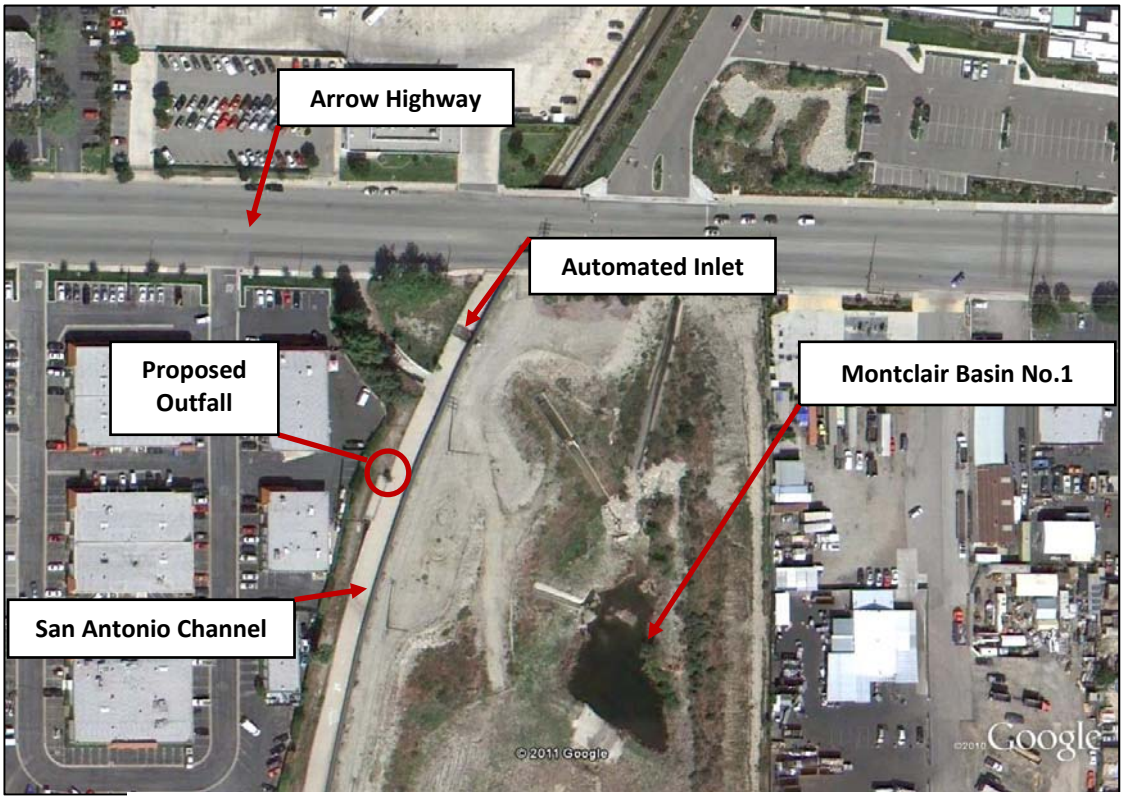

Figure 2
Aerial of Proposed MS4 Sampling Outfall at San Antonio Channel and Arrow Highway

Figure 3
MS4 Outfall (no outlet) to San Antonio Channel

Figure 4
View of San Antonio Channel adjacent to Proposed Outfall (no outlet in wall)

Figure 5
Outfall Diversion Structure to Montclair Basin No.1

Figure 6
Automated Inlet located within San Antonio Channel
Diverts Dry and Wet Weather Runoff to Montclair Basin No.1

After eliminating the Arrow Highway outfall as an option for sampling (due to its permanent structural diversion to Montclair Basin #1), CDM conducted additional field observations to locate any other viable outfall within Claremont to the San Antonio Channel.

From a desktop GIS review of MS4 mapping data, a potential outfall was identified on the west side of San Antonio Channel located at Moreno Street, located within the City of Montclair. CDM conducted further field verification and observed no existing outfalls at Moreno Street. Based on these field observations, CDM and Claremont staff concluded there are no existing outfalls to monitor for dry weather runoff in San Antonio Channel.

Pomona MS4 Sample Location

CDM coordinated with Meg McWade, City of Pomona Utility Facilities Manager, to identify a sample location that would be representative of runoff draining predominantly City of Pomona jurisdictional areas. The City and its consultant team previously conducted a field survey in mid-2010 to identify potential sample locations. The three identified locations included two along Chino Creek (upstream of San Antonio Channel) and one site within San Antonio Channel. The three potential MS4 outfalls sites (see Figure 7) included:

- Location 1: Chino Creek near Market Place and South Garey Avenue
- Location 2: Chino Creek near Towne Avenue
- Location 3: San Antonio Channel at East County Road

Based on field verifications and desktop GIS review of MS4 mapping, CDM determined with concurrence from the City's Consultant, Charles Abbot Associates, that the sample location to best represent and capture dry weather MS4 discharges from the City of Pomona was a sample location within Chino Creek just upstream of its confluence with San Antonio Channel (see Figure 8). Flows within the Chino Creek channel at this location capture discharges from MS4 lines running south through the City of Pomona collecting South Garey Avenue and Towne Avenue before discharging to Chino Creek. The approximate drainage area is 6,036 acres.

Figure 7
Location of Potential Pomona MS4 Outfall Sites

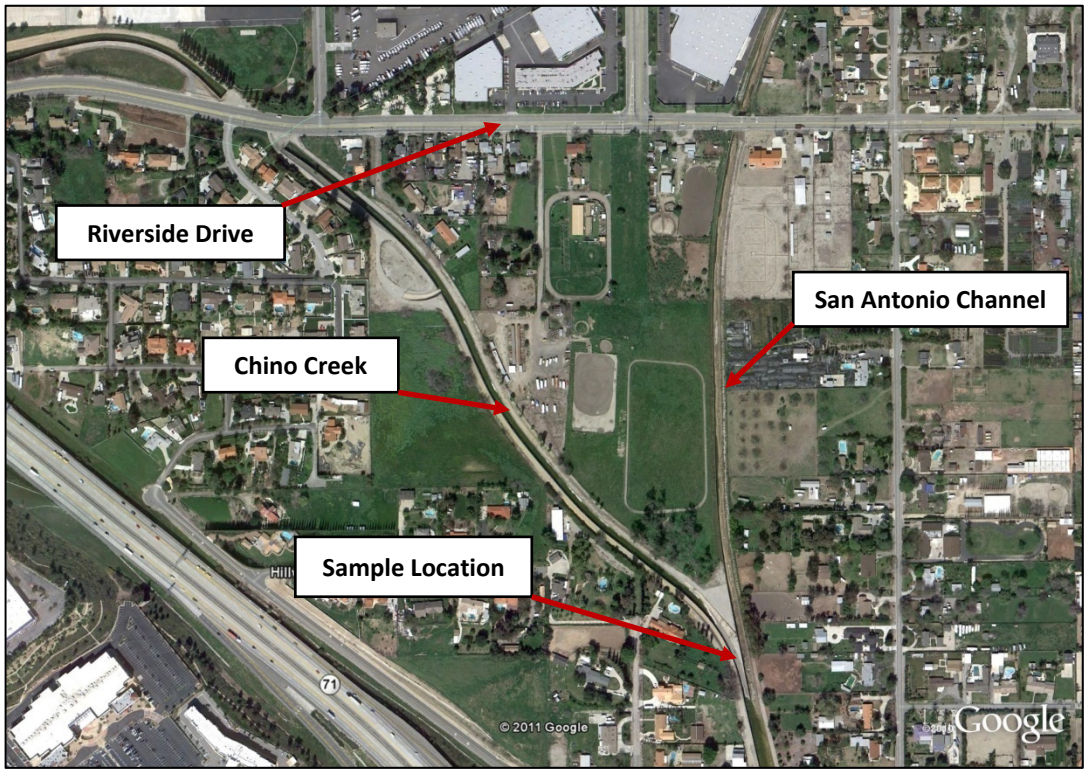

Figure 8
Chino Creek Sample Location (US-CHINOCRK) Located Upstream of San Antonio Channel

Previous Monitoring Results within Chino Creek Watershed

Samples have been collected during dry weather seasons at the Chino Creek Watershed-wide Compliance Site drainage area since 2007. The sites include:

- Watershed-wide Compliance Monitoring - Chino Creek at Central Avenue (WW-C7) has been monitored during each dry season from 2007 to 2011.
- Two USEP Monitoring Program locations monitored in the 2007 dry season:
  - San Antonio Channel at Walnut Ave (US-SACH)
  - Carbon Canyon Creek Channel at Pipeline Avenue (US-CCCH)

Table 1 summarizes the results from the Water-wide Compliance site (WW-C7) for bacterial indicator concentrations during dry seasonal periods from 2007 through 2011. For comparative purposes, previous sampling results are summarized for the monthly time periods (where

available) closest to the time period in which the 2011 Source Evaluation Study was conducted (April to June).

Table 1. Watershed-wide Compliance Monitoring Results at Chino Creek at Central Ave (WW-C7), cfu/100mL

Date		Fecal Coliform (cfu/100 mL)	*E. coli* (cfu/100 mL)
July - Aug 2007	N	5	5
	Median	3000	940
	Range	1,500 to 5,900	560 to 2,700
May - Jun 2008	N	7	7
	Median	590	350
	Range	200 to 3,200	210 to 610
May - Jun 2009	N	6	5
	Median	215	130
	Range	70 to 280	40 to 230
May - Jun 2010	N	7	7
	Median	360	220
	Range	40 to 1,500	90 to 410
May - Jun 2011	N	7	7
	Median	240	230
	Range	150 to 4,800	170 to 2,700

Table 2 summarizes the results from the USEP Monitoring Program sites located within the Chino Creek drainage area.

Table 2. Summary of USEP Monitoring Program Sample Results for Dry Season 2007

Date	Fecal coliform (cfu/100 mL)		*E. coli* (cfu/100 mL)		Human Source *Bacteroides*
	Result	Geomean	Result	Geomean	
San Antonio Channel at Walnut Ave (US-SACH)					
7/12/2007	NS	--	NS	--	NS
7/18/2007	140	--	80	--	ND
7/25/2007	5900	--	40	--	ND
8/1/2007	2300	--	610	--	ND
8/8/2007	8700	n/a[1]	920	n/a[1]	ND
8/28/2007	9000	--	300	--	ND
9/4/2007	8000	--	830	--	ND
9/11/2007	16000	--	1200	--	ND
9/18/2007	4000	--	320	--	ND
9/25/2007	13000	9,026	2000	718	ND
Carbon Canyon Creek Channel at Pipeline Ave (US-CCCH)					
7/11/2007	100	--	9	--	ND
7/17/2007	290	--	150	--	ND
7/24/2007	100	--	280	--	ND
7/31/2007	90	--	50	--	ND
8/7/2007	120	126	9	44	ND
8/28/2007	140		9	--	ND
9/4/2007	400		170	--	ND
9/11/2007	160		90	--	ND
9/18/2007	90		110	--	ND
9/26/2007	1400	257	280	84	ND

NS - no sample collected; site access issue
ND – non-detect

[1] – Insufficient data (results for only 4 of 5 weeks) to calculate geometric mean.

Chino Creek Channel Monitoring for Pomona MS4 Discharges

Between April 19 and June 24, 2011, CDM conducted monitoring over a ten week dry weather period at Chino Creek (US-CHINOCRK), just upstream of its confluence with San Antonio Channel (see Figure 1). Field parameters were measured on a weekly basis (see Table 3). Additionally, laboratory analyses were performed for bacterial indicator concentrations and also to test for the presence/absence of human source bacteria. Table 4 and 5 summarize the results for US-CHINOCRK location.

Table 3. Summary of Field Parameter Data Observed at US-CHINOCRK During 2011 Dry Season

Date	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	pH (Standard Units)	Turbidity (NTU)	Water Temperature (°C)	Flow (cfs)
4/19/2011	947	14.57	7.99	2.81	18.29	1.12
4/28/2011	782	11.83	9.86	1.85	18.54	2.19
5/5/2011	996	11.15	9.89	1.51	18.84	2.02
5/12/2011	1,026	10.70	9.72	3.21	22.73	2.94
5/20/2011	882	10.44	10.03	3.50	17.47	1.70
5/24/2011	860	10.84	10.16	3.04	16.30	1.45
6/2/2011	941	9.97	9.98	5.33	19.69	1.52
6/9/2011	900	9.35	9.79	4.12	17.05	1.42
6/14/2011	969	9.73	9.54	5.44	21.38	1.42
6/24/2011	1,002	10.95	9.45	7.43	23.38	1.18

Table 4. Summary of Bacterial Indicator Results Observed at US-CHINOCRK During 2011 Dry Season

Date	Fecal Coliform (cfu/100 mL)		*E. coli* (cfu/100 mL)	
	Result	Geomean	Result	Geomean
4/19/2011	370	-	160	-
4/28/2011	60	-	80	-
5/5/2011	510	-	1510	-
5/12/2011	1280	-	970	-
5/20/2011	480	370	1290	475
5/24/2011	440	383	390	568
6/2/2011	550	597	410	787
6/9/2011	800	653	1000	725
6/14/2011	570	556	670	673
6/24/2011	950	637	750	604

Results for Human Source Bacteria

Orange County Water District (OCWD) analyzed samples to determine the presence or absence of human source *Bacteroides* (see Table 5). In late April and early May, samples for two consecutive weeks showed presence of human source bacteria. On June 9th, a third sample showed presence of human source bacteria at very low concentrations.

Table 5. Presence/Absence for *Bacteroides*, US-Chino Creek	
Sample Date	**Human Marker: Presence/Absence of *Bacteroides***
4/19/2011	Absent
4/28/2011	Present
5/5/2011	Present (at a very low concentration)
5/12/2011	Absent
5/20/2011	Absent
5/24/2011	Absent
6/2/2011	Absent
6/9/2011	Present (at a very low concentration)
6/14/2011	Absent
6/24/2011	Absent

Study Findings

CDM worked with the Cities of Claremont and Pomona to identify urban source identification sampling locations to collect data to characterize dry weather MS4 discharges to the Chino Creek drainage.

No dry weather MS4 discharges from Claremont flow downstream within San Antonio Channel from Arrow Highway to State Street, since dry and wet weather flows are diverted to either the Montclair Basins or to Brooks Basins as part of the Chino Basin Recycled Water Groundwater Recharge Program, operated by IEUA and CBWM. Although no specific sampling location representing dry weather flows from Claremont MS4 discharges was identified for monitoring, a small portion of Claremont MS4 network connects to the Pomona MS4 network. Because of this inter-connected MS4 network, dry weather discharges from Claremont to the Chino Creek watershed are still possible. The contribution of bacterial indicators from this area of Claremont was not evaluated as part of this study.

Dry weather samples collected at Chino Creek at upstream of San Antonio Channel represent flows from MS4 discharges from the City of Pomona. Bacterial indicator sample results were elevated for both fecal coliform and *E. coli*.

Results for *Bacteroides* analyses indicate that human source bacteria were present in three of ten water samples at the US-CHINOCRK sample location.

Attachment C

Survey of Dry Weather Flows from MS4 Outfalls to Major Tributaries (Task 2.3)

Memorandum

To: *Rick Whetsel, SAWPA*

From: *CDM*

Date: *September 14, 2011*

Subject: *Source Evaluation Task 2.3 – Dry Weather Flows from MS4 Outfalls (2011 Dry Season)*

Study Purpose

In Spring 2011, the TMDL Task Force and CDM initiated dry weather flow (DWF) monitoring to enhance the existing DWF dataset for the Middle Santa Ana River (MSAR) watershed. The purpose of this study is to gain additional information to support updates to existing bacterial indicator source contribution analyses (see Technical Memorandum for Task 2.4, Calculate Mass Balance for Dry Weather Conditions). The new data will support characterization of DWF from MS4 outfalls not previously assessed and allow for analysis of the nature of DWF variability.

Flows exist in many MSAR waterbodies during dry weather conditions. Sources of flow include:

- Tertiary treated effluent from Publicly-Owned Treatment Works (POTWs)
- Turnouts of imported water by the Metropolitan Water District (MWD) purchased for groundwater recharge by water agencies in the Santa Ana River watershed
- Groundwater inputs from areas of rising groundwater
- Temporary de minimus discharges, such as well blow-offs
- Water transfers between water agencies for conjunctive use programs
- Authorized non-stormwater discharges as defined by Waste Discharge Requirements issued by the Santa Ana Regional Water Quality Control Board (RWQCB)
- Non-permitted discharges including Phase 2 Municipal Separate Storm Sewer System (MS4) discharges.

Within the MSAR watershed, many MS4 drainage areas do not typically cause or contribute to flow at downstream watershed-wide compliance monitoring sites established under the MSAR Bacteria Total Maximum Daily Load (TMDL). DWF from these drainage areas is hydrologically disconnected from downstream waterbodies, by either (1) purposefully recharging groundwater in constructed regional retention facilities, or (2) through losses in earthen channel bottoms, where the recharge capacity of underlying soils exceeds dry weather runoff generated in upstream drainage areas.

Identification of Flow Monitoring Sites

CDM worked with San Bernardino County Flood Control District (SBCFCD) and Riverside County Flood Control &Water Conservation District (RCFC&WCD) staff to select at least ten locations in the MSAR watershed to collect flow measurements for ten consecutive weeks under dry weather conditions from April to June 2011. CDM coordinated with SBCFCD and RCFC&WCD staff to finalize site selection after proposing a potential list of MS4 outfalls for field review.

Site selection considered factors such as where flow data are lacking, other data collection efforts ongoing or in the past, potential for the site to receive water transfers, and need for additional data for better understanding of hydrologic connectivity during dry weather conditions. Additional selection factors included outfall/channel physical constraints and any limiting factors that could hinder field staff from measuring or estimating flows.

Riverside County MS4 Outfall/Channel Locations

Riverside County MS4 outfalls/channels considered for new or additional flow monitoring included those tributary to the Santa Ana River and Cucamonga Creek channel. CDM presented a list of potential MS4 outfalls or channels for flow monitoring. CDM and RCFC&WCD staff then conducted a field visit at each site on March 17, 2011, to gather additional information concerning presence of flow and connectivity to downstream waterbodies. Table 1 summarizes the observations recorded from the field visit.

Field staff also observed flow connectivity was often limited from MS4 outfalls tributary to the Santa Ana River (SAR), particularly where outfalls are located a significant distance from the SAR mainstem due to the changing course of the SAR.

Based on field observation, CDM and RCFC&WCD staff narrowed the list of flow monitoring sites to seven locations. Table 2 lists the seven sites selected for DWF monitoring (see also Figure 1).

Table 1. Potential Flow Monitoring Locations, Riverside County

MS4 Outfall/Channel	Flow Observation (March 17, 2011)
Tributary to Santa Ana River	
Wilson Street Storm Drain	No connectivity to SAR; flow was observed from outfall pipe but limited to area surrounding outlet structure; lots of standing water around structure
University Wash -Lake Evans Outlet	No connectivity to SAR; slight flow exiting lake; appears to be a lake shutoff valve in a box
Outfall located just north of Mission Avenue and SAR	No connectivity – flow from the outfall proceeds along left bank of riverbed (~100 ft downstream of Mission Avenue Bridge overcrossing), but then ponds and infiltrates; SAR mainstem is located ~500' to the west along the right bank
Box Springs Channel[1]	Observed flow connectivity to SAR mainstem; part of channel half covered with sand bar; flow depth is 5"-6"
Magnolia Avenue Storm Drain ("Magnolia Center Outlet")	No flow connectivity to SAR mainstem due to over ½ mile of floodplain between the outfall and SAR mainstem; may reach SAR if SAR mainstem changes course over time
Phoenix Avenue Storm Drain	No flow connectivity to SAR mainstem; over ½ mile of floodplain between the outfall and SAR mainstem; may reach SAR if SAR mainstem changes course over time
Anza Channel (Drain)[1]	Observed flow connectivity to SAR mainstem
Sunnyslope Channel[1]	Observed flow connectivity; flow observed from end of lined portion of Sunnyslope Channel to convergence with SAR mainstem
Norco North Sub Drainage D1	Observed no flow at outlet structure; completely dry; distance to mainstem is several hundred feet to the west
Tributary to Cucamonga Creek	
Eastvale MDP Line A	Directly connected outfall to Cucamonga Creek; observed slight sheet flow into Cucamonga Creek
Eastvale MDP Line B	Directly connected outfall to Cucamonga Creek; slight amount of sheet flow
Schleishman Road Storm Drain	Directly connected outfall to Cucamonga Creek; slight amount of sheet flow
Chandler Street Channel	No flow observed, completely dry channel; observation from Hellman Avenue overcrossing
County Line Channel	Observed flow downstream to Cucamonga Creek

[1] Previous 2007-08 USEP Monitoring Program site

Table 2. Selected Flow Monitoring Locations, Riverside County

Flow Site	Site Description
Tributary to Santa Ana River	
US-BXSP	Box Springs Channel at Tequesquite Avenue
US-SNCH	Sunnyslope Channel near confluence with SAR
US-ANZA	Anza Drain upstream of confluence of Riverside effluent channel
Tributary to Cucamonga Creek	
US-CLCH	County Line Channel near confluence with Cucamonga Creek
US-EVLA	Eastvale MPD Line A – Outfall discharges to Cucamonga Creek on east side of channel at near 65th Street.
US-EVLB	Eastvale MPD Line B - Outfall discharges to Cucamonga Creek on east side of channel at just downstream of Schleishman Ave overcrossing.
US-SRSD	Schleishman Road Storm Drain - outfall discharges to Cucamonga Creek on west side of channel at Schleishman Road

San Bernardino County MS4 Outfalls/Channel Locations

CDM coordinated with SBCFCD staff to identify at least five MS4 outfall/channels to collect dry weather flows. CDM presented for SBCFCD review a recommended list of locations to conduct additional flow measurements. Table 3 summarizes SBCFCD staff observations at outfalls/channels visited on March 30 and April 6, 2011. SBCFCD staff also made visual estimates of flow by conducting windshield surveys of other outfalls in the area.

Table 3. Potential Flow Monitoring Locations, San Bernardino County

MS4 Outfall/Channel	Field Observations
Tributary to San Antonio Channel	
Chino-Central Storm Drain	Small discharge; drain outlet is at same elevation of channel invert leading to backflow and ponding into drain outlet; accurate flow measurement not possible
Boys Republic South Channel	Observed constant flow; invert allows for easier flow measurement
Yorba-Chino Storm Drain	Drain outlet is at same elevation of channel invert leading to backflow and ponding in drain outlet; accurate flow measurement not possible
San Antonio Channel at Riverside Drive	Slight flow observed
Tributary to Cucamonga Creek	
Cucamonga Creek at Chino Avenue	Observed runoff mixes with Inland Empire Utilities Agency recycled water
Airport Drive Storm Drain	Storm drain has four separate discharge outlets to the channel; flows to channel observed had shallow depth
Tributary to SAR	
San Sevaine Channel at Philadelphia Street	DWF with very shallow depth; flows split into different separate ribbons; challenge to collect flow measurement

Based on SBCFCD staff knowledge of typical DWF conditions and field observation, seven MS4 flow locations were selected for DWF measurements (Table 4 and Figure 1). Sites were

prioritized based on ability to measure an accurate flow reading. Many outfalls have physical constraints such that flow from the channel backflows into the outfall pipe which makes flow measurements challenging, requiring entry into confined spaces in the outfall pipes.

Table 4. Selected Flow Locations, San Bernardino County

Flow Location	Site Description
Tributary to Cucamonga Creek	
US-CUC57	Outfall located upstream of Union Pacific Railroad
US-CUC25	Outfall located 110-ft downstream of Riverside Avenue
Tributary to San Antonio Channel	
US-CHSD	Chino Storm Drain at San Antonio Channel
US-SAC21	Outfall located 1/4 mile downstream of Grand Avenue
US-BRSC	Boys Republic South Channel
US-SAC13	Outfall located below Pipeline Avenue / State Route 71
Tributary to Santa Ana River	
US-SSCH-PHIL	San Sevaine Channel at Philadelphia Street, near county line

2011 Dry Season Flow Monitoring

Flow monitoring for the 14 selected MS4 outfalls/channels commenced on April 19 and concluded on June 24, 2011 (Figure 1). In addition to these flow sites, Figure 1 also includes US-CHINOCRK and US-BXSP monitoring locations. US-CHINOCRK was monitored for bacterial indicators and flow as part of a Task 2.2 - Preliminary Characterization of Bacteria Loading in Pomona and Claremont. US-BXSP was also monitored as part of Task 2.1 – Box Springs Channel Follow-up Study.

Table 5 lists the combined flow locations in the MSAR watershed located in both San Bernardino and Riverside County jurisdictions. SBCFCD staff recorded flows at seven MS4 outfalls/channels within SBCFCD jurisdiction, while CDM conducted monitoring at seven locations within RCFC&WCD jurisdiction. Flow measurements were collected weekly for ten weeks at varying times and days using methods established in the MSAR Water Quality Monitoring Plan, May 2011.

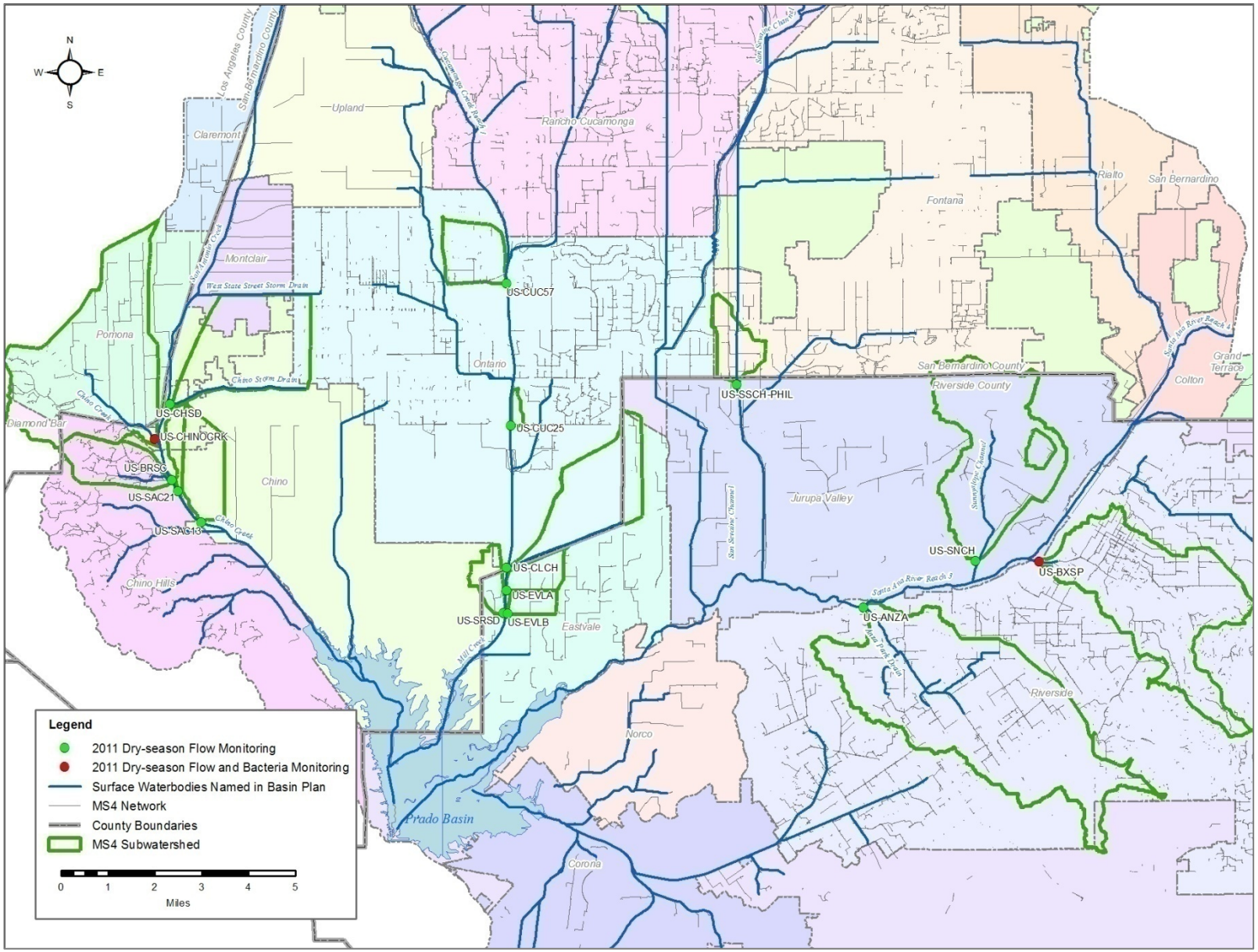

Figure 1. 2011 Dry Weather Flow Monitoring Locations

Table 5. Flow Locations within MSAR Watershed

Flow Location	Site Description
Tributary to Santa Ana River	
US-BXSP[1]	Box Springs Channel at Tequesquite Avenue
US-SNCH	Sunnyslope Channel near confluence with SAR
US-ANZA	Anza Drain upstream of confluence of Riverside effluent channel
US-SSCH-PHIL	San Sevaine Channel at Philadelphia Street
Tributary to Cucamonga Creek	
US-CUC57	Outfall located upstream of Union Pacific Railroad
US-CUC25	Outfall located 110-ft downstream of Riverside Avenue
US-CLCH	County Line Channel above confluence with Cucamonga Creek
US-EVLA	Eastvale MPD Line A – Outfall discharges to Cucamonga Creek on east side of Cucamonga Creek channel south of 65th Street
US-EVLB	Eastvale MPD Line B - Outfall located on east side of Cucamonga Creek channel just downstream of Schleishman Avenue overcrossing
US-SRSD	Schleishman Road Storm Drain - outfall located on west side Cucamonga Creek channel at Schleishman Road
Tributary to Chino Creek	
US-CHINOCRK[2]	Chino Creek upstream of confluence with San Antonio Channel
Tributary to San Antonio Channel	
US-CHSD	Chino Storm Drain at San Antonio Channel
US-SAC21	Outfall located 1/4 mile downstream of Grand Avenue
US-BRSC	Boys Republic South Channel
US-SAC13	Outfall located below Pipeline Avenue / State Route 71

[1] US-BXSP: Initial five weeks of flow measurements collected by RCFC&WCD; latter 5 weeks of flow collected by CDM

[2] US-CHINOCRK: Flow measurements collected as part of Preliminary Characterization of Bacteria Loading from MS4 in Pomona (reported in Task 2.2 Technical Memorandum).

2011 Dry Weather Flow Monitoring Results

Table 6 shows the range of DWF measurements from all MS4 outfall/channel locations monitored during the 2011 dry weather period. Within the Chino and Cucamonga Creek watersheds, these measurements provide information for MS4 outfalls that were not characterized in the original Urban Source Evaluation Plan (USEP) Monitoring Program (2007-2008), increasing the monitored urbanized drainage area by 16,800 acres. Figure 2 shows that there are still unmonitored areas for assessment in upcoming years, but that the 2011 dry season provided data for about 40 percent of the MS4 drainage area that was not evaluated in the original USEP Monitoring Program.

Table 6 also estimates the urban runoff generation rate (gal/acre/day) by comparing the median of DWF measurements with the upstream MS4 drainage area. Urban runoff generation rates vary widely between the 2011 dry season monitoring sites. As expected, relatively high rates (> 100 gal/ac/day) were measured at outfalls where SBCFCD and RCFC&WCD staff have observed

groundwater inputs occur via springs in unlined channels or weep holes in concrete lined channels; such as drainage from Boys Republic South Channel, Chino Creek, Sunnyslope Channel, Box Springs Channel, and Anza Drain. Conversely, several sites with MS4 drainage areas in the Cities of Chino and Ontario had very low rates of urban runoff generation.

Table 6. Flow Results for 2011 Dry Weather Flow Monitoring

Location	Dry Weather Flow (cfs)			Drainage Area (acre)	Urban Runoff Rate (gal/ac/day)
	Min	Max	Median		
Chino Creek at Central Avenue (WW-C7)					
US-CCCH	2.30	15.31	6.55	1,766	2,396
US-SACH	0.17	1.25	0.71	5,031	91
US-CHSD	0.00	0.07	0.015	3,224	3
US-CHINOCRK	1.12	2.94	1.49	6,036	159
US-BRSC	0.08	1.08	0.33	1,161	181
US-SAC21	0.06	0.39	0.09	312	178
US-SAC13	0.00	0.06	0.01	1,148	5
Cucamonga Creek at Chino Corona Road (WW-M5)					
US-CHRIS	0.25	1.72	0.79	3,091	165
US-CLCH	0.00	2.00	0.06	373	95
US-CUC	1.30	4.63	2.77	602	2,974
US-CUC57	0.01	0.06	0.02	1,051	13
US-CUC25	0.001	0.01	0.005	98	33
US-CLCH	0.00	0.13	0.00	2,474	0
US-EVLA	0.01	0.19	0.05	499	69
US-EVLB	0.00	0.01	0.00	335	0
US-SRSD	0.003	0.09	0.05	463	73
Santa Ana River at MWD Crossing (WW-S1)					
US-BXSP	0.50	3.66	1.50	5,632	172
US-SNCH	1.15	3.18	1.96	4,646	273
Santa Ana River at Pedley Ave (WW-S4)					
US-ANZA	2.12	6.08	2.81	9,268	196
US-DAY	0.00	4.91	0.52	2,759	122
US-SSCH	0.00	11.84	1.30	2,489	338
US-SSCH-PHIL	0.00	1.75	0.01	788	8

Discussion

Based on monitoring data from the watershed-wide compliance monitoring program and USEP Monitoring Program, the San Bernardino County and Riverside County MS4 Programs have each developed a long term dry weather Comprehensive Bacteria Reduction Plan (CBRP)

designed to achieve compliance with urban wasteload allocations under dry weather conditions. Understanding dry weather hydrology is critical in implementing the CBRP, Attachment B.2 – Dry Weather Hydrology (CBRP, June 28, 2011), evaluates DWFs within the MSAR watershed on a watershed-wide compliance site basis (please refer to the CBRP for more background discussion). The following section updates findings based on the additional flow monitoring data obtained during the 2011 dry season for each Watershed-wide compliance monitoring site.

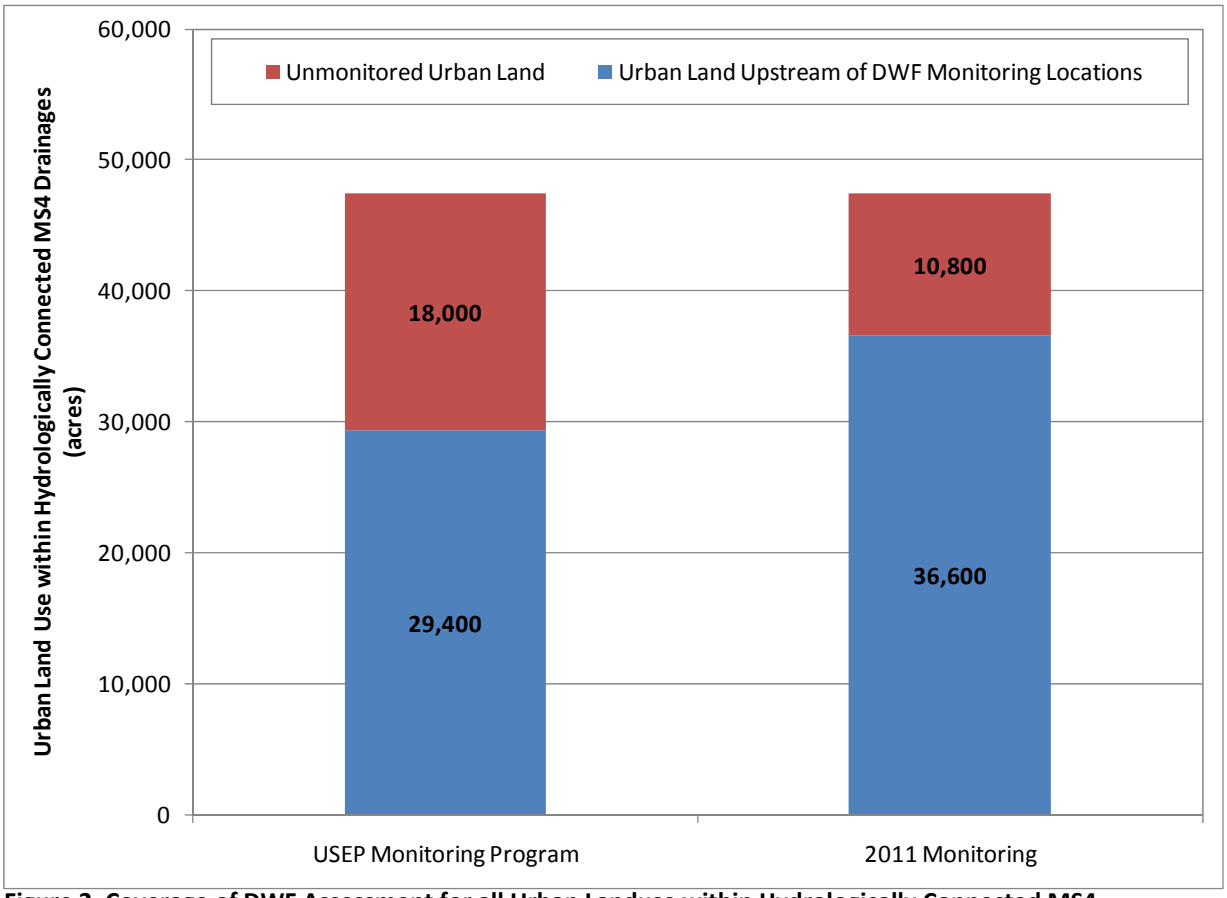

Figure 2. Coverage of DWF Assessment for all Urban Landuse within Hydrologically Connected MS4 Drainage Area within the MSAR Watershed (post 2007 USEP Monitoring Program; post 2011

Chino Creek at Central Avenue (WW-C7)

New flow sites at US-CHINOCRK, US-BRSC, and US-SAC21 have urban runoff generation rates ranging from 159 to 178 gal/acre/day (Table 6). DWF from the drainage areas upstream of these sites is higher than was assumed (100 gal/ac/day) in the CBRP. The US-CHINOCRK site captures DWF from most of the City of Pomona's drainage area within the MSAR watershed. DWF measured at this site ranged from 1.1 to 3.0 cfs, with a median of 1.5 cfs, which equates to approximately 15 percent of the DWF from the MS4 to Chino Creek.

Mill-Cucamonga Creek at Chino Corona Road (WW-M5)

The results from 2011 DWF monitoring sites upstream of this watershed-wide compliance site show that these outfalls (US-CUC57, US-CUC25, US- CLCH, US-EVLA, US-EVLB, and US-SRSD) contribute very small volumes (<0.05 cfs) of DWF to Cucamonga Creek. DWF at US-CLCH in 2007 was 0.06 cfs (median), which was similar to median DWFs in 2011 from other MS4 outfalls to Cucamonga Creek. DWF from US-CHRIS in 2007 was 0.79 (median) and is therefore a more significant source of urban DWF to Cucamonga Creek than other monitored outfalls.

In 2011, DWF measurements were taken at US-CUC57, which discharges to the segment of Cucamonga Creek downstream of the Turner Basins and upstream of the US-CUC site. DWF measurements showed very low DWF (median of 0.02 cfs). In addition, SBCFCD windshield surveys evaluated all 36" diameter and larger outfalls in this segment of Cucamonga Creek. These surveys identified only minimal additional DWF, which could not explain the DWF in Cucamonga Creek above RP1. Therefore, DWF in Cucamonga Creek above RP1 is most likely from MS4 discharges that bypass or flow through the Turner Basins. IEUA is currently developing a project to improve operations at the Turner Basins, which will improve the capacity to capture urban DWF from Upper Deer and Cucamonga Creeks.

Santa Ana River at MWD Crossing (WW-S1)

Sources of urban runoff to the Santa Ana River at MWD Crossing during the dry season are limited to two key tributaries; Sunnyslope Channel and Box Springs Channel. In 2011, DWF at US-SNCH was 1.96 cfs (median) compared to 2.9 cfs in 2007. For US-BXSP, median DWF was 1.50 cfs compared to 3.33 cfs in 2007.

CDM and RCFC&WCD conducted field observations of other potential MS4 discharges to the Santa Ana River upstream of the MWD Crossing site on March 17, 2011. With one exception, no measurable DWF was observed to connect to the Santa Ana River from other MS4 drainages in this watershed including High Grove Channel, Agua Mansa Storm Drain, Phoenix Storm Drain, and a few other minor outfalls along the north side of the river. For Magnolia Storm Drain, significant DWF was observed at the outfall; however the distance from the MS4 outfall to the mainstem of the SAR is approximately one-half mile, over which recharge into the river bottom sediment occurs. Observations at Magnolia Storm Drain and other MS4 outfalls should continue to assess DWF connectivity or confirm that the lack of DWF is consistent.

Santa Ana River at Pedley Avenue (WW-S4)

In the 2011 dry season, DWF measurements were recorded for the Anza Drain tributary to the Santa Ana River at a location ~1,000 feet upstream of the US-ANZA site from the 2007 USEP Monitoring Program which resulted in a negligible increase in upstream drainage area . The new site facilitated access to a larger cross-sectional area with unobstructed flow, where more measurements were recorded in developing a velocity profile. The 2011 DWF measurements result in a reduced DWF estimate for Anza Drain (from 6.3 cfs in 2007 to 2.8 cfs in 2011). This revised flow is more comparable to measurements taken during a single day field survey in 2002

by RCFC&WCD[1], which suggested DWF flows to be is less than 1.5 cfs. Other sources of urban DWF from MS4s in this watershed include San Sevaine Channel and Day Creek. SBCFCD field observations for the 2011 dry season included 10 visits to San Sevaine Channel at the county line near Philadelphia Street (US-SSCH-PHIL). Most of San Sevaine Channel within San Bernardino County is upstream of the Jurupa and Declez Basins, where urban DWF is spread for groundwater recharge. At the US-SSCH-PHIL site, one flow reading was particularly high (1.75 cfs in early June 2011) compared to the average of less than 0.02 cfs for the remaining weeks. The field observations confirm that DWF is effectively captured in Jurupa Basin and that MS4 outfalls between the Jurupa Basin and county line generate minimal DWF (<0.05 cfs). The remainder of flow in San Sevaine Channel that reaches the Santa Ana River comes from MS4 outfalls in the City of Jurupa Valley or non-urban discharges.

Field observations of other potential MS4 discharges to the Santa Ana River upstream of the Pedley Avenue site were conducted on March 17, 2011 by CDM and RCFC&WCD. During these field observations, no measurable DWF was observed from any other sites in this watershed. Observations at these outfalls should continue to confirm that the lack of DWF is consistent.

Summary of Findings

Additional DWF measurements taken at existing and new urban source evaluation sites showed that urban runoff generation was less than the assumed value of 100 gal/ac/day for unmonitored outfalls in the assessment of urban sources from the 2007 USEP Monitoring Program, except in the Chino Creek watershed. The data collected in the 2011 dry season was used to revise the bacterial indicator source contribution analysis, as described in the Technical Memorandum for Task 2.4, Calculate Mass Balance for Dry Weather Conditions.

Analysis of Variability of Dry Weather Flow

Additional DWF measurements were taken at Anza Drain, Box Springs Channel, and Sunnyslope Channel. These measurements increase the robustness of DWF estimates at these tributaries from the MS4 to the Santa Ana River. In the case of Anza Drain, the measurements taken in the 2011 dry season were significantly lower than from the 2007 dry season. In 2011, a new field method was employed to measure flow. The new method involved moving the cross section for determining a velocity profile by ~200 ft to a location with more uniform flow and better access, which allowed for velocity readings at more intervals across the section. Therefore the dataset was reduced to the ten measurements from the 2011 dry season.

For Sunnyslope Channel, the data collected in the 2011 dry season increases the DWF dataset from 10 to 20 measurements. The coefficient of variation from the 2007-2008 USEP Monitoring Program and 2011 dry season measurements was relatively low; therefore, additional measurements at this site are not a high priority.

[1] RCFC&WCD staff, Clark and Clem, conducted flow field survey at Anza Drain in 2002.

Increasing the number of flow observations at dry outfalls in the MSAR provides additional statistical power to assessments of water balance at watershed-wide compliance sites during dry weather conditions. Power analysis is suited for naturally occurring variables, and therefore is not applied to approximate level of monitoring activities for variables that are controlled by human behavior. Urban DWF in the MSAR watershed is primarily controlled by human behavior. Sources range from actions by individuals that are relatively small but widespread such as illicit discharges and excess outdoor water use, to relatively high volume inputs at specific points by water and wastewater agencies such as tertiary treated effluent from POTWs, imported water turnouts, other water transfers, and temporary de-minimus discharges.

One important consideration in developing outfall monitoring programs is the diurnal pattern of outdoor water use. Accordingly, the CBRP Inspection Program includes assessment of DWF during different times of day as well as seasons to account for variability associated with diurnal outdoor water use patterns in the watershed. Data obtained from the CBRP Inspection Program will continue to be evaluated to understand specific sources of DWF in MS4 drainage areas in order to select appropriate controls for prioritized outfalls based on source contribution analysis.

Attachment D

Calculate Mass Balance for Dry Weather Conditions (Task 2.4)

Memorandum

To: *Rick Whetsel, SAWPA*

From: *Richard Meyerhoff, CDM*
Steven Wolosoff, CDM

Date: *August 12, 2011*

Subject: *Source Evaluation - Task 2.4 Dry Weather Bacterial Indicator Mass Balance*

The role of discharges from municipal separate storm sewers systems (MS4s) in receiving water bacterial quality was evaluated in the USEP Study in the dry seasons of 2007 and 2008. Generally, this characterization provided monitoring data from most urban drainages upstream of watershed wide TMDL compliance monitoring sites. The Comprehensive Bacteria Reduction Plan (CBRP) synthesized these data to approximate the bacterial indicator source contribution from MS4s for each of the Middle Santa Ana River (MSAR) Bacteria TMDL compliance monitoring sites.

In the dry season of 2011, additional dry season bacterial indicator and flowrate data were collected at key MS4 outfalls that were not monitored as part of the original USEP Study or where additional data was needed to support source characterization. This technical memorandum updates the MSAR bacterial indicator source contribution analysis for average dry season conditions based on the results of 2011 dry season source evaluation monitoring activities. The original data for this analysis are summarized in the CBRP. New data used incorporated into this updated analysis are described in the following technical memoranda:

- Source Evaluation Task 2.1 Box Springs Channel Follow-up Study
- Source Evaluation Task 2.2 Preliminary Characterization of Bacteria Loading in Pomona And Claremont
- Source Evaluation Task 2.3 Survey of Dry Weather Flows from MS4 Outfalls to Major Tributaries.

Data Summary

For each of the 2007-2008 USEP Study sites, data were collected for dry weather flow (DWF) rates and bacterial indicator concentration. In the 2011 dry season, follow up DWF measurements were performed at Anza Drain (US-ANZA), Box Springs Channel (US-BXSP), County Line Channel (US-CLCH), and Sunnyslope Channel (US-SNCH). In addition, DFW

measurements were collected at nine new outfalls from MS4 systems in both San Bernardino and Riverside Counties to receiving waterbodies (Figure 1).

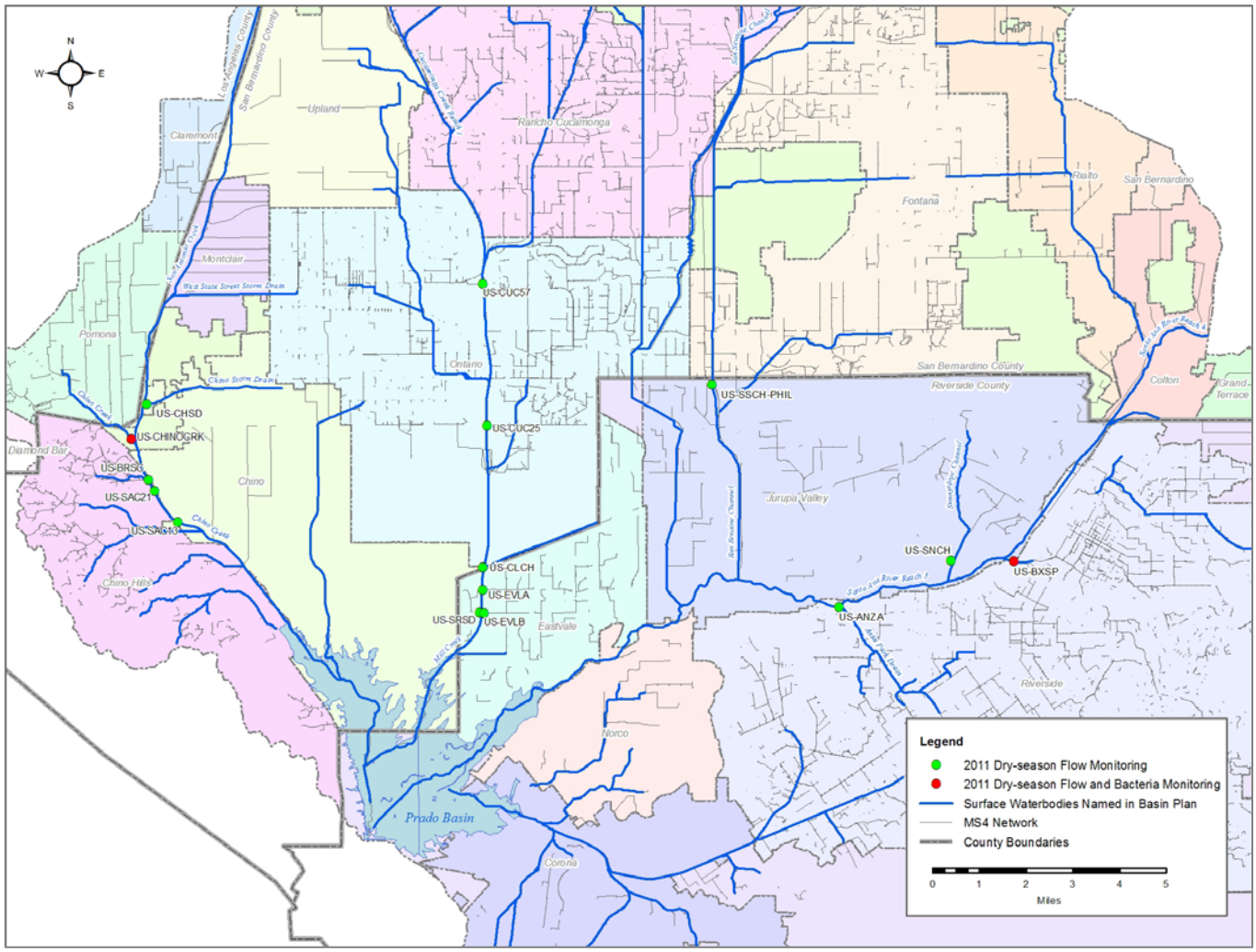

Figure 1. 2011 Dry Season DWF and Bacterial Water Quality Monitoring Sites

While DWF measurements were recorded weekly for 10 weeks in the 2011 dry season, bacterial indicator samples were only collected at two sites; Box Spring Channel (US-BXSP) and Chino Creek above San Antonio Creek (CHINOCRK). To allow for estimation of bacterial indicator loads to receiving waterbodies, the median *E. coli* concentration from all source evaluation monitoring samples in the MSAR watershed from the 2007 and 2011 dry seasons (560 cfu/100 mL) was assumed for MS4 systems discharges without any data.

Source Contribution Analysis

Relative source contribution analyses were prepared for each of the watershed-wide compliance locations. This analysis provided a comparison of monitored inputs of DWF (Q_{inflow}) and

bacterial indicator concentrations (C_{inflow}) from MS4 facilities and POTWs with downstream flow (Q_{comp}) and bacterial indicator concentrations (C_{comp}), as follows:

$$FIB_{comp} = Q_{comp} * C_{comp} = \left[\sum_{i}^{j} Q_{inflow} * C_{inflow}\right] + e$$

This type of analysis characterizes the relative role of different flow sources in the watershed on downstream bacterial indicator concentrations. An important outcome of this analysis is the identification of the level of bacterial indicators (e) at the compliance locations that cannot be explained by known DWF sources within the watershed (referred to as "unaccounted-for sources"). The presence of an unbalanced set of inputs and outputs in relation to downstream bacterial indicator levels is not surprising, given the potential for increases in bacteria indicator levels from illegal and illicit discharges, direct input from wildlife, air deposition, transient encampments, environmental growth, or resuspension, or decreases in bacterial indicator levels due to environmental decay or settling.

Source Contribution Results

Table 1 provides the average DWF (column 2) and bacteria concentrations (column 3) used to estimate *E. coli* loads (column 4) from MS4 drainages and total loads at downstream compliance monitoring sites. The difference between loads from urban source evaluation sites and watershed wide TMDL compliance sites approximates the contribution of MS4s discharges to receiving water impairments relative to other unaccounted-for sources of bacterial indicators. This table is equivalent to Table 3-2 in the CBRP. Highlighted cells indicate data that were updated based on source evaluation activities completed during the 2011 dry season.

The relative source contribution analysis shows high amounts of unaccounted-for bacterial indicators at all four compliance points during DWF in the dry season (Figure 2). The following sections discuss the findings of the this analysis and remaining data gaps specific to each watershed-wide compliance monitoring location.

The relative source contribution analysis shows high amounts of unaccounted-for bacterial indicators at all four compliance points during DWF in the dry season (Figure 2). The following sections discuss the findings of the this analysis and remaining data gaps specific to each watershed-wide compliance monitoring location.

Table 1. Source Contribution Analysis for *E. coli* in Dry Season for Each Watershed Wide Bacterial Indicator TMDL Compliance Site in the MSAR Watershed

Site	Hydrologically Connected MS4 Acres	Dry Weather Runoff (cfs)	Dry Weather Geometric Mean of *E. coli* (cfu/100ml)	Dry Weather *E. coli* (cfu/day)
Santa Ana River at MWD Crossing (WW-S1)	6,297	73.2	149	265
POTW Influent	n/a	68.7	2	4
USEP SNCH	2,104	2.0	183	9
USEP BXSP	4,193	1.8	1,549	69
MS4 Runoff		4.5		78
Unaccounted-for Sources				183
Santa Ana River at Pedley Ave (WW-S4)	17,921	55.5	149	202
POTW Influent	n/a	49.4	2	3
USEP ANZA	6,335	3.3	492	38
USEP DAY	2,759	0.5	577	7
USEP SSCH	2,489	1.3	320	10
Other MS4 Areas [1]	6,338	1.0	560 [2]	13
MS4 Runoff		6.1		69
Unaccounted-for Sources				131
Chino Creek at Central Ave (WW-C7)	17,678	19.0	394	183
POTW Influent	n/a	8.8	2	0.5
USEP CCCH	1,766	6.5	61	10
USEP SACH	5,031	0.7	412	7
CHINOCRK	4,357	1.7	499	21
BRSC	707	0.4	560 [2]	5
SAC13	1,080	0.02	560 [2]	0
SAC 21	266	0.1	560 [2]	2
Other MS4 Areas [1]	4,472	0.7	560 [2]	9
MS4 Runoff		10.2		54
Unaccounted-for Sources				128
Mill Creek at Chino Corona Rd (WW-M5)	5,510	30.9	877	663
POTW Influent	n/a	27.1	2	1
USEP CHRIS	3,091	0.8	868	17
USEP CLCH	373	0.1	1,194	2
USEP CUC	602	2.8	139	9
CUC57	760	0.02	560 [2]	0
CUC25	38	0.01	560 [2]	0
EVLA	184	0.1	560 [2]	1
EVLB	45	0.004	560 [2]	0
SRSD	417	0.1	560 [2]	1
MS4 Runoff		3.8		30
Unaccounted-for Sources				632

1) Other MS4 areas include all MS4 outfalls to receiving waterbodies where DWF measurements have not been recorded. For these areas, the source contribution analysis assumed a DWF generation rate of 100 gallons per day per acre of urbanized land use. DWF and bacterial indicator concentrations for these areas will be evaluated through CBRP source evaluation activities prior to 2015 and IDDE programs.

2) Median of all 2007 and 2011 dry season *E. coli* samples from MS4 systems

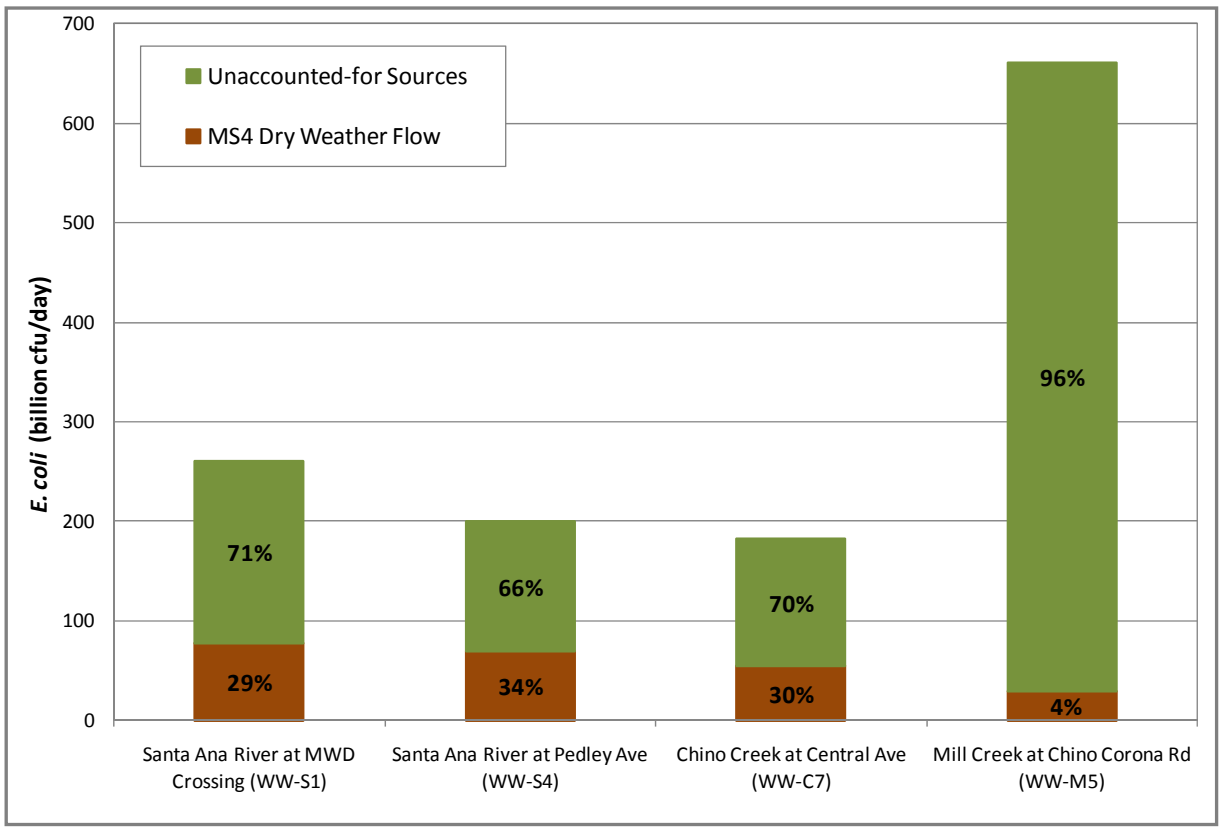

Figure 2. Relative Contribution of Bacterial Indicators from MS4 Discharges to Total Downstream Loading

Santa Ana River at MWD Crossing

Sources of urban runoff to the Santa Ana River at MWD Crossing during the dry season are limited to two key tributaries; Sunnyslope Channel and Box Springs Channel. Sunnyslope Channel DWF includes mostly rising groundwater and therefore has significantly lower *E. coli* concentrations than other USEP sites. Conversely, Box Springs Channel was the single highest priority site based on ranking from the 2007 USEP Study. One of the reasons for this was the presence of human source bacteria in the majority of samples collected in 2007. In 2008, Riverside County Flood Control and Water Conservation District (RCFC&WCD) and the City of Riverside discovered that a single restroom toilet located in the Sam Evans Sports Complex on the Riverside Community College (RCC) Campus was inadvertently connected to a storm drain pipe rather than a sewer line. Data collected after the elimination of this source of bacteria in Box Springs Channel indicated the elimination of human polymerase chain reaction (PCR) markers in runoff from Box Springs Channel. Despite this correction, follow up monitoring of bacterial indicators at Box Springs Channel in the 2011 dry season showed that this MS4 drainage area remains to be a high priority for non-human bacterial indicators.

Field observations of other potential MS4 discharges to the Santa Ana River upstream of the MWD Crossing site were conducted on March 17, 2011 by CDM and RCFC&WCD. With one

exception, these observations found no measurable DWF was observed to connect to the Santa Ana River from other MS4 drainages in this watershed including High Grove Channel, Agua Mansa Storm Drain, Phoenix Storm Drain, and a few other minor outfalls along the north side of the river. For Magnolia Storm Drain, significant DWF was observed at the outfall; however the distance from the MS4 outfall to the mainstem of the SAR is approximately one-half mile, over which recharge into the river bottom sediment may occur. Observations at Magnolia Storm Drain and other MS4 outfalls should continue to assess DWF connectivity or confirm that the lack of DWF is consistent.

Santa Ana River at Pedley Avenue

In the 2011 dry season, DWF measurements were recorded for the Anza Drain tributary to the Santa Ana River. The cross section used to collect the flow measurement allowed for a more accurate reading than was obtained in 2007 during the original USEP Study. Reduced estimates of DWF from Anza Drain (from 6.3 cfs in 2007 to 3.2 cfs in 2011) resulted in a reduction in the urban MS4 source contribution to *E. coli* loads in the Santa Ana River.

Other sources of urban DWF from MS4s in this watershed include San Sevaine Channel and Day Creek. San Bernardino County Flood Control District (SBCFCD) field observations for the 2011 dry season included 10 visits to San Sevaine Channel at the county line. Most of San Sevaine Channel within San Bernardino County is upstream of the Jurupa Basin, where urban DWF is spread for groundwater recharge. The field observations confirm that DWF is effectively captured in Jurupa Basin and that MS4 outfalls between the Jurupa Basin and county line generate minimal DWF during typical operating conditions (<0.05 cfs).

Field observations of other potential MS4 discharges to the Santa Ana River upstream of the Pedley Avenue site were conducted on March 17, 2011 by CDM and RCFC&WCD. During these field observations, no measurable DWF was observed from any other MS4 outfalls in this watershed. Observations at these MS4 outfalls should continue to confirm that the lack of DWF is consistent.

Mill-Cucamonga Creek at Chino Corona Road

Mill-Cucamonga Creek has the largest fraction of unaccounted for bacteria of the impaired waterbodies in the MSAR watershed. Additional DWF measurements of outfalls to Cucamonga Creek were conducted in the 2011 dry season to characterize outfalls that were not assessed in the 2007 dry season USEP Study. Weekly DWF measurements at five key MS4 outfalls (EVLA, EVLB, SRSD, CUC 25, and CUC57) downstream of the Turner Basins were recorded for 10 consecutive weeks. The results showed that these outfalls contribute less than expected volumes of DWF to Cucamonga Creek, thus the unaccounted-for source of bacterial indicators in this watershed may not be attributable to previously unmonitored MS4 discharges.

The 2007 dry season DWF measurements at US-CUC (Cucamonga Creek above RP1) are high relative to expected DWF generation rates, if all MS4 drainage areas upstream of the Turner Basins are hydrologically disconnected. Thus, it was important to assess MS4 sources to

Cucamonga Creek downstream of the Turner Basins, largely between Highway 10 and Highway 60 in the City of Ontario. In 2011, DWF measurements were taken at a MS4 outfall, which discharge to this segment of Cucamonga Creek (CUC57). DWF measurements at this outfall showed very low DWF (average of 0.02 cfs). In addition, SBCFCD windshield surveys evaluated all 36" diameter and larger outfalls in this segment of Cucamonga Creek. These surveys identified only minimal additional DWF, which could not explain the DWF in Cucamonga Creek above RP1. Therefore, DWF in Cucamonga Creek above RP1 is most likely from MS4 discharges that bypass or flow through the Turner Basins. Inland Empire Utilities Agency is currently developing a project to improve operations at the Turner Basins, which will improve the capacity to capture urban DWF from Upper Deer and Cucamonga Creeks. It is important to note that reducing DWF in Cucamonga Creek above RP1 will only address the portion of downstream bacteria loads that could be attributed to MS4 discharges (~5 percent). Source evaluation activities included in the CBRP will attempt to characterize the unaccounted-for fraction of bacterial indicators, which are the predominant cause for non-compliance.

Chino Creek at Central Avenue

In the Chino Creek watershed, there were several key tributaries that were not monitored during the 2007 dry season USEP Study. New data obtained in the dry season of 2011 improved the characterization of urban DWF and bacterial indicators in this watershed. DWF measurements and bacterial indicator samples were collected from Chino Creek upstream of the San Antonio Creek confluence (CHINOCRK). This tributary captures DWF from most of the City of Pomona's MS4 drainage area within the MSAR watershed. The data indicate an average *E. coli* concentration of 500 cfu/100, which is comparable to the assumed concentration used in previous source contribution analyses. DWF measurements were also taken in a major MS4 outfall to San Antonio Creek, which also includes drainage from the City of Pomona. With an assumed *E. coli* concentration for this MS4 discharge of 500 cfu/100mL (median of all 2007 and 2011 dry season samples from MS4 systems), the combined loading from City of Pomona accounts for approximately 40 percent of all *E. coli* loads attributed to urban DWF sources in the Chino Creek watershed.

Other DWF measurements during the 2011 dry season increased source contribution analysis input data for MS4 discharge to Chino Creek. Accordingly, the relative role of MS4 sources to bacterial indicator loads in Chino Creek at Central is greater than approximated in the CBRP, increasing the estimated contribution of *E. coli* loads from MS4s to 30 percent.

Summary of Findings

DWF measurements and windshield surveys, and bacterial water quality samples collected in the 2011 dry season provided some key information necessary to understand the sources of bacterial indicators in the MSAR watershed. Each of the following findings characterizes specific MS4 drainage areas and will be used to guide future source evaluation activities to be completed as part of CBRP implementation:

- Non-human sources of bacterial indicators at Box Springs Channel are a high priority in the Santa Ana River at MWD Crossing watershed.

- DWF from the Anza Drain MS4 drainage area is 50 percent less than measured in the 2007 dry season. Flow measurements taken in the 2011 dry season involved an improved approach, using a better cross section and more readings in developing a cross-sectional velocity profile to compute flowrate. Consequently, MS4s have reduced relative source contribution to total bacterial loads in the Santa Ana River at Pedley Avenue watershed.

- DWF measurements and windshield surveys suggest that unaccounted-for bacterial indicator loads may be predominantly from non-urban sources in the Mill-Cucamonga Creek at Chino Corona Rd watershed.

- The Turner Basins do not typically capture 100 percent of DWF from the Upper Deer and Cucamonga Creek watersheds.

- Approximately 40 percent of the bacterial load in the Chino Creek watershed could be attributed to MS4 discharges from the City of Pomona.

Attachment E

Calculate Site-Specific Log Standard Deviation at Monitoring Sites (Task 2.5)

Memorandum

To: *SAWPA*

From: *CDM*

Date: *September 14, 2011*

Subject: *Source Evaluation Task 2.5 - Site-Specific Log Standard Deviation at Middle Santa Ana River Watershed Monitoring Sites*

Task Overview

Antidegradation policy in the Clean Water Act requires that existing beneficial uses in all Waters of the US be protected by ensuring that water quality is maintained at levels sufficient to support such uses. Two methods for evaluating water quality monitoring data to assess whether antidegradation policy is achieved for bacterial water quality in the MSAR watershed were implemented as described in the following sections.

Single Sample Maximum Criteria

The EPA uses a default log standard deviation (LSD) of 0.4 for E. coli when calculating single sample maximum criteria. A local log standard deviation may be substituted for the default value where such data exist, which would result in different single sample maximum criteria. The potential to use a site-specific log standard deviation to establish site-specific single sample criteria has been incorporated into the Basin Plan amendment under development by the Stormwater Quality Standards Task Force. The purpose of this task is to calculate site-specific criteria for antidegradation objectives for waterbodies in the MSAR watershed. Sites included in this analysis include the five watershed-wide TMDL compliance monitoring sites (sampled regularly since 2007), major tributaries sampled in the 2007-2008 Urban Source Evaluation Plan (USEP) Monitoring Program[1], and one new urban source evaluation monitoring site sampled during the 2011 dry season (see Source Evaluation Task 2.2 Preliminary Characterization of Bacteria Loading in Pomona and Claremont).

Table 1 shows the geometric mean, 95th percentile, and potential antidegradation objectives based on the default LSD of 0.4 and site specific LSD for dry season *E. coli* for each site.

[1] SAWPA. 2008. *Middle Santa Ana River Water Quality Monitoring Plan*. Prepared by CDM on behalf of SAWPA and the Middle Santa Ana River Watershed TMDL Task Force. April, 2008.

The EPA Procedure for Estimating the Maximum Expected Concentration[2] estimates site-specific alternative single sample maximums for each site. This method assigns the 95th or 99th percentile of the fitted lognormal distribution as the single sample maximum. As shown in Figure 1, for sites with robust datasets (n > 100 for the five watershed-wide TMDL compliance sites), the 95th percentile of the data is similar to the 95th percentile of the lognormal distribution, because the data fit a lognormal distribution.

Table 1. Single Sample Maximum Criteria for *E. coli* at USEP and Watershed-Wide Monitoring Sites

Site Name	Number of Samples [1]	95th Percentile of Dry Weather *E. coli* Samples (cfu/100 mL)	95th Percentile of Lognormal Dist. With LSD of 0.4 (cfu/100 mL)	95th Percentile of Lognormal Dist. with Site Specific LSD (cfu/100 mL)
Urban Source Evaluation Sites				
US-ANZA	18	5,565	663	2,790
US-BXSP	23	5,910	2,487	19,056
US-CCCH	19	590	190	854
US-CHINOCRK	10	1,411	1,034	2,526
US-CHRIS	18	4,600	2,087	7,415
US-CLCH	7	8,170	1,498	43,612
US-CUC	19	3,930	367	6,264
US-CYP	12	32,625	5,204	17,699
US-DAY	13	6,200	902	3,977
US-SACH	18	4,205	739	8,838
US-SAR	5	6,360	1,792	21,725
US-SNCH	19	1,546	284	1,481
US-SSCH	14	4,090	704	6,086
US-TEM[1]	18	1,180	691	1,644
Watershed-wide TMDL Compliance Monitoring Sites				
WW-C3	131	740	230	688
WW-C7	128	1,929	624	1,563
WW-M5	127	3,380	1,180	3,537
WW-S1	125	400	263	510
WW-S4	123	489	263	474

[1] Outlier sample collected from Temescal Creek on 9/8/2007 was removed

[2] EPA, 1991. Technical Support Document for Water Quality Based Toxics Control. Report EPA/505/2-90-001

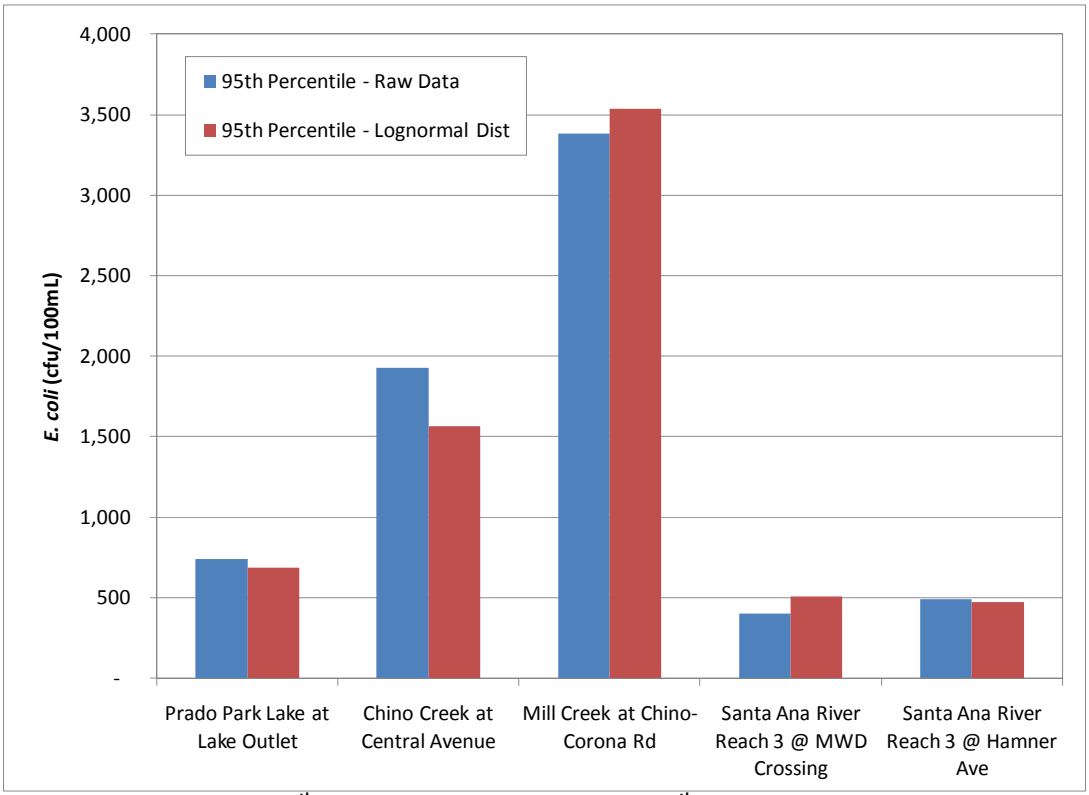

Figure 1. Comparison of 95th Percentile of *E. coli* Data with 95th Percentile of Lognormal Distribution (Site Specific Single Sample Maximum Criteria)

Maximum Expected Geometric Mean

Single sample criteria provide limited benefit for evaluation of potential degradation, because of the inherent sample-to-sample variability in bacterial indicators concentration. One alternative to using a single sample maximum objective is to use a maximum expected geometric mean. Land's Method[3] was applied to estimate the 95th percentile upper confidence limit for the geometric mean). When calculating geometric means based on new data, it is improbable that they would exceed the 95th percentile upper confidence limit, unless bacterial indicator quality was degraded. Table 2 summarizes the results of this analysis for all dry weather *E. coli* samples from USEP and watershed–wide TMDL compliance monitoring sites. The difference between the geometric mean of historical data and the maximum expected geometric mean is a function of the number of samples and variability of the original dataset. EPA's guidance document recommends that caution be used when applying this method because it is sensitive to potential outliers. Results shown for the USEP Study monitoring sites show that this method does not produce valuable results given the small dataset (n < 20) and higher variability (LSD > 3.0), therefore it is only recommended that this antidegradation objective be considered for the watershed-wide TMDL compliance monitoring sites. Figure 2 compares geometric means and

[3] EPA, 1991. Technical Support Document for Water Quality Based Toxics Control. Report EPA/505/2-90-001

95th percentile upper confidence limits for geometrics means for each watershed-wide monitoring site. The site with the greatest variability, Mill-Cucamonga Creek at Chino-Corona Road, has the greatest relative difference between the historical geometric mean and the 95th percentile upper confidence limit.

Table 2. Maximum Geometric Mean Criteria for *E. coli* at USEP Study and Watershed-Wide TMDL Compliance Monitoring Sites

Site Name	Number of Samples [1]	Geometric Mean (cfu/100 mL)	95th Percentile Upper Confidence Limit for Geometric Mean (cfu/100 mL)
US-ANZA	18	343	1,952
US-BXSP	23	1,302	16,720
US-CCCH	19	99	590
US-CHINOCRK	10	613	2,145
US-CHRIS	18	1,081	5,027
US-CLCH	7	776	65,180,370
US-CUC	19	190	16,467
US-CYP	12	2,695	15,640
US-DAY	13	467	3,769
US-SACH	18	382	17,315
US-SAR	5	928	47,647,003
US-SNCH	19	147	1,255
US-SSCH	14	364	11,038
US-TEM[1]	18	358	1,952
WW-C3	131	119	272
WW-C7	128	323	1,383
WW-M5	127	611	2,268
WW-S1	125	136	415
WW-S4	123	136	461

[1] Outlier sample collected from Temescal Creek on 9/8/2007 were removed

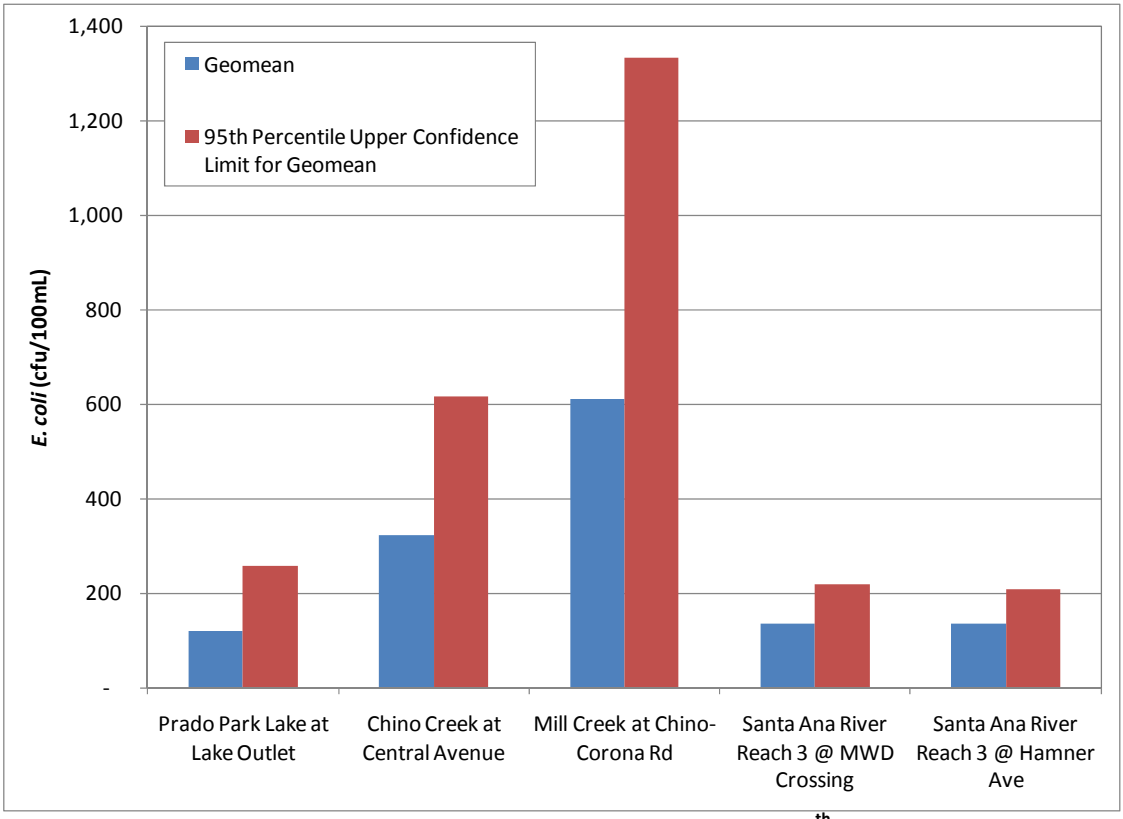

Figure 2. Comparison of Geometric Mean of Historical *E. coli* Data with 95th Percentile Upper Confidence Limit for Geometric Mean