

**County of San Diego
Water Quality Monitoring Services
2017-2018 Los Coches Creek Microbial Source Tracking
Dry Weather Follow-up Study**

Final Report

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Acronyms & Abbreviations

APHA	American Public Health Association
cfs	cubic feet per second
CFU	colony forming unit
COC	chain of custody
EDD	electronic data deliverable
EM&TS	Environmental Monitoring & Technical Services
FIB	fecal indicator bacteria
mL	milliliter
MPN	most probable number
QA/QC	quality assurance/quality control
SCCWRP	Southern California Coastal Water Research Project
SDR	San Diego River
USEPA	United States Environmental Protection Agency

1.0 INTRODUCTION

In 2010, the San Diego Regional Water Quality Control Board (San Diego Water Board) adopted the *Total Maximum Daily Loads for Indicator Bacteria, Project I – Twenty Beaches and Creeks in the San Diego Region* (San Diego Water Board, 2010). Three waterbody segments in the San Diego River Watershed Management Area were included in the total maximum daily load (TMDL) due to elevated levels of fecal indicator bacteria that were impairing beneficial uses.

The *Los Coches Creek Storm Drain Outfall Microbial Source Tracking Study* assessed dry weather discharges in the unincorporated portion of the Los Coches Creek watershed for potential sources of human fecal bacteria. The study focused on the collection of grab samples from storm drain outfalls for analysis of human-associated genetic markers and fecal indicator bacteria. The human-associated marker HF183 was detected at five of the 18 monitored outfalls (WESTON, 2017). Based on the levels of HF183 observed in the samples, three stations were selected for follow-up monitoring in this study.

2.0 MONITORING AND ASSESSMENT METHODS

2.1 Monitoring Locations and Sampling Events

Three County storm drain outfalls were identified for follow-up monitoring in the Los Coches Creek watershed (Table 1, Figure 1). Weston Solutions, Inc. (WESTON) field scientists visited the three outfalls during dry weather conditions (less than [$<$] 0.1 of rainfall in the previous 72 hours) on April 5, April 19, May 17, July 5, and July 26, 2018 between the hours of 8:00 am and 11:00 am. Grab samples were collected at each location if water was flowing or ponded.

Due to dry conditions on April 19 and May 17, 2018, samples could not be collected at station MS4-SDR-098. This station was subsequently revisited and successfully sampled on August 3, August 16, and August 31, 2018. Revisits were conducted between 4:00 am and 4:30 am in an effort to overlap with one of the peak periods of flow identified by the County’s continuous flow monitoring efforts.

Table 1. Los Coches Creek Microbial Source Tracking Monitoring Locations

Station ID	Outfall Location Description	Latitude	Longitude
MS4-SDR-098	Calle Lucia, 680' N. of Via Diego	32.84121	-116.916
MS4-SDR-207	Los Coches Road East, 200' E. of Los Coches Road	32.8327	-116.9053
SDR-780	End of East Los Coches Rd., behind unit 103 and Caltrans wall, near I-8	32.83635	-116.89258

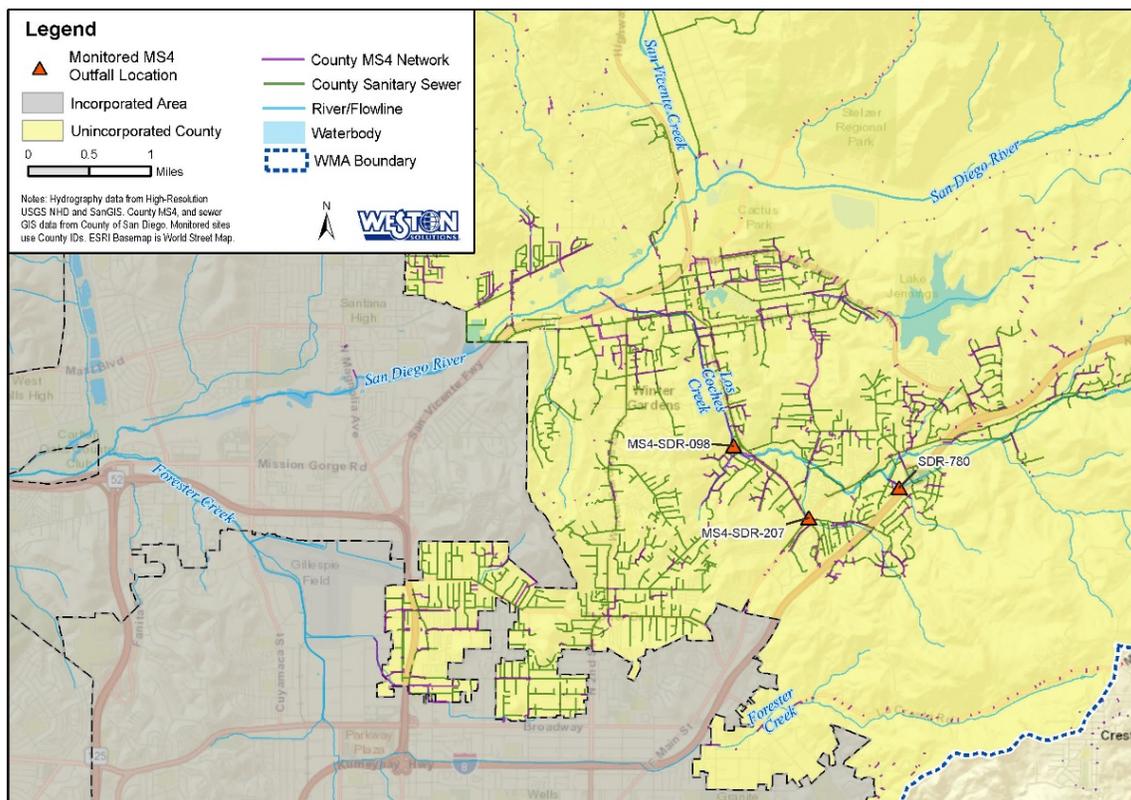


Figure 1. Los Coches Creek Microbial Source Tracking Follow-up Monitoring Locations

2.2 Sampling & Analysis Methods

Samples were collected by field scientists trained in proper sample collection and handling techniques. Samples for bacteria and HF183 analyses were collected in sterile sample bottles by trained personnel and placed into separate clean Ziploc bags. All samples were put on ice for transport to the laboratories for start of processing within eight hours. Chain-of-custody (COC) forms (Attachment A) were completed for each sample, and appropriate COC procedures were adhered to throughout the transport of the samples. Sample preservatives, where applicable, and holding time requirements were based on recommendations in *Standard Methods (SM) for the Examination of Water and Wastewater 22nd Edition* (American Public Health Association [APHA] et al., 2012) and applicable United States Environmental Protection Agency (USEPA) methods.

During each monitoring event, bacteria samples were collected and transported to either the City of San Diego Environmental Monitoring and Technical Services (EM&TS) Laboratory or Weck Laboratories (Weck) for analysis of *Enterococcus*, *E. coli*, and fecal coliform. Samples collected for HF183 analysis were transported to WESTON’s Molecular Laboratory.

Laboratory methods are summarized in Table 2. Methods differed between the EM&TS and Weck laboratories as noted in the table. Analysis of the human-associated fecal marker HF183 was performed by WESTON using quantitative polymerase chain reaction (qPCR).

Table 2. Monitored Parameters and Laboratory Methods

Analyte	Laboratory	Method
<i>E. coli</i>	EM&TS	SM9223B (IDEXX)
Fecal coliform		SM9222D (membrane filtration)
<i>Enterococcus</i>		Enterolert (IDEXX)
<i>E. coli</i>	Weck	SM9223B (IDEXX)
Fecal coliform		SM 9221E (MTF)
<i>Enterococcus</i>		Enterolert (IDEXX)
HF183 (TaqMan)	WESTON	HF183 by qPCR
Flow	Field measurement	March McBirney/ volumetric approximation

qPCR - quantitative polymerase chain reaction; MTF – multiple tube fermentation
 MTF – multiple tube fermentation

Width, depth, and velocity measurements were taken after water quality grabs were collected at each site in order to quantify flow. WESTON staff measured velocity using a Marsh McBirney Model 2000 Portable Flowmeter where possible, or estimated flow using the bottle fill method.

Qualitative observations such as water color and odor were also made by WESTON field scientists and recorded on field data sheets (Attachment B). Photographs were taken at each site and are included as Attachment C.

2.3 Quality Assurance/ Quality Control Samples

Quality assurance/quality control (QA/QC) samples, including a field duplicate sample and a field blank, were collected to assess sample variability and contamination arising from the collection, transport, and storage of samples. There were no detections above the detection limit for HF183 or fecal indicator bacteria in the field blank sample that was collected on May 17, 2018. One field duplicate sample was collected at SDR-780 on April 19, 2018. Results of the sample and sample duplicate are provided in Table 3. Laboratory reports and electronic data deliverables (EDDs) are included in Attachment A.

Table 3. Field Duplicate Results

Analyte	Units	4/19/2018	
		SDR-780	SDR-780-DUP
<i>E. coli</i>	MPN/100 mL	93.3	108.1
<i>Enterococcus</i>	MPN/100 mL	39.1	27.2
Fecal Coliforms	CFU/100 mL	48	55
HF183	Copies/100 mL	BDL	ND

BDL - below detection limit

ND - not detected

3.0 RESULTS AND DISCUSSION

As previously stated, sampling was conducted at three storm drain outfalls within the Los Coches Creek watershed to assess dry weather discharges for potential sources of human fecal bacteria. Two of the outfalls were successfully sampled five times each, and six samples were collected at MS4-SDR-098.

3.1 Fecal Indicator Bacteria Results

Fecal coliform, *Enterococcus*, and *E. coli* were detected at all three monitored outfalls during each sampling event. Monitoring results are summarized in Table 4 and provided in detail in Table 5 and Figure 2. Sample results were compared to single sample contact recreation (REC-1) criteria in the Water Quality Control Plan for the San Diego Basin (Basin Plan). *E. coli* and *Enterococcus* results were compared to REC-1 criteria for designated beaches. Laboratory reports, EDDs and COC forms are provided in Attachment A.

All of the samples collected at MS4-SDR-098 were above the WQOs for fecal coliform and *Enterococcus* and five of the six samples were also above the WQO for *E. coli*. The highest values for all three FIB were measured in samples collected at MS4-SDR-098. Results in samples collected at MS4-SDR-207 were above the WQOs for *Enterococcus* in all five samples, for *E. coli* in three of the five samples and for fecal coliform in two of the five samples. Samples collected at SDR-780 were above the WQOs for *Enterococcus* in three of the five samples and for fecal coliform in one of the five samples. All samples collected at SDR-780 were below the *E. coli* WQO.

Table 4. Summary of Fecal Indicator Bacteria Results

Station	Indicator Bacteria	Number of Samples	Number of Samples above WQO	Minimum Result (CFU/100 mL or MPN/100 mL*)	Maximum Result (CFU/100 mL or MPN/100 mL*)
MS4-SDR-098	Fecal Coliforms	6	6	700	160,000
	<i>E. coli</i>	6	5	4.1	160,000
	<i>Enterococcus</i>	6	6	2,000	248,900
MS4-SDR-207	Fecal Coliforms	5	2	23	17,000
	<i>E. coli</i>	5	3	130	1,137
	<i>Enterococcus</i>	5	5	260.3	2,400
SDR-780	Fecal Coliforms	5	1	9	490
	<i>E. coli</i>	5	0	7.5	204.6
	<i>Enterococcus</i>	5	3	27	550

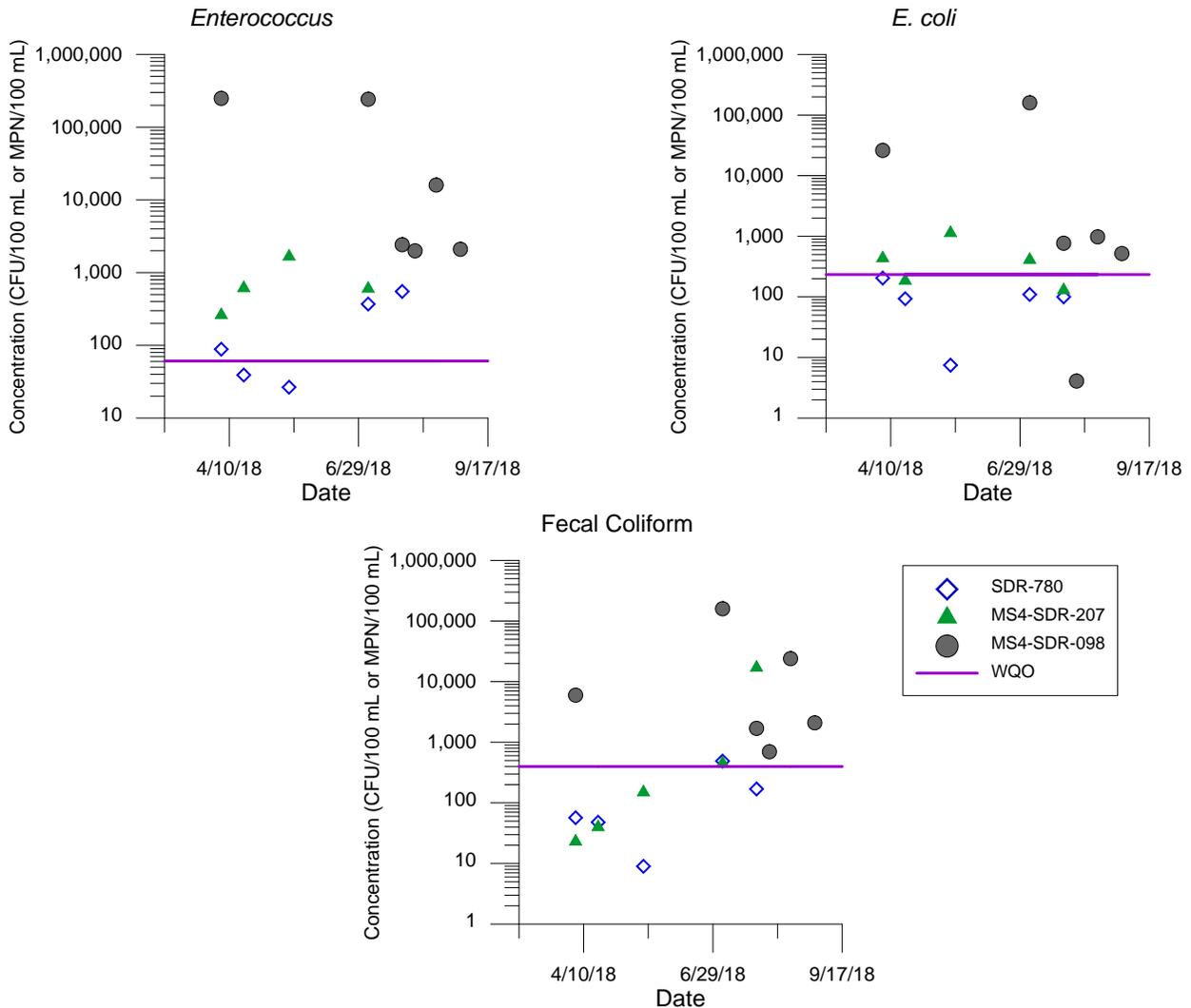


Figure 2. Fecal Indicator Bacteria Concentrations

3.2 HF183 Results

The strongest HF183 signal was detected at station MS4-SDR-098 during the first monitoring event on April 5, 2018 (894 copies/100 mL). Samples were not collected at this location during the next two sampling events due to dry conditions at the site. HF183 was detected but was below the detection limit in samples collected on July 5, August 16 and August 31, 2018 and was not detected in samples collected during the other two monitoring events.

HF183 was detected in samples collected on April 5, 2018 at MS4-SDR-207, but was below the detection limit. There were no other detections of HF183 at this station in the four following events. All five samples collected at SDR-780 contained HF183 signals, two samples collected on April

5 and July 5, 2018 were detected not quantifiable, and the other three on April 19, May 17, and July 26, 2018 were detected below the detection limit.

Table 5. Sample Results

Station	Date	Time	Fecal Coliforms (CFU/100 mL or MPN/100 mL*)	<i>E. coli</i> (MPN/100 mL)	<i>Enterococcus</i> (MPN/100 mL)	HF183 (copies/100 mL)
MS4-SDR-098	04/05/18	9:06	6,000	26,130	248,900	894
	04/19/18	Dry	NS	NS	NS	NS
	05/17/18	Dry	NS	NS	NS	NS
	07/05/18	10:55	160,000*	160,000	>241,960	BDL
	07/26/18	10:20	1,700*	770	>2,419.6	ND
	08/03/18	4:25	700*	4.1	2,000	ND
	08/16/18	4:30	24,000*	980	16,000	BDL
	08/31/18	4:30	2,100*	520	2,100	BDL
MS4-SDR-207	04/05/18	9:50	23	435.2	260.3	BDL
	04/19/18	9:35	40e	186	613.1	ND
	05/17/18	10:30	150e	1,137	1,658	ND
	07/05/18	10:35	450*	410	600	ND
	07/26/18	9:55	17,000*	130	2,400	ND
SDR-780	04/05/18	10:24	57	204.6	88.4	Detected, DNQ (35 copies/100 mL)
	04/19/18	10:00	48	93.3	39.1	BDL
	05/17/18	10:00	9	7.5	26.6	BDL
	07/05/18	10:05	490*	110	370	Detected, DNQ (50 copies/100 mL)
	07/26/18	9:15	170*	100	550	BDL

* Results for fecal coliform from samples analyzed by Weck Laboratories are reported in MPN/100mL.

Bold and highlighted values indicate exceedances of WQOs based on comparison of results with single sample maximum indicator bacteria objectives.

e - plate count falls outside recommended reporting limits per EPA method guidelines.

BDL - Below Detection Limit; DNQ - Detectable but not quantifiable

ND - Not Detected; NS - Not Sampled

3.3 Flow Measurements

Measurements of outfall width, depth, and velocity were collected to estimate flow. Flow estimates are provided in Table 6. Field data sheets that include measurements of the width, depth, and velocity of observed runoff (or timed volumetric measurements) are provided in Attachment B.

A weir was installed at MS4-SDR-207 between the monitoring events on April 19 and May 17, 2018 in order to monitor flows at the station as part of a separate study the County is conducting to continuously monitor dry weather flows. A weir was also installed at MS4-SDR-098 between the May 17 and July 5, 2017 sampling events, which resulted in ponded conditions during the site visit on July 5, and trickling conditions on July 26. Follow-up visits to MS4-SDR-098 were made between 4:00 am and 4:30 am on August 3, August 18, and August 31, in order to sample while there was sufficient flow. These times were chosen based on flow data from the County’s low flow study indicating higher flows during this time period.

Table 6. Flow Estimates

Monitoring Station	Sample Date	Flow Estimate (cfs)
MS4-SDR-098	4/5/18	Slight trickle- flow too low for accurate measurement
	4/19/18	Dry – No Flow
	5/17/18	Dry – No Flow
	7/5/18	Ponded
	7/26/18	Slight trickle- flow too low for accurate measurement
	8/3/18	0.0014
	8/16/18	0.028
	8/31/18	<0.001
MS4-SDR-207	4/5/18	0.059
	4/19/18	0.036
	5/17/18	0.018
	7/5/18	0.018
	7/26/18	0.028
SDR-780	4/5/18	0.009
	4/19/18	0.021
	5/17/18	0.016
	7/5/18	0.01
	7/26/18	0.005

cfs – cubic feet per second

4.0 CONCLUSIONS

Follow up sampling was conducted at three MS4 outfall stations previously sampled in 2017 as part of the *Los Coches Creek Storm Drain Outfall Microbial Source Tracking Study*. Follow up samples were collected during five dry weather monitoring events at two locations (MS4-SDR-207 and SDR-780) and during six dry weather monitoring events at one location (MS4-SDR-098). Samples were analyzed for *Enterococcus*, *E. coli*, fecal coliform, and HF183 (qPCR).

Enterococcus and fecal coliform results were above the WQOs at MS4-SDR-098 in all of the samples collected and *E. coli* results were above the WQO in five of the six samples. The strongest HF183 signal in the study was measured at station MS4-SDR-098 during the first monitoring event on April 5, 2018 with 894 copies/100 mL. This was the only sample in the study with HF183 detected above the detection limit. FIB levels continued to exceed the WQOs at MS4-SDR-098 (for at least two of the three FIB) in all of the remaining samples when there was either no detection of HF183 or a detection below the detection limit (BDL). This data suggests that the high levels of FIB at this station may be due to a source other than humans and do therefore not indicate increased risk from human contamination in these remaining samples.

At least one FIB was above the WQO in all of the samples collected at MS4-SDR-207. HF183 was detected in only one sample at this location and was below the detection limit. FIB results for three of the five samples collected at SDR-780 were above the WQO for at least one indicator. HF183 signals were detected not quantifiable (DNQ) in two samples from SDR-780 and were detected below the detection limit in the remaining three samples. These results suggest that FIB at these locations may be due to non-human sources.

While there are no regulatory benchmarks for HF183, a recent risk assessment that considered decay rates of pathogen and human source markers in aging sewage contamination of surface water suggested a risk-based threshold (30 illnesses per 1000 exposures) of 9,700 copies/100 mL for unaged sewage contamination and 4,100 copies/100 mL when considering an unknown (i.e. mixed) age of contamination (Boehm et al., 2018). The difference is caused by the faster decay rates of the HF183 marker compared to viruses. Thus, the risk-based threshold is reached at lower human source marker concentrations as the sewage contamination ages. The study finds that after 2.5 days, contamination ages the human marker concentration meeting the risk-based threshold is 900 copies/100 mL. However, after 3.3 days, less than 24 hours later, the risk-based threshold can't be exceeded anymore due to excessive decay of pathogens. The only detection of HF183 marker in this study, which occurred at the beginning of the study period, does not exceed the risk-based threshold for any assumed age. Therefore, no further follow-up sampling is recommended at this time.

5.0 REFERENCES

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