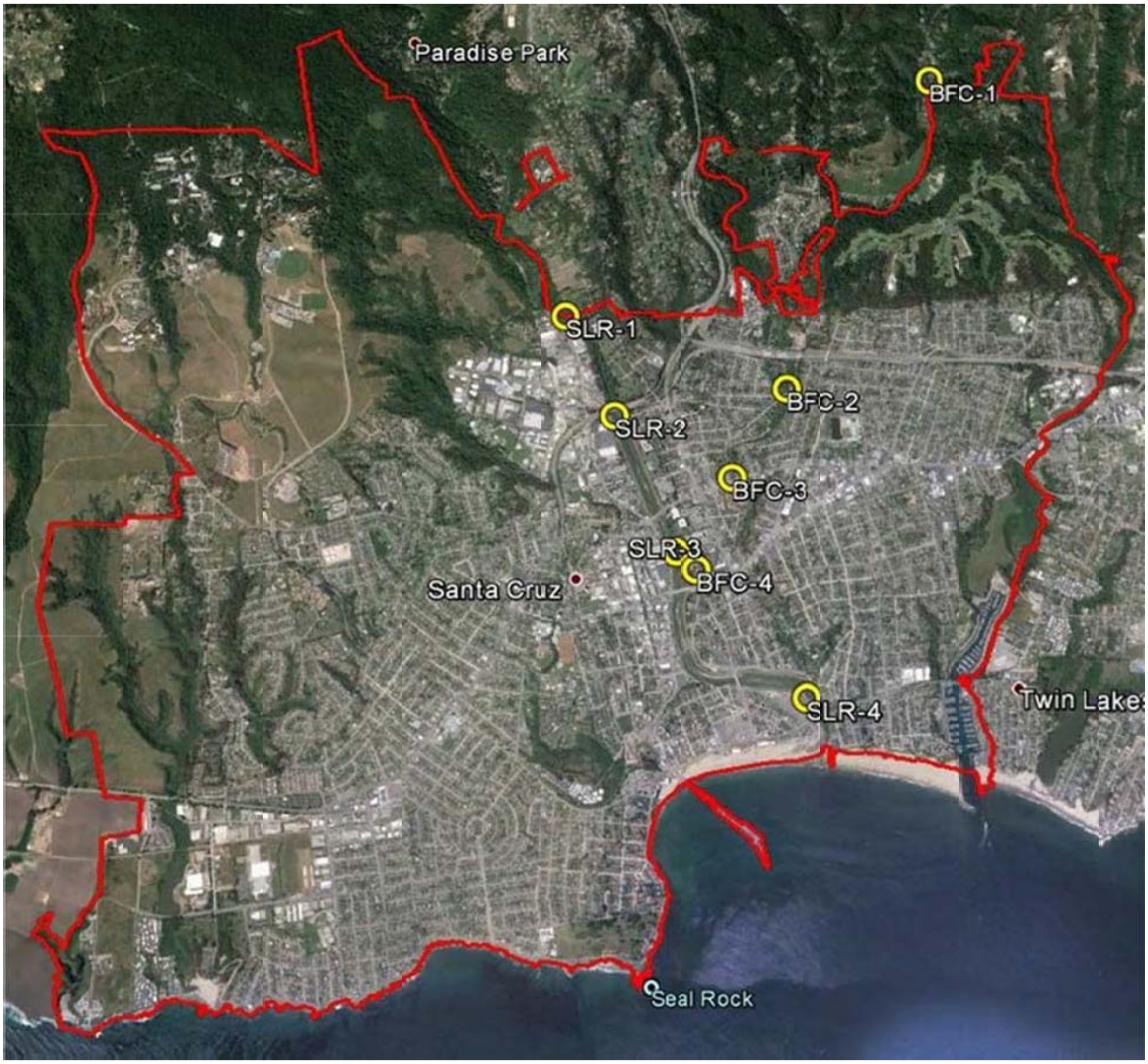
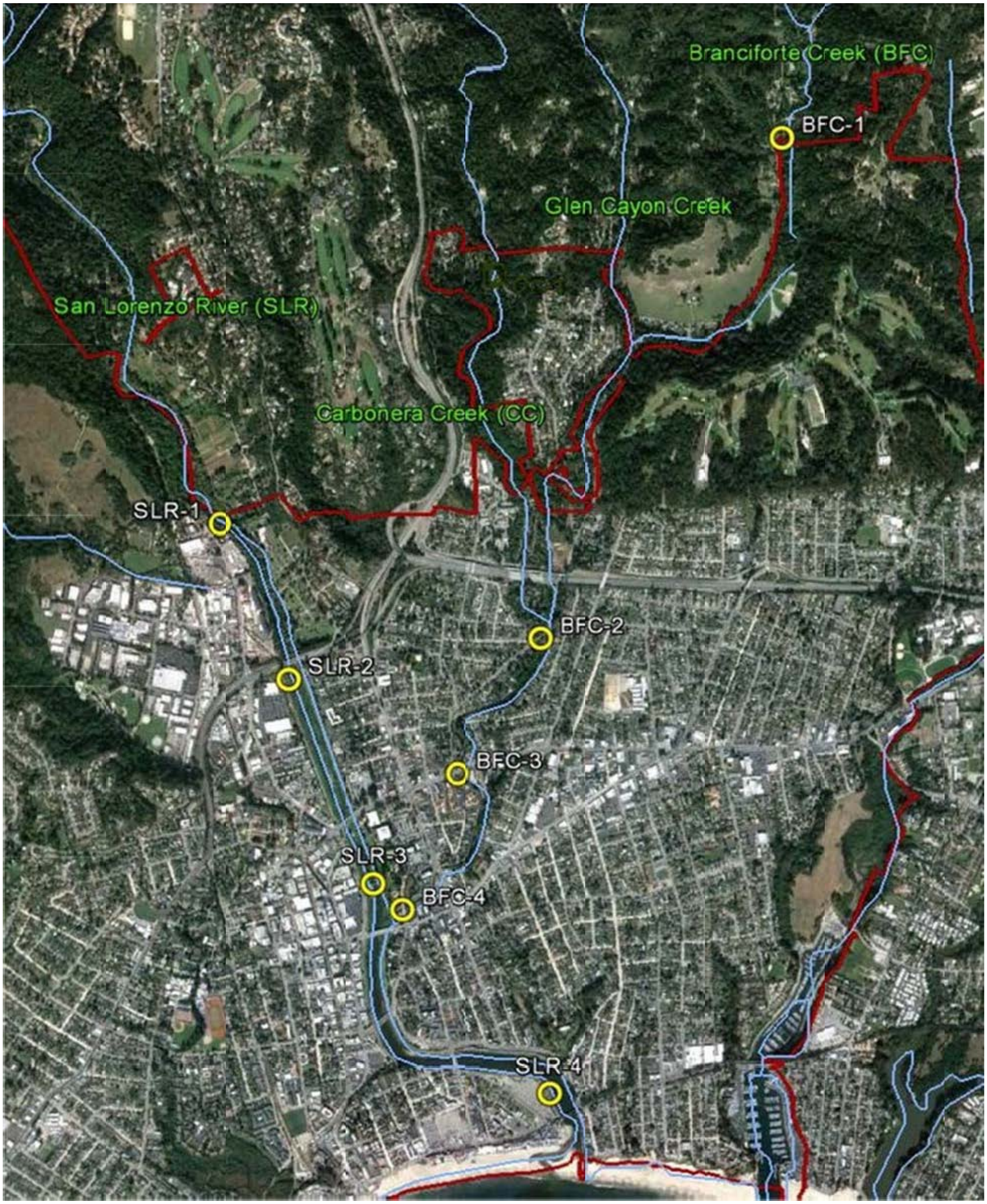
Monitoring of Waterborne Indicator Bacteria and Nutrients within San Lorenzo River and Branciforte Creek

Performed by the Santa Cruz City Wastewater Treatment Facility

2017 Update

Sample locations include four along the San Lorenzo River and four along Branciforte Creek.




Branciforte Creek (BFC)
BFC-1
Glen Cayon Creek
San Lorenzo River (SLR)
Carbonera Creek (CC)
SLR-1
BFC-2
SLR-2
BFC-3
SLR-3
BFC-4
SLR-4

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Executive Summary

The City is submitting this update of its bacteria monitoring program in San Lorenzo River (SLR) which was initiated in 2010 after the USEPA promulgated the pathogen TMDL in San Lorenzo River. The City's monitoring program goals, as initiated in 2010, were to fulfill its TMDL obligations under the Clean Water Act specifically by:

- developing information on the trends of bacteria levels in order to assess the effectiveness of the interventions and management practices implemented;
- and also by developing information for controlling anthropogenic sources of the bacteria so as to subsequently implement measures, to affect those and other identifiable controllable sources of bacteria in the river

After a comprehensive review of the monitoring data was conducted in 2014 and the results indicated that exceedance of indicator bacteria levels in the river had not improved despite the intensification of BMPs implemented to date, the City expanded and applied additional and different analytical regimen designed to better assess the controllable portions of the bacteria beginning that year. Under this regimen, samples continued to be analyzed for **indicator bacteria**, in addition to **caffeine** along the San Lorenzo River from Tait Street and from the Branciforte Creek junction through the SLR estuary into the ocean. The City also initiated limited testing for **Fecal Sterol Ratios with Axys laboratory** for a limited number of these samples in 2014.

In addition, the City subscribed to working within a regional framework with the hope that this would assist in the TMDL goals. The City contributed funds to continue Fecal sterols ratios' analyses associated with high FIB in the river, among other significant inputs including additional analytical work at the City's Environmental Laboratory, within this regional program. In 2015, the City augmented this strategy further by including the analyses of **sediments** and **nutrients** to aid in the unraveling of the emerging bacteria profile in the lower San Lorenzo River. In 2016, the City implemented the review of its own data on **trace organic compounds** (**TrOC**) upstream in the river to further assist in assessing the sources of anthropogenic compounds associated with high FIB. Finally the City received a license from

USEPA to apply specific molecular tools (**qPCR for HumM2; HumM3 and DG37**) to analyze for possible human or canine gut bacteria in the river.

The current report provides an important update to the version submitted in 2015 with respect to the emerging status of controllable sources of water and waterborne bacteria and chemicals into the river within its course and within the city limits of Santa Cruz City.

Findings from data and efforts to identify the controllable sources of the bacteria impairments in San Lorenzo River.

1. City and other TMDL partners to examine the importance of the established linkage of indicator bacteria and sediments within SLR and its tributaries in their course before the city limits; and the necessity to link the sampling and analyses of these indicators and solids in the river;
2. Provide an updated and informed reinterpretation of the initial findings with respect to fecal sterol ratios and caffeine detection in the river;
3. And measured anthropogenic compounds including caffeine and the TrOC at locations within the San Lorenzo River and Branciforte Creek within city limits between July 2014 and September 2016. And therefore
4. The need for similar quality work upstream of SLR outside of the city limits to develop a truer picture.

Tables of the anthropogenic compounds monitored in the river and its tributaries; and their impact on the analyses of controllable bacteria sources in the river are included in this update. Following this page are annotated tables and data summaries not included in the report previously submitted in 2015.

E. coli and NO3 in the SLR at Tait St.

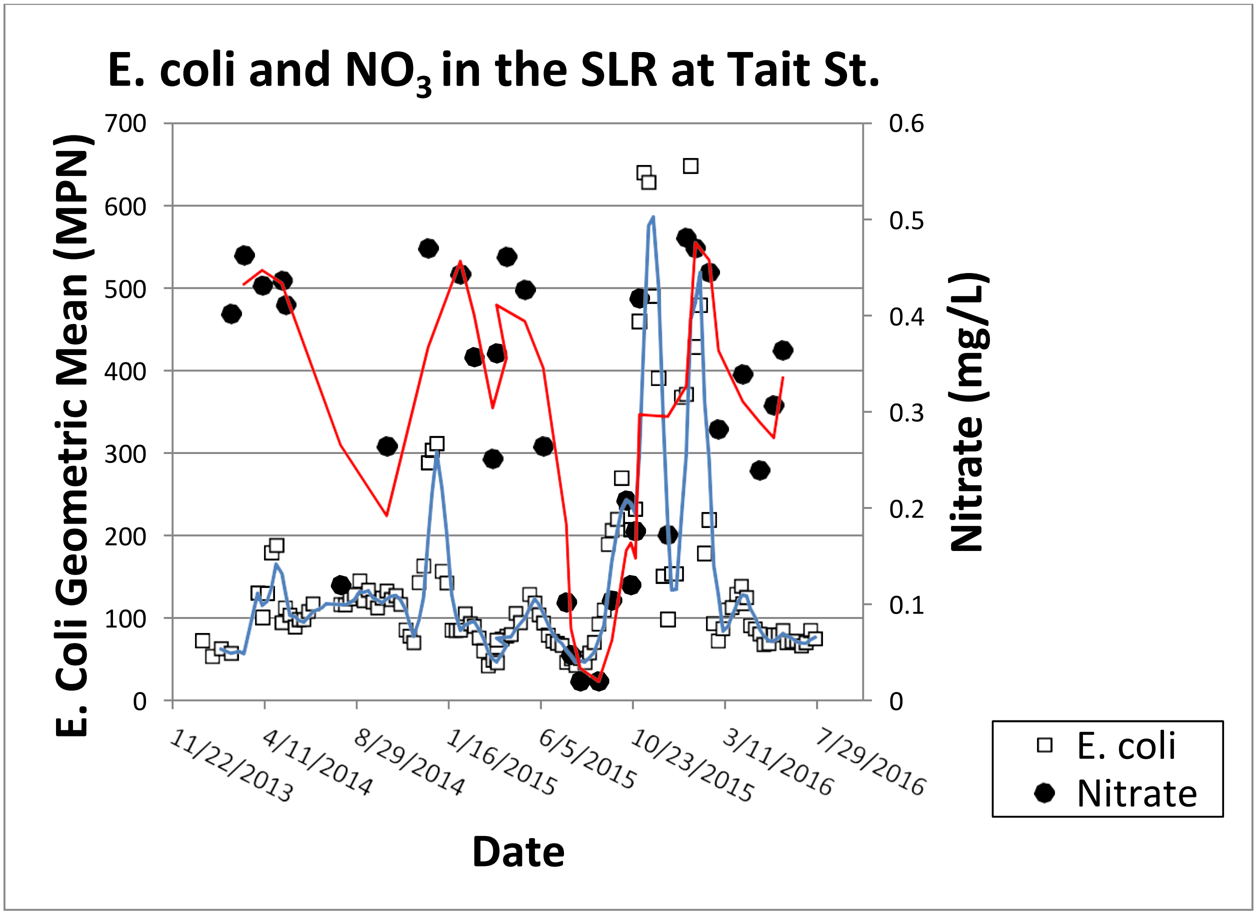

Figure 1. Visual relationship of NO3 and E.coli in SLR

The above is a visual display of the initial data showing the synchronous relationship between NO3 levels in SLR taken at Tait Street and the E.coli concentrations at the same source. The City has now initiated a similar sampling pattern for studying the bacteria at Branciforte Creek. That study has yet to garner enough data to make similar analyses.

Integrative Sampling of TrOC

Updated List of Anthropogenic Chemicals of (Emerging/Emergent) Concern, from integrative samples at the San Lorenzo River @Tait Street : Data Compiled since the last report submitted in 2015

*Note a zero value indicates coelution or no reporting limit

Date	Analysis Name	Analysis Group	Result	Unit
March 2015	Acenaphthene	PAH	0.0003	ug/L
March 2015	ACENAPHTHYLENE	PAH	<0.0003	ug/L
March 2015	Anthracene	PAH	<0.0001	ug/L
March 2015	Benzo(a)anthracene	PAH	<0.0001	ug/L
March 2015	Benzo(a)pyrene	PAH	<0.0001	ug/L
March 2015	Benzo(b)fluoranthene	PAH	<0.0001	ug/L
March 2015	Benzo(ghi)perylene	PAH	<0.0001	ug/L
March 2015	Benzo(k)fluoranthene	PAH	<0.001	ug/L
March 2015	Chrysene	PAH	<0.001	ug/L
March 2015	Dibenz(a,h)anthracene	PAH	<0.002	ug/L
March 2015	Fluoranthene	PAH	0.0006	ug/L
March 2015	Fluorene	PAH	0.0006	ug/L
March 2015	Indeno(1,2,3-cd)pyrene	PAH	<0.0004	ug/L
March 2015	Naphthalene	PAH	0.0043	ug/L
March 2015	Perylene	PAH	<0.0001	ug/L
March 2015	Phenanthrene	PAH	0.0018	ug/L
March 2015	Pyrene	PAH	0.0003	ug/L
March 2015	Total of PAH's	PAH	0.00442	ug/L
March 2015	Polychlorinated biphenyl congener 100	PCB	0.108	ug/L
March 2015	Polychlorinated biphenyl congener 101	PCB	0.051	ug/L
March 2015	Polychlorinated biphenyl congener 102	PCB	0.029	ug/L
March 2015	Polychlorinated biphenyl congener 105	PCB	1.504	ug/L
March 2015	Polychlorinated biphenyl congener 108	PCB	0.042	ug/L
March 2015	Polychlorinated biphenyl congener 110	PCB	6.089	ug/L
March 2015	Polychlorinated biphenyl congener 113	PCB	0.194	ug/L
March 2015	Polychlorinated biphenyl congener 115	PCB	0.038	ug/L
March 2015	Polychlorinated biphenyl congener 118	PCB	4.274	ug/L
March 2015	Polychlorinated biphenyl congener 119	PCB	0.166	ug/L
March 2015	Polychlorinated biphenyl congener 125	PCB	0.043	ug/L
March 2015	Polychlorinated biphenyl congener 128	PCB	0.605	ug/L
March 2015	Polychlorinated biphenyl congener 129	PCB	0.372	ug/L
March 2015	Polychlorinated biphenyl congener 132	PCB	1.619	ug/L

March 2015	Polychlorinated biphenyl congener 135	PCB	1.161	ug/L
March 2015	Polychlorinated biphenyl congener 138	PCB	4.833	ug/L
March 2015	Polychlorinated biphenyl congener 141	PCB	1.58	ug/L
March 2015	Polychlorinated biphenyl congener 147	PCB	0.08	ug/L
March 2015	Polychlorinated biphenyl congener 149	PCB	0.052	ug/L
March 2015	Polychlorinated biphenyl congener 151	PCB	2.763	ug/L
March 2015	Polychlorinated biphenyl congener 153	PCB	6.41	ug/L
March 2015	Polychlorinated biphenyl congener 154	PCB	0.121	ug/L
March 2015	Polychlorinated biphenyl congener 156	PCB	0.449	ug/L
March 2015	Polychlorinated biphenyl congener 157	PCB	0.102	ug/L
March 2015	Polychlorinated biphenyl congener 158	PCB	0.766	ug/L
March 2015	Polychlorinated biphenyl congener 159	PCB	0.09	ug/L
March 2015	Polychlorinated biphenyl congener 160	PCB	0.048	ug/L
March 2015	Polychlorinated biphenyl congener 163	PCB	0.047	ug/L
March 2015	Polychlorinated biphenyl congener 166	PCB	0.078	ug/L
March 2015	Polychlorinated biphenyl congener 168	PCB	0.089	ug/L
March 2015	Polychlorinated biphenyl congener 170	PCB	0.939	ug/L
March 2015	Polychlorinated biphenyl congener 174	PCB	2.034	ug/L
March 2015	Polychlorinated biphenyl congener 177	PCB	1.106	ug/L
March 2015	Polychlorinated biphenyl congener 18	PCB	15.44	ug/L
March 2015	Polychlorinated biphenyl congener 180	PCB	2.503	ug/L
March 2015	Polychlorinated biphenyl congener 183	PCB	1.548	ug/L
March 2015	Polychlorinated biphenyl congener 185	PCB	0.382	ug/L
March 2015	Polychlorinated biphenyl congener 187	PCB	0.067	ug/L
March 2015	Polychlorinated biphenyl congener 193	PCB	0.182	ug/L
March 2015	Polychlorinated biphenyl congener 194	PCB	0.304	ug/L
March 2015	Polychlorinated biphenyl congener 195	PCB	0.275	ug/L
March 2015	Polychlorinated biphenyl congener 20	PCB	8.828	ug/L
March 2015	Polychlorinated biphenyl congener 201	PCB	0.550	ug/L
March 2015	Polychlorinated biphenyl congener 203	PCB	0.09	ug/L
March 2015	Polychlorinated biphenyl congener 21	PCB	0.019	ug/L
March 2015	Polychlorinated biphenyl congener 28	PCB	18.115	ug/L
March 2015	Polychlorinated biphenyl congener 30	PCB	0.091	ug/L
March 2015	Polychlorinated biphenyl congener 31	PCB	10.666	ug/L
March 2015	Polychlorinated biphenyl congener 33	PCB	0.019	ug/L
March 2015	Polychlorinated biphenyl congener 44	PCB	9.023	ug/L
March 2015	Polychlorinated biphenyl congener 47	PCB	2.419	ug/L
March 2015	Polychlorinated biphenyl congener 49	PCB	0.031	ug/L
March 2015	Polychlorinated biphenyl congener 52	PCB	11.508	ug/L
March 2015	Polychlorinated biphenyl congener 56	PCB	5.139	ug/L
March 2015	Polychlorinated biphenyl congener 60	PCB	0.025	ug/L

March 2015	Polychlorinated biphenyl congener 61	PCB	7.437	ug/L
March 2015	Polychlorinated biphenyl congener 65	PCB	0.095	ug/L
March 2015	Polychlorinated biphenyl congener 66	PCB	6.788	ug/L
March 2015	Polychlorinated biphenyl congener 69	PCB	0.033	ug/L
March 2015	Polychlorinated biphenyl congener 70	PCB	0.03	ug/L
March 2015	Polychlorinated biphenyl congener 74	PCB	3.832	ug/L
March 2015	Polychlorinated biphenyl congener 76	PCB	0.027	ug/L
March 2015	Polychlorinated biphenyl congener 8	PCB	8.017	ug/L
March 2015	Polychlorinated biphenyl congener 83	PCB	0.365	ug/L
March 2015	Polychlorinated biphenyl congener 86	PCB	0.171	ug/L
March 2015	Polychlorinated biphenyl congener 87	PCB	2.468	ug/L
March 2015	Polychlorinated biphenyl congener 90	PCB	8.142	ug/L
March 2015	Polychlorinated biphenyl congener 93	PCB	0.105	ug/L
March 2015	Polychlorinated biphenyl congener 95	PCB	7.247	ug/L
March 2015	Polychlorinated biphenyl congener 97	PCB	1.57	ug/L
March 2015	Polychlorinated biphenyl congener 98	PCB	0.114	ug/L
March 2015	Polychlorinated biphenyl congener 99	PCB	2.735	ug/L
April 13, 2015	Dacthal	pesticide	0.622	ng/L ww
April 13, 2015	Oxadiazon	pesticide	<2.17	ng/L ww
April 13, 2015	Aldrin	pesticide	<0.0182	ng/L ww
April 13, 2015	Dieldrin	pesticide	0.123	ng/L ww
April 13, 2015	Endosulfan I	pesticide	<0.0121	ng/L ww
April 13, 2015	Endosulfan II	pesticide	<0.0108	ng/L ww
April 13, 2015	Endosulfan Sulfate	pesticide	0.029	ng/L ww
April 13, 2015	Endrin	pesticide	<0.0105	ng/L ww
April 13, 2015	HCH, alpha	pesticide	0.012	ng/L ww
April 13, 2015	HCH, beta	pesticide	<0.0172	ng/L ww
April 13, 2015	HCH, delta	pesticide	<0.005	ng/L ww
April 13, 2015	HCH, gamma	pesticide	<0.0227	ng/L ww
April 13, 2015	Heptachlor	pesticide	<0.0119	ng/L ww
April 13, 2015	Heptachlor Epoxide	pesticide	0.017	ng/L ww
April 13, 2015	Mirex	pesticide	<0.0365	ng/L ww
April 13, 2015	Toxaphene	pesticide	<2.27	ng/L ww
April 13, 2015	Chlordane, alpha-	pesticide	0.074	ng/L ww
April 13, 2015	Chlordane, gamma-	pesticide	0.073	ng/L ww
April 13, 2015	DDD(o,p')	pesticide	<0.0098	ng/L ww
April 13, 2015	DDD(p,p')	pesticide	0.022	ng/L ww
April 13, 2015	DDE(o,p')	pesticide	<0.007	ng/L ww
April 13, 2015	DDE(p,p')	pesticide	0.114	ng/L ww
April 13, 2015	DDT(o,p')	pesticide	0.025	ng/L ww
April 13, 2015	DDT(p,p')	pesticide	0.106	ng/L ww

April 13, 2015	Nonachlor, alpha-	pesticide	0.021	ng/L ww
April 13, 2015	Nonachlor, trans-	pesticide	0.073	ng/L ww
April 13, 2015	Oxychlordane	pesticide	<0.0782	ng/L ww
April 13, 2015	2-Methylnaphthalene	PAH	1.76	ng/L ww
April 13, 2015	Acenaphthene	PAH	0.482	ng/L ww
April 13, 2015	Acenaphthylene	PAH	0.611	ng/L ww
April 13, 2015	Anthracene	PAH	0.212	ng/L ww
April 13, 2015	Benzo(a)anthracene	PAH	<0.038	ng/L ww
April 13, 2015	Benzo(a)pyrene	PAH	0.422	ng/L ww
April 13, 2015	Benzo(b)fluoranthene	PAH	0.594	ng/L ww
April 13, 2015	Benzo(e)pyrene	PAH	0.665	ng/L ww
April 13, 2015	Benzo(ghi)perylene	PAH	0.726	ng/L ww
April 13, 2015	Benzo(j/k)fluoranthenes	PAH	0.439	ng/L ww
April 13, 2015	Biphenyl	PAH	0.692	ng/L ww
April 13, 2015	Chrysene	PAH	1.01	ng/L ww
April 13, 2015	Dibenz(ah)anthracene	PAH	<0.078	ng/L ww
April 13, 2015	Dibenzothiophene	PAH	<0.03	ng/L ww
April 13, 2015	Dimethylnaphthalene, 1,2-	PAH	<0.039	ng/L ww
April 13, 2015	Dimethylnaphthalene, 2,6-	PAH	0.571	ng/L ww
April 13, 2015	Fluoranthene	PAH	2	ng/L ww
April 13, 2015	Fluorene	PAH	0.429	ng/L ww
April 13, 2015	Hexachlorobenzene	PAH	0.019	ng/L ww
April 13, 2015	Hexachlorobutadiene	PAH	<0.0022	ng/L ww
April 13, 2015	Indeno(123cd)pyrene	PAH	0.414	ng/L ww
April 13, 2015	Methylnaphthalene, 1-	PAH	1.08	ng/L ww
April 13, 2015	Methylphenanthrene, 1-	PAH	0.319	ng/L ww
April 13, 2015	Naphthalene	PAH	7.1	ng/L ww
April 13, 2015	Perylene	PAH	0.625	ng/L ww
April 13, 2015	Phenanthrene	PAH	3.64	ng/L ww
April 13, 2015	Pyrene	PAH	2.5	ng/L ww
April 13, 2015	Trimethylnaphthalene, 2,3,5-	PAH	<0.028	ng/L ww
April 13, 2015	PBDE 007	PBDE	0.333	pg/L ww
April 13, 2015	PBDE 008	PBDE	0.482	pg/L ww
April 13, 2015	PBDE 010	PBDE	<0.0335	pg/L ww
April 13, 2015	PBDE 011	PBDE	0	pg/L ww
April 13, 2015	PBDE 012	PBDE	0.39	pg/L ww
April 13, 2015	PBDE 013	PBDE	0	pg/L ww
April 13, 2015	PBDE 015	PBDE	2.42	pg/L ww
April 13, 2015	PBDE 017	PBDE	3.31	pg/L ww
April 13, 2015	PBDE 025	PBDE	0	pg/L ww
April 13, 2015	PBDE 028	PBDE	6.53	pg/L ww

April 13, 2015	PBDE 030	PBDE	<0.062	pg/L ww
April 13, 2015	PBDE 032	PBDE	<0.0495	pg/L ww
April 13, 2015	PBDE 033	PBDE	0	pg/L ww
April 13, 2015	PBDE 035	PBDE	<0.0372	pg/L ww
April 13, 2015	PBDE 037	PBDE	0.379	pg/L ww
April 13, 2015	PBDE 047	PBDE	64.8	pg/L ww
April 13, 2015	PBDE 049	PBDE	5.43	pg/L ww
April 13, 2015	PBDE 051	PBDE	0.872	pg/L ww
April 13, 2015	PBDE 066	PBDE	3.98	pg/L ww
April 13, 2015	PBDE 071	PBDE	0.679	pg/L ww
April 13, 2015	PBDE 075	PBDE	0.36	pg/L ww
April 13, 2015	PBDE 077	PBDE	0.11	pg/L ww
April 13, 2015	PBDE 079	PBDE	0.066	pg/L ww
April 13, 2015	PBDE 085	PBDE	2.29	pg/L ww
April 13, 2015	PBDE 099	PBDE	54.2	pg/L ww
April 13, 2015	PBDE 100	PBDE	14.8	pg/L ww
April 13, 2015	PBDE 105	PBDE	<0.21	pg/L ww
April 13, 2015	PBDE 116	PBDE	<0.297	pg/L ww
April 13, 2015	PBDE 119	PBDE	0.407	pg/L ww
April 13, 2015	PBDE 120	PBDE	0	pg/L ww
April 13, 2015	PBDE 126	PBDE	<0.109	pg/L ww
April 13, 2015	PBDE 128	PBDE	<0.873	pg/L ww
April 13, 2015	PBDE 138	PBDE	1.51	pg/L ww
April 13, 2015	PBDE 140	PBDE	<0.136	pg/L ww
April 13, 2015	PBDE 153	PBDE	8.42	pg/L ww
April 13, 2015	PBDE 154	PBDE	7.19	pg/L ww
April 13, 2015	PBDE 155	PBDE	0.518	pg/L ww
April 13, 2015	PBDE 166	PBDE	0	pg/L ww
April 13, 2015	PBDE 181	PBDE	<0.424	pg/L ww
April 13, 2015	PBDE 183	PBDE	9.52	pg/L ww
April 13, 2015	PBDE 190	PBDE	<0.711	pg/L ww
April 13, 2015	PBDE 203	PBDE	11.1	pg/L ww
April 13, 2015	PBDE 206	PBDE	56.6	pg/L ww
April 13, 2015	PBDE 207	PBDE	75.1	pg/L ww
April 13, 2015	PBDE 208	PBDE	63.6	pg/L ww
April 13, 2015	PBDE 209	PBDE	336	pg/L ww
April 13, 2015	PCB 001	PCB	2.27	pg/L ww
April 13, 2015	PCB 002	PCB	0.815	pg/L ww
April 13, 2015	PCB 003	PCB	1.58	pg/L ww
April 13, 2015	PCB 004	PCB	37.4	pg/L ww
April 13, 2015	PCB 005	PCB	<0.395	pg/L ww

The table above displays the levels of anthropogenic compounds sampled with technologies appropriate to capture time weighted averages (TWA) from integrated samples taken at SLR at Tait Street in 2015. A similar analytical profile was derived from sampling at Tait Street in September 2015. All the data inform that:

1. SLR has evidence of anthropogenic inputs before it reaches the city limits, using the most reliable sampling and analytical technologies;
2. Combined with the table of E.coli measurements in Figure I, these indicate that there are human and probably controllable sources associated with the bacterial loads in SLR before it reaches the city limits and certainly at Tait Street.
3. These data indicate the need for jurisdictions outside of the City of Santa Cruz to conduct similar monitoring to enable the effective implementation of the bacteria TMDL in San Lorenzo River.

In addition to the above, City Environmental Laboratory integrated molecular biology technologies to assess the presence and relative quantities of specific human gut bacteria in SLR in 2016. The data were combined with analytical results of fecal sterol ratios developed with higher quality controls than those previously implemented in the earlier reports. All the data are integrated in the spreadsheet following this session of the TMDL update. Due to the density of the information the data are left in Microsoft Excel worksheet formats.

In summary, the data present the highest quality of sampling and analytical efforts implemented thus far into the TMDL program. The data indicate as follows:

1. There are clearly high levels of indicator bacteria associated with identifiable anthropomorphic signatures in the river at the earliest sampling points where the river enters city of Santa Cruz boundaries;
2. The molecular indicators and the Fecal sterol ratios indicative of human sources associated with high bacteria are clearly identifiable within SLR in the city after storm events;
3. Therefore a number of controllable points have now been identified within the city, and
4. There is a clear need to coordinate an effective integrated sampling and monitoring regimen outside of the City limits to be able to control the bacteria effectively.

Table of Analyses in SLR Tributaries

Table of Analyses of Indicator Bacteria; Nutrients and Caffeine in SLR Tributaries - 2016

Analytical Method			**Sampling GPS Location**			**SM-2540D**	**EPA 300**	**ELISA Microplate Test**	**SM 4500-NH3D**	**SM 9222D**	**EPA 1600**
Date/Time Collected	**Sample ID**		**Latitude**	**Longitude**	**LIMS No.**	**TSS** (mg/L)	**Nitrate** (mg N/L)	**Caffeine** (µg/L)	**Ammonia** (mg N/L)	**Fecal Coliform** (CFU/100mL)	**Enterococcus** (CFU/100mL)
Branciforte (BFC) and Carbonera Creek (CC) Samples											
9-19-2016@ 1152	BFC#1	Site#7	37.007219	-122.001575	AA77439-43	5	<0.10	<0.175	<0.1	1,300	1,300
9-26-2016@ 1200	BFC#1	Site#7	37.007219	-122.001575	AA77648-52	1	<0.10	<0.175	<0.1	2,200	288
10-3-16 @ 1146	BFC#1	Site#7	37.007219	-122.001575	AA77896-00	1	<0.10	<0.175	<0.1	340	71
10-10-16 @ 1146	BFC#1	Site#7	37.007219	-122.001575	78120-24	<1	<0.10	<0.175	<0.1	395	210
9-19-2016@ 1230	BFC#2	Site#12	36.985975	-122.014481	AA77449-53	9	<0.10	<0.175	<0.1	800	1,400
9-26-2016@ 1239	BFC#2	Site#12	36.985975	-122.014481	AA77658-62	1	<0.10	**0.24**	<0.1	450	67
10-3-16 @ 1201	BFC#2	Site#12	36.985975	-122.014481	AA77901-05	4	<0.10	<0.175	<0.1	488	72
10-10-16 @ 1220	BFC#2	Site#12	36.985975	-122.014481	78130-34	3	<0.10	<0.175	<0.1	760	620
9-19-2016@ 1246	BFC#3	Site#8	36.980589	-122.018778	AA77454-58	3	<0.10	<0.175	<0.1	800	850
9-26-2016@ 1254	BFC#3	Site#8	36.980589	-122.01	AA77663-67	1	<0.10	<0.175	<0.1	257	83

				8778							
10-3-16 @ 1220	BFC#3	Site#8	36.980589	-122.018778	AA77906-10	10	<0.10	<0.175	<0.1	833	153
10-10-16 @ 1238	BFC#3	Site#8	36.980589	-122.018778	78135-39	31	<0.10	<0.175	<0.1	1,333	510
9-19-2016@ 1101	BFC#4	Site#3	36.974567	-122.021656	AA77429-33	1	<0.10	**0.25**	<0.1	490	84
9-26-2016@ 1116	BFC#4	Site#3	36.974567	-122.021656	AA77638-42	105	<0.10	<0.175	<0.1	38	10
10-3-16 @ 1236	BFC#4	Site#3	36.974567	-122.021656	AA77911-15	1	<0.10	<0.175	<0.1	24	4
10-10-16 @ 1110	BFC#4	Site#3	36.974567	-122.021656	78110-14	1	<0.10	<0.175	<0.1	88	16
9-19-2016@ 1212	CC	Site#15	37.001967	-122.016961	AA77444-48	1	0.76	<0.175	<0.1	11	52
9-26-2016@ 1216	CC	Site#15	37.001967	-122.016961	AA77653-57	<1	0.87	<0.175	<0.1	60	97
10-3-16 @ 1118	CC	Site#15	37.001967	-122.016961	AA77891-95	1	0.89	<0.175	<0.1	200	460
10-10-16 @ 1202	CC	Site#15	37.001967	-122.016961	78125-29	<1	0.94	<0.175	<0.1	27	185

The table above indicates the occasional presence of caffeine associated with high levels of indicator bacteria in a tributary of SLR within city limits. This study lacks the requested Fecal Sterol ratios component because of the critical specificity necessary to determine the ratios of the sterols and stanols within the large body of water that SLR represents within city limit. The critical standards to qualify the sensitivity of the fecal sterol ratios have since been acquired, and will be applied to the development of Fecal Sterol ratios in an updated table.

Despite the detection of caffeine at a sampling point in close proximity to SLR, the caffeine in SLR at the same time was below analytical detection limits. These results confirm the following:

1. Indicator bacteria laden water with trace anthropogenic compound enters the SLR within city limits, although the signal is lost within the river; and
2. Additional monitoring of SLR and its tributaries upstream of the city limits is required to define additional sources of controllable bacteria into the river.

Conclusions From the Update

Overall, the City monitoring program results indicate the following:

1. Bacteria levels generally increase as the river courses through the city to and through the estuary;
2. Bacteria concentrations from Branciforte Creek into the river are very high and would be expected to keep the river's bacteria levels high in spite of interventions taken within the lower stretches of the river within the city;
3. Bacteria inflow to San Lorenzo River from Branciforte Creek is occasionally associated with caffeine levels indicative of anthropogenic, and therefore potentially controllable sources.
4. Bacteria levels in Branciforte Creek feeding into lower San Lorenzo River increase with rainfall events, and can be expected to correlate with sediment inflows from Branciforte into the river.
5. Trace Organic Compounds (**TrOC**) levels measured in SLR at Tait Street show anthropogenic chemicals in the river presumably present before it reaches that sampling point.
6. The initial 6-month studies leading to the identification of avian sources as the predominant bacteria source was informed by combining the non-detection of caffeine in the river with the ratios of fecal sterols measured in the river, however this picture needs to be updated with additional and better sourced information that indicate the following:
    - Caffeine detection in SLR is hindered by dilution and matrix effects, and NOT by the relative absence of anthropogenic inputs;
    - Utilization of Fecal sterol ratios in SLR is less definitive in the lower SLR because of the above and because of the critical analytical sensitivity required in the identification of sterol fractions especially in large water bodies such as the SLR within its lower reaches in Santa Cruz city.

7. The City’s data are instructive and should allow for convening a truly regional monitoring program focused on identifying bacteria sources and the anthropogenic signals at all sources especially where the confounding effects of a large matrix will be effectively diminished.