Urban Watch 2016 Report: Annual Monitoring Results

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Introduction

The mission of the Coastal Watershed Council (CWC) is to preserve and protect coastal watersheds through community stewardship, education and monitoring. The Urban Watch program is an annual monitoring program conducted by the Coastal Watershed Council in partnership with the City of Capitola with the purpose of first serving as a tool for education and outreach to the community regarding the impacts that citizens have on local water quality through urban runoff; and second, collecting scientifically valid water quality data to support environmental management decision-making at the local and regional levels.

The Urban Watch Program started regionally in 1997 as a joint effort between CWC, the City of Monterey, and the Monterey Bay National Marine Sanctuary. Since 2000, the City of Capitola Urban Watch Program has trained citizen volunteers to collect water samples and conduct water quality assessments at City storm drains and creek sites within the Soquel Creek watershed. The 2016 Urban Watch monitoring program was conducted by CWC for the City of Capitola as part of their National Pollutant Discharge Elimination System (NPDES) Phase II Storm Water Management Program.

The Urban Watch program monitors surface water flows in creeks and discharges from storm drains during dry weather. Perennial streams like Soquel Creek typically flow throughout the summer. Yet without rain water entering the storm drain system one may wonder: where are the flows in storm drain outlets coming from? Sometimes cracks in the storm drain system allow for groundwater to seep in via infiltration. But often, dry weather discharges from storm drain outlets come from incidental flows somewhere in the urban environment. Incidental flows, sometimes called “urban drool”, are human-caused dry weather flows that run off the landscape and into gutters and the storm drain system. Incidental flows can pick up fertilizers, pet waste, pesticides, and other pollutants that have been deposited on lawns, sidewalks and driveways. They also contribute to the growth of bacterial biofilm in the storm drain systems. Incidental flows go untreated and eventually are deposited into Soquel Creek as urban runoff.

The Urban Watch 2016 monitoring program covered seven sites in the City of Capitola over the course of fifteen water quality monitoring events, from June through the end of September. During each event CWC staff led teams of volunteers in monitoring Soquel Creek and Noble Gulch and adjacent storm drains. At each site volunteers recorded observations and field measurements. Samples were collected at all sites on a monthly basis for laboratory analysis of nutrients and bacteria indicators, and once during the dry season for copper analysis.

Field Methods

Citizen Scientists

Each year Urban Watch is made possible by the hard work and commitment of volunteers trained as citizen scientists. CWC trainings for water quality monitoring focus on imparting knowledge and skills required to follow quality assurance protocols consistent with USEPA and State Water Resources Control Board procedures. The trainings stress the importance of volunteer safety above all other considerations.

The 2016 Urban Watch monitoring program volunteers received hands-on, in-the-field trainings for basic field water quality tests, including measurements of temperature, pH, dissolved oxygen, electrical conductivity, salinity, total dissolved solids (TDS), chlorine, detergent, and turbidity, and observations related to odor, trash, and other conditions. They were also taught how to properly collect and preserve water samples for laboratory analysis of nutrients (nitrate, ammonia, and orthophosphate), bacteria (*Escherichia coli* and total coliform), and copper.

During the 2016 Urban Watch monitoring study CWC trained 19 volunteers who participated in a total of 215 person-hours of water quality monitoring over 4 months.

Sites

This report presents the results for samples collected at three Soquel Creek stream sites, two Noble Gulch Creek sites, and two storm drains. Sites represent the upper, middle, and lower reaches of Soquel Creek, as well as major urban runoff discharge points within the boundaries of the City of Capitola. These sites were selected specifically to measure the health of freshwater stream characteristics and the impact of storm drain outfalls that discharge urban runoff into the creeks. Comparing water quality information for discharges versus receiving waters (in this case Soquel Creek) can help to geographically place sources of pollutants.

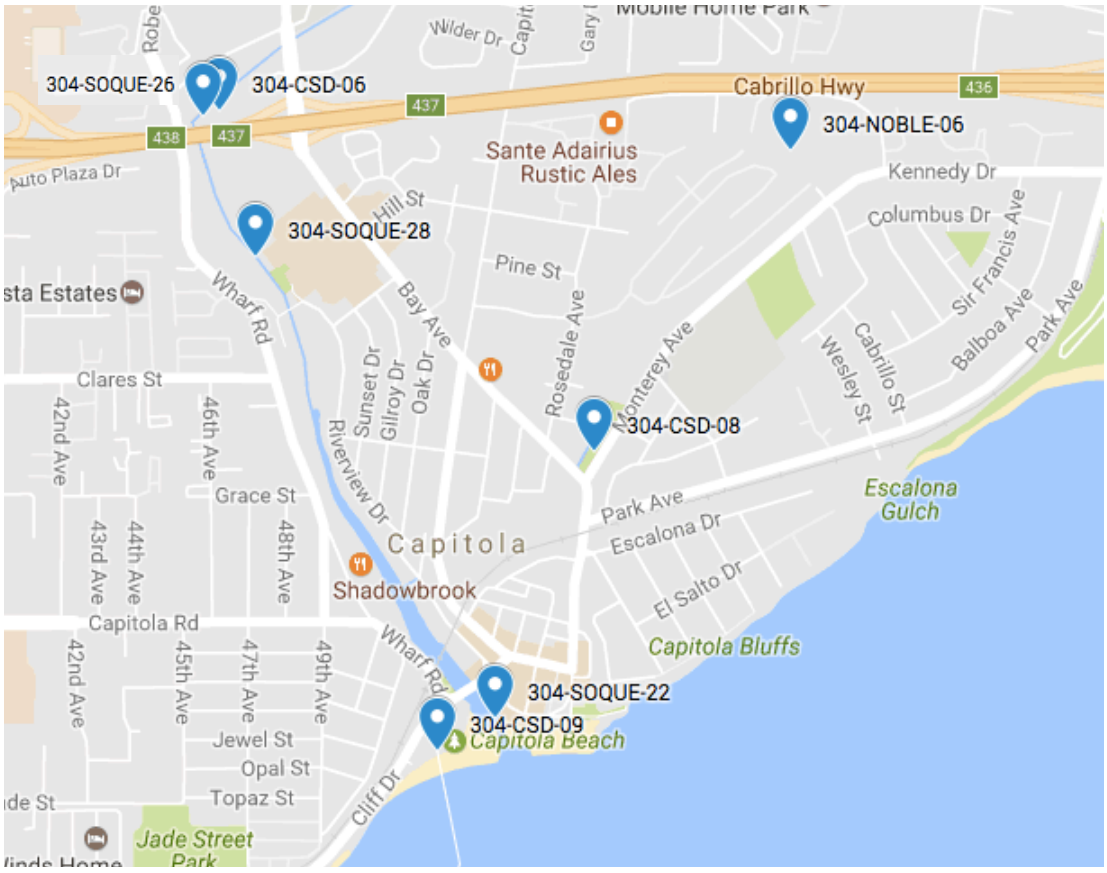


Figure 1: Lower Soquel Creek Watershed, Map of Urban Watch 2016 sites

CWC and staff from the Capitola Public Works Department chose the sites with consideration of safe access for volunteer monitoring teams. During pre-season site visits, access to the Noble Gulch Upper site monitored in previous seasons was deemed unsafe. It was replaced by the Noble Creek upstream of Brookvale Terrace site (304-NOBLE-06) located 300 feet downstream from the original Noble Gulch Upper site. Details on site characteristics are shown below.

Site ID	Site name	Site Description	Latitude	Longitude
304-CSD-06	Creekside Storm Drain	Storm Drain at Creekside Plaza	36.983419	-121.958828
304-CSD-08	Noble Gulch Creek at Monterey Avenue	At Noble Gulch Park on Monterey Ave	36.976967	-121.950044
304-CSD-09	Capitola Pier Storm Drain	Storm Drain under the Capitola Pier	36.971283	-121.953783
304-NOBLE-06	Noble Gulch Upstream of Brookvale Terrace	Noble Gulch upstream of Brookvale Terrace Mobile Home	36.98271	-121.94535
304-SOQUE-22	Soquel Creek Lagoon	Soquel Creek mouth, lagoon formed in dry months	36.971897	-121.952406
304-SOQUE-26	Soquel Creek Upper	Soquel Creek north of Cabrillo Highway at Creekside Plaza	36.98359	-121.95903
304-SOQUE-28	Soquel Creek Mid	Soquel Creek adjacent to Nob Hill on Bay Avenue	36.98068	-121.9581

Field Data Collection

Field equipment included a YSI 556 multi-parameter probe, which was used to measure water temperature, pH, specific and electrical conductivity, salinity, TDS, and dissolved oxygen (both total mg/L and as a percentage of saturation), and a Hach turbidimeter to measure turbidity. A digital thermometer was used to measure air temperature. Physical observations such as flow depth, wetted width, weather, and site conditions (trash, oil sheen, scum, sewage sited or smelled, and wildlife) were also recorded on field data sheets and photographed.

Spencer Schwartz submerges a YSI 556 probe to collect field measurements at Soquel Creek Upper site.

Sample containers were filled with creek or storm drain water for laboratory analysis of nitrate, orthophosphate, ammonia, *E.coli*, total coliform, and copper. All collected water samples were analyzed as individual grab samples rather than as a composite of samples. Following the completion of each monitoring event, all samples were promptly delivered to the Monterey Bay Analytical Services lab for analysis.

Field Lab

A field lab was conducted by volunteers and CWC staff following the completion of each monitoring event. Samples collected from each site were tested for detergent and chlorine using LaMotte testing kits. Water odor and color were also observed as preliminary indicators of water quality.

Megan Tang tests water samples for detergents and chlorine during field lab.

Laboratory Analytical Methods

All samples were analyzed by the Monterey Bay Analytical Services using the following methods.

Constituent	Analytical Method
Nitrate	EPA300.0
Orthophosphate	EPA300.0
Ammonia	SM4500NH3 D
E. Coli	SM9223B
Total Coliform	SM9223B

Data Analysis Methods

CWC teams follow scientific protocols to ensure that our data are reliable and can be compared to regulatory water quality objectives. Water quality objectives ("WQOs") are set by regulators to ensure that ambient water quality is sufficient to support the "beneficial uses" of each ambient water body, as designated in the regional Water Quality Control Plan (usually referred to as the "Basin Plan"). With respect to human activities, common beneficial uses include swimming, fishing, drinking water, or irrigation. When a WQO is exceeded, it indicates that the water quality may not be protective of one or more beneficial uses and the water body may be designated as "impaired". The designated beneficial uses of Soquel Creek, per Chapter II of the Basin Plan, are:

MUN – Municipal and Domestic Supply
AGR – Agricultural Supply
IND – Industrial Service Supply
GWR – Ground Water Recharge
REC1 – Water Contact Recreation
REC2 – Non-Contact Water Recreation
WILD – Wildlife Habitat
COLD – Cold Fresh Water Habitat
MIGR – Migration of Aquatic Organisms
SPWN – Spawning, Reproduction, and/or Early Development
BIOL – Preservation of Biological Habitats of Special Significance
FRESH – Freshwater Replenishment
COMM – Commercial and Sport Fishing

Monitoring results for nitrate, ammonia, copper[1], dissolved oxygen, pH, and turbidity were compared to the WQOs in Chapter III of the Central Coast Regional Water Quality Control Board's Basin Plan. *E.coli* results were compared to the USEPA 2012 Recreational Water Quality Criteria. Orthophosphate results were compared to the former Central Coast Ambient Monitoring Program (CCAMP) Attention Level.

There is no applicable WQO in the Central Coast Basin Plan for total coliform; for reporting purposes the WQO for total coliform in the neighboring San Francisco Bay Basin Plan is referenced. There are no applicable WQO's or attention levels for air temperature, water temperature, electrical conductivity, or salinity. Details regarding the applicable WQOs and other criteria are shown in Appendix A.

While it is essential to note that WQOs apply only to receiving waters (such as named creeks, rivers, and the Bay), and not to urban runoff discharges, comparisons of urban runoff monitoring results to WQOs provide a frame of reference by which results can be evaluated. Absent other objective standards to use as a comparison, these WQOs are the most appropriate values to compare to environmental results for both receiving waters and discharges.

[1] The copper Basin Plan WQO is dependent on water hardness, as higher hardness mitigates the toxic effects of copper and other heavy metals. Based on historical hardness data from Soquel Creek monitoring, creek hardness is assumed to be typically >100 mg/L; therefore the higher (30 µg/L) copper WQO is used for comparison to the Urban Watch data.

Results

The 2016 Urban Watch annual report is designed to facilitate public education and awareness, and to engage residents in best management practices to reduce urban runoff pollution in our local watersheds. The analytical results and instances of exceedance of WQOs and other criteria are provided in Appendix B for the field-measured parameters and in Appendix C for the laboratory-measured constituents. The data were evaluated and combined with historical data to illustrate temporal and spatial trends or patterns, as reflected in the following graphs, map, and discussion. Notable outcomes of laboratory and field measured parameters are outlined below.

Nitrate

Occurring naturally in the environment, nitrate is the primary source of nitrogen for plants. It promotes growth of aquatic vegetation and algae, but too much nitrate can cause overproduction, leading to algal blooms that deplete oxygen in water. Excessive nitrate contributes to the presence of harmful algal blooms (HABs) a rapidly growing problem in California. Anthropogenic sources of nitrate include runoff from lawns or fields containing fertilizers, animal waste, wash water, leaking sewer lines or failing septic systems, and excess dumping of vegetative material.

During Urban Watch 2016, 100% of nitrate samples met the Basin Plan Water Quality Objective level of <10.0 mg/L as non-detects. In 2015, all sites monitored met the WQO. Historically only three of 202 results exceeded the WQO over a twelve-year period.

Hats off to City of Capitola residents for continuing to keep nitrate inputs at a minimum! To maintain healthy nitrate levels in our surface waters please continue to do your part:

- Limit the use of chemical fertilizers.
- Wash pets and vehicles where water won't run into a storm drain, or go to commercial pet or car washes that collect the wash water.
- Where possible, redirect roof downspouts and use the lawn to spread runoff.
- Place cut or dead vegetation, a natural source of nitrate, into your yard waste bin can or compost it.

Learn more at: http://coastal-watershed.org/stewardship/ .

Orthophosphate:

Orthophosphate is found naturally in living and decaying plants and animals and in rocks and sediment. Orthophosphate is a necessary nutrient for aquatic species growth, but like nitrate, excess amounts can stimulate rapid growth in aquatic ecosystems resulting in algal blooms, oxygen depletion and eutrophication. Sources of orthophosphate include runoff from fertilized lawns, fields, or animal manure storage areas; leaking sewer lines, failing septic systems and commercial cleaning products.

During Urban Watch 2016, 100% of 2016 samples met the former CCAMP attention level of <0.12 mg/L as non-detects. Good job City of Capitola residents!

Historically, 193 of 217 samples (89%) across 11 years met the attention level. Of the 24 historical exceedances, 22 occurred from 2012–2015 (Creekside: 7 times, Noble

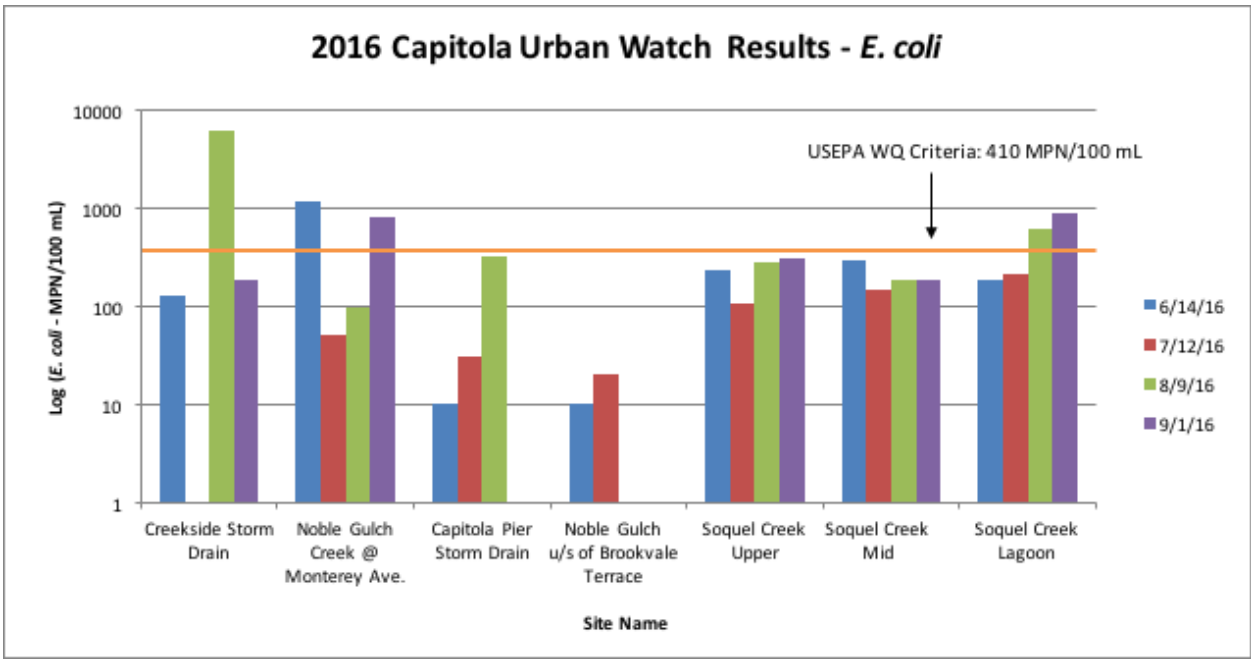
Gulch Creek at Monterey Avenue: 2 times, Noble Gulch Upper: 4 times, Soquel Creek Lagoon: 1 time, Soquel Creek Upper: 4 times, & Soquel Creek Mid: 4 times); two exceedances occurred in 2008 (Soquel Creek Upper & Mid, respectively).

To continue to maintain healthy levels of orthophosphate in our creeks, residents can implement the measures listed above for nitrate, as the urban sources are similar for orthophosphate.

E. Coli:

E. coli is a common type of fecal bacteria originating in the intestines of warm blooded animals. In water quality it is used as an indicator of human waste in the form of sewage or animal waste contamination. High *E. coli* levels can be an indication of a septic tank failure or leaky sewer pipes. The bacteria can also be attributed to more diffuse sources such as wildlife, pets, and birds.

During Urban Watch 2016, 80%, or 20 of the 25 of the samples collected met the USEPA Water Quality (WQ) Criterion of 410 MPN/100 mL. Five of the 25 samples exceeded the USEPA WQ Criterion during the 2016 season.



The Creekside Storm Drain, Noble Gulch Creek at Monterey Avenue, and Soquel Creek Lagoon sites each exceeded the USEPA Criterion for one or more sampling events. The other monitoring sites did not exceed the criterion during any sampling events.

Over the past 9 years, the USEPA *E. coli* Criterion of 410 MPN/100 mL was exceeded in 18 of 38 (47%) of samples collected at Soquel Creek Lagoon, 4 of 33 (12%) of samples collected at the Soquel Creek Mid site, and 8 of 35 samples collected at the Soquel Creek Upper site. An analysis of the results from the 106 Soquel Creek samples collected over the 9 years (2008-2016; see Figure 2) shows a decreasing trend in *E. coli* levels samples at all three Soquel Creek sites. These trend lines should be evaluated cautiously, as they are influenced by the several high values produced in summer 2008.

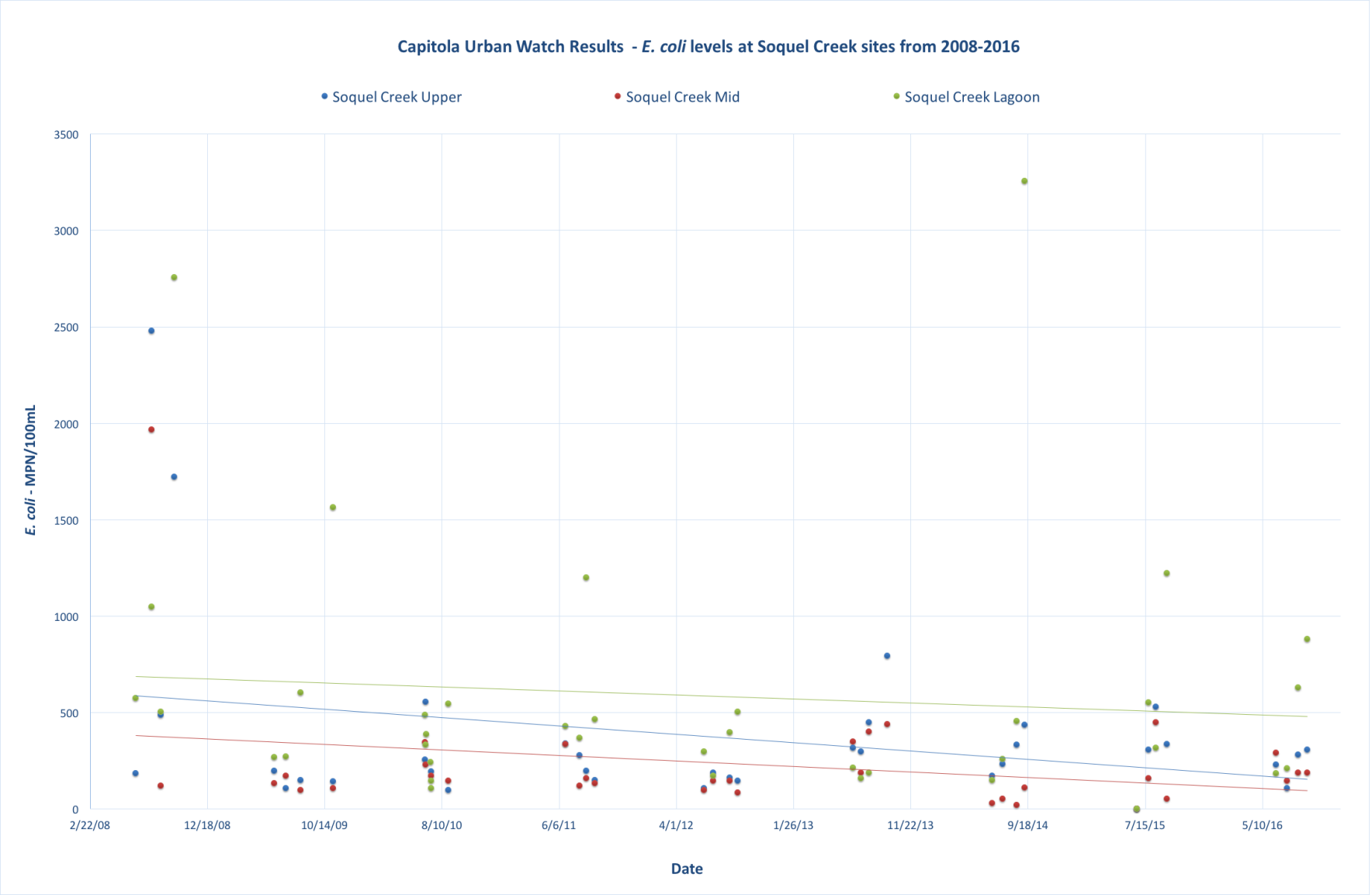
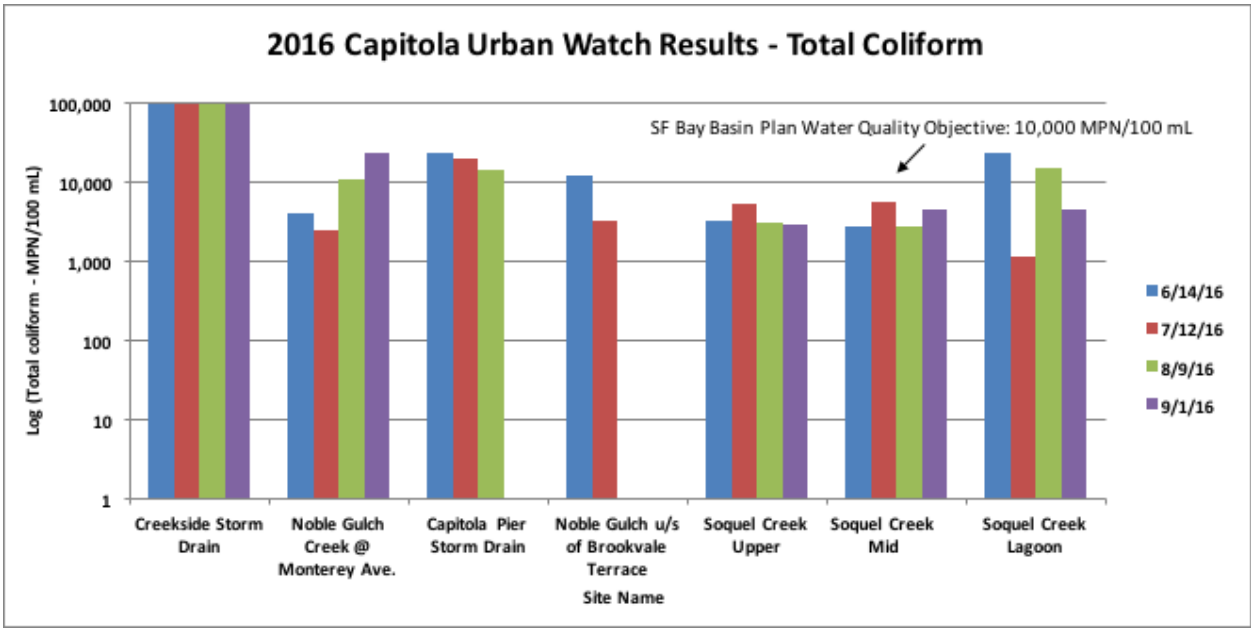


Figure 2. *E. coli* levels at Soquel Creek from 2008 to 2016. Trend lines for each site are highlighted in corresponding color.

To continue to reduce *E. coli* bacteria in our waterways, we each have to do our part. Maintain septic systems, inspect sewer laterals (the pipe leading from home to street) and repair as needed, clean up after pets, report leaking sewer lines, and reduce incidental flows going into storm drains.

Total Coliform:

Total coliform is a general group of bacteria that includes naturally occurring bacteria and also potentially harmful fecal coliform bacteria, including *E. coli*. While coliform bacteria occur naturally, they can also be sourced from anthropogenic sources such as leaky sewer pipes, failing septic systems, pets and wildlife (esp. birds).



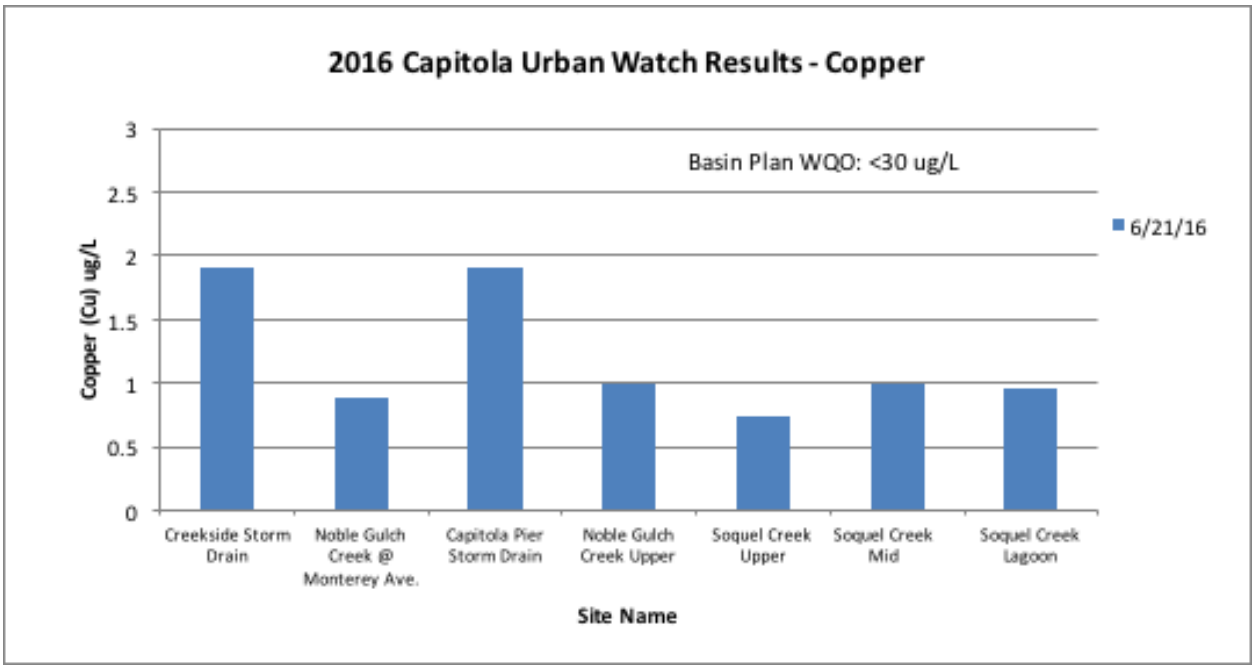
Twelve of the 25 samples, or 48%, exceeded the SF Bay Basin Plan Water Quality Objective (WQO) of <10,000 MPN/100 mL during the 2016 season. Samples collected during every monitoring event at the Creekside Storm Drain site exceeded the WQO. Soquel Creek Upper and Soquel Creek Mid were the only sites to not have any total coliform WQO exceedances during the monitoring study.

Prevention methods for total coliform are similar to those for *E. Coli*, as they follow similar pathways to our streams. You can regularly maintain septic systems, inspect sewer laterals (the pipe leading from home to street) and repair as needed, clean up after pets, report leaking sewer lines, reduce water going into your storm drain and reduce trash that may attract birds. Learn more at: http://coastalwatershed.org/stewardship/ .

Copper

Copper is a mineral element that occurs naturally. It also has many industrial applications and it used in items we use daily like break pads and tires in our cars. Surface runoff and stormwater flows can pick up copper and zinc that are deposited on roadways or mobilized while you are washing your car. Concentrations over 0.025 mg/L (25 µg/L) are typically toxic to freshwater fish.

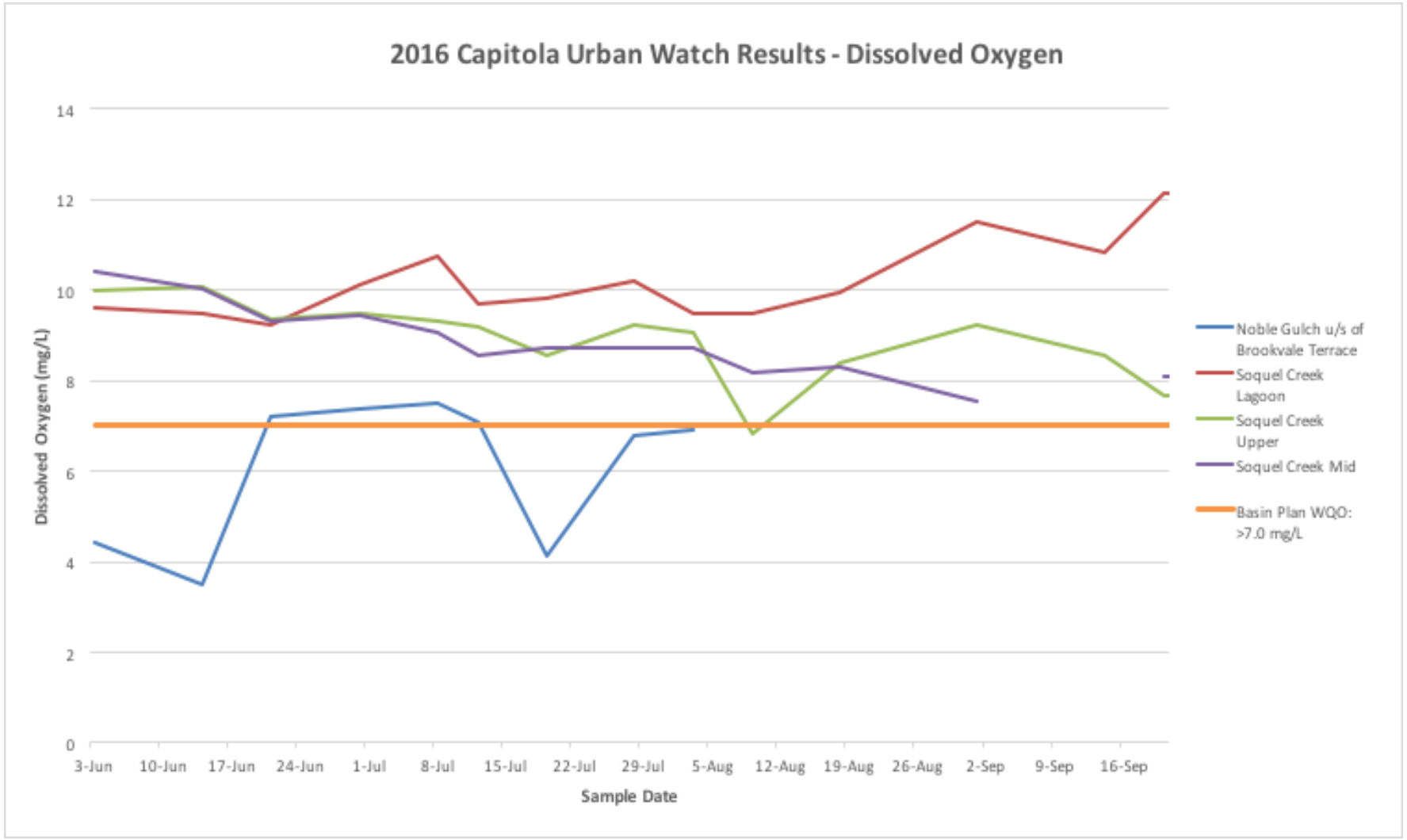
All 7 sites met the Basin Plan Water Quality Objective (WQO) of <30 µg/L in annual samples taken on 6/21/2016. Historically, only one sample has exceeded the WQO (Soquel Creek Lagoon in 2009).



Dissolved Oxygen:

Dissolved Oxygen is the amount of oxygen present in the water and is imperative for survival and growth of nearly all aquatic organisms. As a result, it is a good indicator of stream health. Dissolved oxygen enters water through diffusion aeration at turbulent reaches of a stream or through photosynthesis. Low levels can be caused by excess nutrients, warm water temperatures, and/or poor water circulation.

During 2016 Urban Watch, 87% of measurements met the Basin Plan Water Quality Objective (WQO) level of >7 mg/L; 13% of measurements failed to meet the WQO. Historically, on average 80% of results met the WQO from 2010-2015. Almost all of the readings lower than 7 mg/L were at the Noble Gulch u/s of Brookvale Terrace site. Throughout the monitoring season this site had very low stream flow despite the average hydrologic year. By comparison, 97% of Soquel Creek sites met the WQO.


2016 Capitola Urban Watch Results - Dissolved Oxygen
Dissolved Oxygen (mg/L)
14
12
10
8
6
4
2
0
3-Jun
10-Jun
17-Jun
24-Jun
1-Jul
8-Jul
15-Jul
22-Jul
29-Jul
5-Aug
12-Aug
19-Aug
26-Aug
2-Sep
9-Sep
16-Sep
Sample Date
Noble Gulch u/s of Brookvale Terrace
Soquel Creek Lagoon
Soquel Creek Upper
Soquel Creek Mid
Basin Plan WQO: >7.0 mg/L

Discussion/Conclusions

This report summarizes results for the 2016 City of Capitola Urban Watch Program, with comparisons to the historical Urban Watch data set where feasible.

Flow

Like the rest of Santa Cruz County, Capitola and Soquel Creek watershed experienced average rainfall during the 2016 water year. Many sites not available for monitoring in past drought years had sufficient flow for sampling during the 2016 Urban Watch program. In the 2013 – 2015 seasons, visible flow at the Capitola Pier Storm Drain was observed only once (on 6/18/13); during the 2014 season evidence of earlier flow was noted six times during June-August; there was no flow during any of the 2015 season events. In 2016, this site experienced consistent flow through 9/1/2016. Consistent flow was also observed at the Creekside Storm Drain site and all Soquel Creek sites.

The Noble Gulch Creek upstream of Brookvale Terrace site experienced pooling and no observable flow conditions due to decreasing flow upstream of the culvert and lack of stream connectivity. As a result samples were not collected on the 8/9/2015 and 9/16/2015 monitoring events.

Comparisons to WQOs

WQO exceedances for both *E. coli* and total coliform are not unique to Soquel Creek and Capitola Urban Watch sites. This is typical of urban runoff and urban creeks systems generally, as the sources of these indicator bacteria are ubiquitous in the urban environment. Yet, it merits recognition that annual Urban Watch monitoring has indicated year-to-year improvements in both constituent levels.

It is also notable that the nitrate WQO and orthophosphate attention level were not exceeded during the 2016 monitoring.

Dissolved oxygen levels in Soquel Creek were healthy at all three creek sites, and only fell below the Basin Plan minimum once in the 45 measurements taken in Soquel Creek. By comparison, at the Noble Gulch upstream of Brookvale Terrace site, dissolved oxygen was below the Basin Plan minimum for 5 of the 8 measurements taken. Noble Gulch has a history of lower dissolved oxygen levels, and for the 2016 monitoring season it can be associated with the lack of flow from upstream starting in August.

As in previous years, copper met the Basin Plan WQOs at all sites.

Ammonia (unionized) results were below 0.025 mg/L in all samples and therefore met the Basin Plan WQO during the 2016 monitoring season. Historically, ammonia has met the attention level in 99% of all samples across twelve years.

Three pH results at the Soquel Creek Upper site and one at the Soquel Creek Mid site exceeded the Basin Plan WQO of >7.0 and <8.5 pH (see Appendix A). Exceedances at the Noble Gulch upstream of Brookvale Terrace site were frequent, at six out of nine measurements taken.

Summary

Soquel Creek is a key natural asset to the local community, and to the region. The City of Capitola is acknowledged for its leadership and efforts in striving to not just reduce but eliminate non-point source pollution in the Creek. The City's pollution reduction efforts have substantially reduced the levels of nutrients and bacteria entering the storm drain system and Soquel Creek during the dry season. The approach of partnering with other organizations and engaging the community through citizen-based monitoring is an excellent example for other communities to follow.

Where *E. coli* and total coliform WQOs are exceeded, there is a need for additional investigative and/or remedial work. This can be addressed among residents with education around picking up pet waste, properly disposing of trash and reducing incidental flows from car washing or power washing that contribute to biofilm growth. A particular challenge for coastal communities involves educating the visitors that come to the area during the dry season for vacation. As in the past, the City is encouraged to focus on visible signage with educational messages and instructions, and strategic placement of waste bins for these audiences.

Key recommendations to improve water quality for the future include:

1. Investigate the potential watershed sources of elevated indicator bacteria levels throughout the study area.
2. Continue water quality monitoring involving volunteers from the public at the selected stations. Data from continued monitoring offer opportunities to measure improvements or degradation in water quality over time, and volunteer-based monitoring in particular helps to raise public awareness of local water quality issues.
3. Continue and expand pollution prevention outreach programs targeting local populations and visitors to the City, such as strategic signage, educational water tours, environmental film series, efficient utilization of social media networks and new media (e.g., CWC's Stewardship Toolkit), continued implementation of school-based stormwater education programs, and expansion of public participation in existing monitoring programs.
4. Collaborate with other cities and counties in the region to collectively fund monitoring and education efforts related to NPDES permit requirements, achieving efficiency in funding and sharing of success stories and challenges.

CWC will continue to partner with the City of Capitola in water quality monitoring to engage the public and generate useful data to measure the effectiveness of public education and infrastructure investments. With support from the City of Capitola Public Works Department, CWC hosts a series of environmental water tours free to the public, to facilitate greater public understanding and appreciation of local water resources.

Volunteers collecting this valuable information play a key role in our community as stewards of our watersheds. The information they provide is used by resource agencies,

local governments and community groups to protect and improve the health of our local streams. In the coming months, CWC will work with Urban Watch volunteers to educate Capitola residents, Soquel Creek neighbors and youth on the value of reducing nonpoint source pollution and recent successes in improving water quality in the Soquel Creek watershed.

Geography and Environmental Science students from the University of Exeter participate in the final Urban Watch monitoring day of 2016.

The results in this report and from other monitoring programs can be used to facilitate pollution prevention efforts by identifying which constituents are of greatest concern, and evaluating trends in water quality for key constituents over time. Environmental data, by their very nature, are extremely variable, and conclusions are often difficult to make based on limited data points. Nonetheless, these results are of use in shaping regional programs to inform the public about environmental stewardship.

More information about local water quality data is available at http://coastal-watershed.org or by contacting the CWC office at (831) 464-9200 or info@coastal-watershed.org.

Appendix A: Water Quality Objectives and Other Criteria

Applicable WQOs for field-measured parameters are as follows:

Analyte	WQO or Attention Level	Units	Source of WQO/AL
Air Temperature	NA		NA
Water Temperature	Not Evaluated	°C	CCRWQCB Basin Plan Objective for Cold Water Habitat
Specific Conductivity	NA		NA
TDS	NA		NA
Salinity	NA		NA
Dissolved Oxygen	>7	mg/L	CCRWQCB Basin Plan Objective for Cold Water Habitat
pH	>7.0 and <8.5	pH units	CCRWQCB Basin Plan Objective for Cold Water Habitat
Turbidity	Not Evaluated	NTU	CCRWQCB Basin Plan

Applicable WQOs and other criteria for laboratory-measured parameters are as follows:

Analyte	WQO or Attention Level	Units	Source of WQO/AL
Nitrate (NO_3-N)	<10.0	mg/L	CCRWQCB Basin Plan
Orthophosphate (PO_4-P)	<0.12	mg/L	Former CCAMP Attention Level
Ammonia (NH_3-N) Unionized	<0.025	mg/L	CCRWQCB Basin Plan
E.coli	126	MPN/100 mL	USEPA 2012 Recreational WQ Criteria
Total Coliform*	<240	MPN/100 mL	SF Bay Region Basin Plan for Water Contact Recreation
Copper (Cu) **	<30	µg/L	CCRWQCB Basin Plan

* Total coliform: there is no applicable WQO in the CCRWQCB Basin Plan; for report purposes the neighboring SF Bay Basin Plan is referenced.

** Listed copper WQO pertains to hard water, with hardness of >100 mg/L CaCO3

Appendix B – 2015 Field Observations and Measurements

Appendix B provides the summary of field results for each parameter at each site. Results that exceed the applicable WQO or attention level are shaded in order to highlight these results. During the monitoring season flows from Noble Creek at Monterey Avenue, Creekside Storm Drain and Capitola Storm Drain were too low for use of the YSI multi-parameter probe. Not all field lab tests were performed during every monitoring event (detergent tests were only performed at Storm Drain/CSD sites). Instances in which a test was not performed are listed as "NA" and "NR" if the datum was not recorded.

304-CSD-06: Creekside Storm Drain

	Air Temperature	Water Temperature	Specific Conductivity	TDS	Salinity	DO	pH	Turbidity	Flow Depth	Wetted Width	Trash	Sewage	Oil Sheen	Scum	Detergent	Chlorine	Odor	Color
Date	°C	°C	uS/cm	g/L	ppt	mg/L		NTU	cm	m	T/F	T/F	T/F	T/F	ppm	ppm	T/F	BCS#
6/3/16	17	N/A	N/A	N/A	N/A	N/A	N/A	1.13	0.5	0.6	T	F	F	T	<0.1	<0.2	T	93
6/14/16	14.3	N/A	N/A	N/A	N/A	N/A	N/A	0.43	0.5	0.62	T	F	F	T	<0.1	<0.2	F	107
6/21/16	16.1	N/A	N/A	N/A	N/A	N/A	N/A	1.16	0.5	0.65	T	F	F	F	<0.1	<0.2	T	93
6/30/16	12.9	N/A	N/A	N/A	N/A	N/A	N/A	0.74	0.55	0.65	T	F	F	F	<0.1	<0.2	F	93
7/8/16	15	N/A	N/A	N/A	N/A	N/A	N/A	2.78	0.45	0.63	T	F	F	F	<0.1	<0.2	T	93
7/12/16	14.9	N/A	N/A	N/A	N/A	N/A	N/A	0.37	0.4	0.605	T	F	F	F	<0.1	<0.2	F	93
7/19/16	15.6	N/A	N/A	N/A	N/A	N/A	N/A	2.3	0.4	0.73	F	F	F	F	<0.1	<0.2	F	93
7/28/16	16.1	N/A	N/A	N/A	N/A	N/A	N/A	1.59	0	0.5	F	F	F	F	<0.1	<0.2	F	93
8/3/16	13.9	N/A	N/A	N/A	N/A	N/A	N/A	3.29	0.5	0.5	F	F	F	F	<0.1	<0.2	F	93
8/9/16	15.3	N/A	N/A	N/A	N/A	N/A	N/A	12.8	0.5	0.35	T	F	F	F	<0.1	<0.2	F	91
8/18/16	15.80	N/A	N/A	N/A	N/A	N/A	N/A	1.36	0.45	0.35	T	F	F	F	<0.1	<0.2	T	36
8/27/16	18.6	N/A	N/A	N/A	N/A	N/A	N/A	1.48	0.8	0.3	F	F	F	F	<0.1	<0.2	F	93
9/1/16	16.6	N/A	N/A	N/A	N/A	N/A	N/A	4.02	0.5	0.28	F	F	F	F	<0.1	<0.2	F	93
9/14/16	15.3	N/A	N/A	N/A	N/A	N/A	N/A	3.11	0.5	0.24	F	F	F	F	<0.1	<0.2	F	93
9/20/16	17.70	N/A	N/A	N/A	N/A	N/A	N/A	8.53	0.4	0.2	T	F	F	F	<0.1	<0.2	F	91

304-CSD-08: Noble Gulch Creek at Monterey Avenue

	Air Temperature	Water Temperature	Specific Conductivity	TDS	Salinity	DO	pH	Turbidity	Flow Depth	Wetted Width	Trash	Sewage	Oil Sheen	Scum	Detergent	Chlorine	Odor	Color
Date	°C	°C	uS/cm	g/L	ppt	mg/L		NTU	cm	m	T/F	T/F	T/F	T/F	ppm	ppm	T/F	BCS#
6/3/16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.44	2	1.6	F	F	T	T	<0.1	<0.2	F	93
6/14/16	19.2	N/A	N/A	N/A	N/A	N/A	N/A	3.51	2.5	1	F	F	F	T	<0.1	<0.2	F	91
6/21/16	17.4	N/A	N/A	N/A	N/A	N/A	N/A	2.83	1	1.7	F	F	T	T	<0.1	<0.2	F	91
6/30/16	13.3	N/A	N/A	N/A	N/A	N/A	N/A	8.96	2.5	1.2	F	F	F	T	<0.1	<0.2	T	91
7/8/16	15.8	N/A	N/A	N/A	N/A	N/A	N/A	4.74	5	1.17	T	F	F	T	<0.1	<0.2	T	91
7/12/16	16.5	N/A	N/A	N/A	N/A	N/A	N/A	3.2	4	0.75	F	F	F	F	<0.1	<0.2	T	36
7/19/16	15.4	N/A	N/A	N/A	N/A	N/A	N/A	2.11	2	1.3	F	F	F	F	<0.1	<.02	F	91
7/28/16	15.3	N/A	N/A	N/A	N/A	N/A	N/A	1.81	2	1.45	F	F	F	F	<0.1	<0.2	F	91
8/3/16	15	N/A	N/A	N/A	N/A	N/A	N/A	2.34	1.8	0.5	F	F	F	F	<0.1	<0.2	F	92
8/9/16	14.6	N/A	N/A	N/A	N/A	N/A	N/A	2.56	2	0.23	F	F	F	F	<0.1	<0.2	F	91
8/18/16	16.80	N/A	N/A	N/A	N/A	N/A	N/A	3.8	2	0.46	F	F	F	F	<0.1	<0.2	F	91
8/27/16	20.3	N/A	N/A	N/A	N/A	N/A	N/A	1.34	1.5	0.165	F	F	F	F	<0.1	<0.2	F	91
9/1/16	18.2	N/A	N/A	N/A	N/A	N/A	N/A	1.89	1.5	0.3	F	F	F	F	<0.1	<0.2	F	93
9/14/16	17.2	N/A	N/A	N/A	N/A	N/A	N/A	1.26	1	0.3	F	F	F	F	<0.1	<0.2	F	91
9/20/16	19	N/A	N/A	N/A	N/A	N/A	N/A	2.7	1.5	0.52	T	F	F	F	<0.1	<0.2	F	91

304-CSD-09: Capitola Pier Storm Drain

	Air Temperature	Water Temperature	Specific Conductivity	TDS	Salinity	DO	pH	Turbidity	Flow Depth	Wetted Width	Trash	Sewage	Oil Sheen	Scum	Detergent	Chlorine	Odor	Color
Date	°C	°C	uS/cm	g/L	ppt	mg/L		NTU	cm	m	T/F	T/F	T/F	T/F	ppm	ppm	T/F	BCS#
6/3/16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.98	0.5	0.3	F	F	F	T	<0.1	<0.2	F	93
6/14/16	15.9	N/A	N/A	N/A	N/A	N/A	N/A	2.10	0.52	0.24	T	F	F	T	<0.1	<0.2	T	91
6/21/16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.52	0.5	0.2	F	F	F	F	<0.1	<0.2	T	93
6/30/16	13.9	N/A	N/A	N/A	N/A	N/A	N/A	0.53	0.5	0.30	T	F	T	F	<0.1	<0.2	F	93
7/8/16	16	N/A	N/A	N/A	N/A	N/A	N/A	1.25	0.5	0.3	T	F	F	F	<0.1	<0.2	T	93
7/12/16	16.9	N/A	N/A	N/A	N/A	N/A	N/A	1.49	0.5	0.3	F	F	F	F	<0.1	<0.2	F	93
7/19/16	17.3	N/A	N/A	N/A	N/A	N/A	N/A	1.2	0.2	0.25	T	F	F	T	<0.1	<0.2	F	93
7/28/16	15.8	N/A	N/A	N/A	N/A	N/A	N/A	1.33	0.3	0.2	F	F	F	T	<0.1	<0.2	T	93
8/3/16	15.2	N/A	N/A	N/A	N/A	N/A	N/A	0.97	0.50	0.2	T	F	F	T	<0.1	<0.2	F	93
8/9/16	16.0	N/A	N/A	N/A	N/A	N/A	N/A	1.73	0.25	0.275	T	F	F	F	<0.1	<0.2	F	93
8/18/16	16.20	N/A	N/A	N/A	N/A	N/A	N/A	0.68	0.20	0.3	F	F	F	F	<0.1	<0.2	F	93
8/27/16	17.8	N/A	N/A	N/A	N/A	N/A	N/A	0.86	<0.1	0.1	T	F	F	F	<0.1	<0.2	F	93
9/1/16	17.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	F	F	F	F	N/A	N/A	N/A	N/A
9/14/16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/20/16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

304-NOBLE-06: Noble Gulch Upstream of Brookvale Terrace

	Air Temperature	Water Temperature	Specific Conductivity	TDS	Salinity	DO	pH	Turbidity	Flow Depth	Wetted Width	Trash	Sewage	Oil Sheen	Scum	Detergent	Chlorine	Odor	Color
Date	°C	°C	uS/cm	g/L	ppt	mg/L		NTU	cm	m	T/F	T/F	T/F	T/F	ppm	ppm	T/F	BCS#
6/3/16	20	15.69	954	0.754	0.58	4.44	5.9	9.3	32	3.64	F	F	F	F	N/A	<0.2	T	93
6/14/16	18	14.9	902	0.593	0.45	3.49	5.71	1.27	38	3.57	F	F	F	F	N/A	<0.2	T	93
6/21/16	19.3	16.56	881	0.559	0.42	7.22	6.72	8.73	40	3.25	F	F	F	F	N/A	<0.2	F	93
6/30/16	13.2	16.25	788	0.512	0.39	7.38	6.69	1.41	44	3.3	F	F	F	F	N/A	<0.2	F	107
7/8/16	16.51	17.58	758	0.493	0.37	NA	7.37	1.66	39	3.4	F	F	F	F	N/A	<0.2	F	36
7/12/16	15.9	17.41	739	0.481	0.36	7.07	7.1	1.5	41	3.4	F	F	F	F	N/A	<0.2	F	36
7/19/16	16.6	15.47	813	0.529	0.4	4.15	6.55	2.15	40	3.4	T	F	F	F	N/A	<.02	F	26
7/28/16	16.5	16.57	751	0.489	0.37	6.79	6.94	1.59	38.5	3.4	F	F	F	F	N/A	<0.2	F	93
8/3/16	15.8	16.89	733	0.477	0.36	6.91	7.47	0.93	37	3.7	F	F	F	F	N/A	<0.2	F	93
8/9/16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/18/16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/27/16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/1/16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/14/16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/20/16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

304-SOQUE-26: Soquel Creek Upper

	Air Temperature	Water Temperature	Specific Conductivity	TDS	Salinity	DO	pH	Turbidity	Flow Depth	Wetted Width	Trash	Sewage	Oil Sheen	Scum	Detergent	Chlorine	Odor	Color
Date	°C	°C	uS/cm	g/L	ppt	mg/L		NTU	cm	m	T/F	T/F	T/F	T/F	ppm	ppm	T/F	BCS#
6/3/16	17	14.92	638	0.513	0.39	9.99	NA	0.74	20.5	11.6	F	F	F	F	N/A	<0.2	F	93
6/14/16	14.3	14.7	843	0.548	0.42	10.08	7.77	1	20	11.3	T	F	T	F	N/A	<0.2	F	97
6/21/16	16.1	16	849	0.552	0.42	9.35	6.78	0.73	16	11.2	F	F	F	F	N/A	<0.2	T	107
6/30/16	13.00	15.62	852	0.552	0.42	9.5	6.38	0.51	10	10.95	F	F	F	F	N/A	<0.2	F	93
7/8/16	16.5	16.42	861	0.560	0.43	9.3	7.05	0.68	17	1	F	F	F	F	N/A	<0.2	F	93
7/12/16	15	16.04	803	0.554	0.42	9.2	6.58	0.62	19	11.5	F	F	F	F	N/A	<0.2	F	93
7/19/16	15.6	15.79	895	0.582	0.44	8.57	7.14	1.19	16	11.1	T	F	F	F	N/A	<0.2	F	93
7/28/16	16.1	15.6	881	0.572	0.44	9.24	7.3	0.73	15	11.05	F	F	F	F	N/A	<0.2	F	93
8/3/16	14.5	16.03	877	0.57	0.43	9.08	7.62	0.63	12	5.15	F	F	F	F	N/A	<0.2	F	92
8/9/16	14.5	15.73	878	0.571	0.43	6.82	7.36	0.83	12.50	5.45	F	F	F	F	N/A	<0.2	F	93
8/18/16	16.40	16.18	848	0.551	0.42	8.39	7.03	0.69	11.60	5.05	F	F	F	F	N/A	<0.2	F	93
8/27/17	18.6	16.28	831	0.54	0.41	8.92	7.07	0.61	10	5.65	F	F	F	F	N/A	<0.2	F	93
9/1/16	16.2	16.47	848	0.551	0.42	9.25	7.35	0.74	11.5	5.5	F	F	F	F	N/A	<0.2	F	36
9/14/16	15.20	14.02	833	0.542	0.41	8.56	7.04	1.66	7.5	5.5	F	F	F	F	N/A	<0.2	F	93
9/20/16	17.1	16	842	0.547	0.42	7.69	7.67	1.46	7.6	11.05	T	F	F	F	N/A	<0.2	F	93

304-SOQUE-28: Soquel Creek Mid

	Air Temperature	Water Temperature	Specific Conductivity	TDS	Salinity	DO	pH	Turbidity	Flow Depth	Wetted Width	Trash	Sewage	Oil Sheen	Scum	Detergent	Chlorine	Odor	Color
Date	°C	°C	uS/cm	g/L	ppt	mg/L		NTU	cm	m	T/F	T/F	T/F	T/F	ppm	ppm	T/F	BCS#
6/3/16	17.5	15.12	702	0.563	0.43	10.4	7.39	0.84	56	8	T	F	F	F	N/A	<0.2	T	93
6/14/16	15.35	14.93	843	0.548	0.42	10.01	6.85	0.60	54	8.05	F	F	F	F	N/A	<0.2	F	107
6/21/16	17.6	16.1	853	0.555	0.42	9.32	7.14	0.6	59.5	7.4	F	T	F	F	N/A	<0.2	F	93
6/30/16	13.7	15.69	9	0.554	0.42	9.42	7.11	0.68	59.79	7	F	F	F	F	N/A	<0.2	F	93
7/8/16	14.5	16.48	803	0.561	0.43	9.05	7.63	0.79	55	8.05	T	F	F	F	N/A	<0.2	T	93
7/12/16	15.8	16.2	854	0.555	0.42	8.55	7.21	1.34	61.5	8.85	T	F	F	F	N/A	<0.2	T	93
7/19/16	16.1	16.02	895	0.581	0.44	8.73	7.54	0.72	75	8.35	F	F	F	F	N/A	<.02	F	93
7/28/16	13.4	19.76	883	0.574	0.44	8.74	7.62	1.1	62.5	8.15	F	F	F	F	N/A	<0.2	F	93
8/3/16	14.8	16.25	880	0.572	0.43	8.74	7.86	0.74	76	8	F	F	T	F	N/A	<0.2	F	93
8/9/16	15.1	15.88	879	0.572	0.43	8.16	7.73	0.64	79.5	8.1	F	F	F	F	N/A	<0.2	F	93
8/18/16	17.4	16.38	848	0.551	0.42	8.29	7.31	1.85	66	8.4	F	F	T	F	N/A	<0.2	F	36
8/27/17	18.4	16.5	832	0.541	0.41	8.46	7.3	0.6	52	8.17	F	F	T	F	N/A	<0.2	F	93
9/1/16	16.9	16.84	851	0.553	0.42	7.54	7.01	0.87	49.5	5.3	F	F	T	F	N/A	<0.2	F	93
9/14/16	15.7	14.54	838	0.544	0.41	NA	7.2	0.62	45	8.55	F	F	T	F	N/A	<0.2	F	93
9/20/16	16.8	16.65	846	0.55	0.42	8.1	7.5	0.75	40	8.35	T	F	T	F	N/A	<0.2	F	93

304-SOQUE-22: Soquel Creek Lagoon

	Air Temperature	Water Temperature	Specific Conductivity	TDS	Salinity	DO	pH	Turbidity	Flow Depth	Wetted Width	Trash	Sewage	Oil Sheen	Scum	Detergent	Chlorine	Odor	Color
Date	°C	°C	uS/cm	g/L	ppt	mg/L		NTU	cm	m	T/F	T/F	T/F	T/F	ppm	ppm	T/F	BCS#
6/3/16	20	18.53	791	0.587	0.45	9.61	7.57	0.96	NA	NA	T	F	F	T	NA	<0.2	F	93
6/14/16	19.01	18.04	885	0.575	0.44	9.5	7.01	1.00	NA	NA	T	F	T	F	NA	<0.2	F	93
6/21/16	19.5	20.38	889	0.578	0.44	9.25	8.06	0.97	NA	NA	F	F	F	T	NA	<0.2	F	93
6/30/16	15.2	19.47	905	0.588	0.45	10.12	7.52	1.07	NA	NA	F	F	F	F	NA	<0.2	F	36
7/8/16	15.3	19.77	907	0.589	0.45	10.75	7.93	1.18	NA	NA	T	F	F	F	NA	<0.2	F	93
7/12/16	19.9	20.36	899	0.586	0.44	9.7	7.83	1.04	NA	NA	F	F	F	F	NA	<0.2	T	93
7/19/16	16	19.69	954	0.62	0.47	9.8	8.1	1.04	NA	NA	F	F	F	F	NA	<0.2	F	93
7/28/16	19.2	20.12	964	0.627	0.48	10.2	8.18	1.07	NA	NA	F	F	F	F	NA	<0.2	F	93
8/3/16	14.5	20.58	965	0.628	0.48	9.48	8.17	1.46	NA	NA	F	F	F	F	NA	<0.2	F	93
8/9/16	16.2	19.54	966	0.628	0.48	9.5	8.08	1.27	NA	NA	F	F	F	F	NA	<0.2	F	93
8/18/16	17.50	19.75	933	0.606	0.46	9.93	7.90	1.11	NA	NA	F	F	F	F	NA	<0.2	F	93
8/27/16	24	19.42	933	0.606	0.46	9.64	7.46	0.95	NA	NA	T	F	F	F	NA	<0.2	F	93
9/1/16	21.5	20.48	929	0.604	0.46	11.5	7.95	0.78	NA	NA	F	F	F	F	NA	<0.2	T	93
9/14/16	16	17.75	925	0.601	0.46	10.85	7.9	1.16	NA	NA	T	F	F	F	NA	<0.2	F	93
9/20/16	20	19.22	920	0.598	0.45	12.14	8.1	0.9	NA	NA	F	F	F	F	NA	<0.2	F	93

Appendix C: 2016 Laboratory Results

Appendix C provides a summary of laboratory results for each constituent at each site. Results that exceed the applicable WQO or attention level are shaded in order to highlight these results. Not all tests were performed during every lab event. Capitola Pier Storm Drain did not have any flow on the final sampling date 9/1/2016. Noble Gulch u/s of Brookvale Terrace was not sampled for the final two events as starting August there was no inflow and the reach downstream of the Cabrillo Highway culvert was entirely pooled up. All instances in which a sample was not collected are listed as "NA".

Constituent	WQO or Attention Level	Site Name: / Site ID: / Type:	Creekside Storm Drain / CSD-06 / Storm Drain	Noble Gulch @ Monterey Ave. / CSD-08 / Creek	Capitola Pier Storm Drain / CSD-09 / Storm Drain	Noble Gulch u/s of Brookvale Terrace / NOBLE-06 / Creek	Soquel Creek Upper / SOQUE-26 / Creek	Soquel Creek Mid / SOQUE-28 / Creek	Soquel Creek Lagoon / SOQUE-22 / Creek
		DATE							
Nitrate (NO_3-N)	<10.0 mg/L	6/14/16	4.2	0.1	0.6	ND	ND	ND	ND
		7/12/16	4.2	0.2	0.3	ND	ND	ND	ND
		8/9/16	4.4	0.1	0.2	NA	ND	ND	ND
		9/1/16	3.8	0.1	NA	NA	ND	ND	ND
Orthophosphate (PO_4-P)	<0.12 mg/L	6/14/16	ND	ND	ND	ND	ND	ND	ND
		7/12/16	ND	ND	ND	ND	0.10	0.10	ND
		8/9/16	ND	ND	ND	NA	ND	ND	ND
		9/1/16	ND	ND	NA	NA	ND	ND	ND
Ammonia (NH_3)	0.025 mg/L	6/14/16	ND	ND	ND	ND	ND	ND	ND
		7/12/16	ND	ND	ND	ND	ND	ND	ND
		8/9/16	ND	ND	ND	NA	ND	ND	ND
		9/1/16	ND	ND	NA	NA	ND	ND	ND
E.coli	410 MPN/100 mL	6/14/16	132	1187	10	10	231	292	185
		7/12/16	<10	52	31	20	109	145	211
		8/9/16	6131	98	322	NA	281	189	631
		9/1/16	187	816	NA	NA	309	189	882
Total Coliform	>10,000 MPN/100 mL	6/14/16	>24196	4106	24196	12033	3255	2851	24196
		7/12/16	>24196	2489	19863	3282	5475	5794	1168
		8/9/16	>24196	11199	14136	NA	3076	2755	15531
		9/1/16	>24196	24196	NA	NA	2909	4611	4611
Copper	30 µg/L	6/21/16	1.9	0.89	1.9	1	0.95	0.74	1

Shading indicates results above WQO.

ND = Non-detect result

NA = Not analyzed/no sample