City of Santa Cruz 2011 First Flush Program Final Report

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Prepared for:
City of Santa Cruz
Department of Public Works

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Preserving and protecting our coastal watersheds

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Introduction

As part of a regional effort throughout the Monterey Bay, the Coastal Watershed Council (CWC) conducted the 2011 First Flush Program in Santa Cruz County in the fall of 2011. As CWC's program partner, the Monterey Bay National Marine Sanctuary conducted similar activities in Monterey and San Mateo Counties. CWC's work was partially funded by contracts with the City of Capitola and City of Santa Cruz. This report covers First Flush monitoring in the City of Santa Cruz.

First Flush activities for the City of Santa Cruz included:

- Classroom training of volunteers
- Dry Run event for volunteer teams to visit sites and conduct dry weather water quality monitoring
- First Flush water quality monitoring during the first significant rainfall of the 2011-12 wet season

Four storm drain outfall sites were monitored for the City of Santa Cruz and are referred to as:

1. "Bay Street" – unnamed creek which flows along Bay Street and passes under Escalona Drive, becoming an open channel at the NW corner of Bay & Escalona
2. "Woodrow" – an open channel on Woodrow Drive (a.k.a Bethany Curve); passes under West Cliff Drive and outlets to the ocean
3. "Arroyo Seco" – open channel on the north side of Grandview
4. "Merced" – storm drain culvert from open channel which passes under West Cliff Drive at Merced Avenue and outlets to the ocean.

Rationale for Program: Pollutants have become abundant within the environment, often due to human activities. This includes everyday activities such as performing lawn care, burning of fossil fuels for home heating, and driving motor vehicles. Many components of the urban landscape, such as materials used in roofs and roadways, also contribute pollutants to the environment. Pollutants collect on local street surfaces, sidewalks, driveways, rooftops and other impermeable surfaces, as well as in yards, parks and beaches throughout the year. During the lengthy dry season common for our regional climate, there are no storms to "rinse away" these contaminants. The result of these several months of dry weather is a significant build-up of pollutants, which are then "flushed" into storm drains, creeks, rivers and the Monterey Bay during the first heavy rains of the wet season. The First Flush Program aims to gather data about the amount of pollution entering local waters during this onset of the rainy season.

Results are communicated to the general public and to local leaders through a variety of means, including this report. It is hoped that this program will foster more informed efforts to prevent pollution, and protect the natural resources that this region relies on for tourism, jobs, overall economy, and quality of life for residents. The First Flush Program also represents an efficient way for local jurisdictions to meet a portion of their USEPA National Pollution Discharge Elimination System (NPDES) and MS4 General Permit requirements. Public education and outreach is an integral part of the First Flush Program. Volunteers such as those trained by CWC engage in citizen science and help spread the news about stormwater runoff throughout their communities. While citizen science efforts such as the First Flush Program are important for generating valuable water quality data, they also represent an opportunity to educate and inspire the public to become more environmentally aware, and to act as responsible stewards of our unique natural resources.

Since 2000, the First Flush Program has trained citizen volunteers from San Mateo, Santa Cruz and Monterey Counties to collect water samples and conduct water quality assessments during the first significant rain event of the season. Volunteers are trained to perform basic field water quality tests including measurements of pH, electrical conductivity, transparency and water temperature. They also receive training in collecting water samples for delivery to laboratories for analysis of nutrients (nitrate and orthophosphate), bacteria (*Escherichia coli*, total coliform and enterococcus), metals (copper, lead and zinc), total suspended solids and hardness. All CWC trainings for water quality monitoring focus on imparting to volunteer teams the knowledge and skill required to follow quality assurance protocols consistent with USEPA and State Water Resources Control Board procedures. All training stresses the importance of volunteer safety above all other considerations.

The involvement of trained citizen volunteers provides benefits to the funding agencies in terms of human resource cost savings and training of skilled monitoring personnel. This is especially valuable during events such as First Flush that are time sensitive, as the water quality monitoring must be done immediately upon the onset of the first winter storm, regardless of what time of day or night that occurs.

Methods

Training

Prior to First Flush, volunteers were trained in the classroom on field monitoring techniques, including how to use a conductivity meter, pH strips, transparency tube, and thermometer, and how to properly collect and preserve water samples for laboratory analysis using appropriate containers, and while wearing nitrile gloves. During a follow-up training, volunteers went out to their sites and performed field tests and collected water samples. Known as the First Flush Dry Run, this second training served several purposes. One was to familiarize volunteers with their team members so they form a unified team, and more importantly to give them the opportunity to visit their monitoring site in daylight and during good weather. This is an important safety measure as the First Flush storm often comes during the night, and the familiarity volunteer teams gain during the Dry Run prepares them to visit their site when conditions are wet and possibly dark. In addition, as the Dry Run generates valid data, the results offer a comparison between pollutant concentrations in the dry weather flows and the flows during the First Flush storm.

Volunteers in Santa Cruz County received the classroom training on September 7, 2011, and Dry Run training on September 10, 2011. Monterey County volunteers received their trainings on September 14 and 17, 2011. For the four City of Santa Cruz sites, CWC had thirteen trained volunteers prepared; for the event, eleven volunteers participated in the actual event. The same equipment and protocols were used for both the Dry Run and First Flush events. Field measurements and sample collection for laboratory analyses were performed during both the Dry Run and First Flush events; however, the Arroyo Seco site was dry during the Dry Run event and no field measurements were performed.

Monitoring

Having completed classroom and Dry Run training, volunteer teams were prepared for the arrival of the First Flush storm. CWC staff monitored the offshore storms through the U.S. Naval Research Laboratory in Monterey to anticipate when the first significant rainfall would occur in the Santa Cruz region. An approaching storm event in early October, 2011 was tracked and deemed to meet the mobilization criteria. Using a phone tree, CWC staff then mobilized team leaders who activated all volunteers to meet on-site. Upon seeing that the rain was sheeting off of the streets at the monitoring sites, volunteer teams began monitoring activities late in the evening of October 4, 2011.

The First Flush event typically includes a time series collection of water samples for laboratory analysis and field measurements, conducted at 30 minute intervals for up to three sets of data and water sample collection over the first hour of significant runoff. This is intended to cover multiple points along the rising limb of the rainfall/runoff hydrograph, to capture the heaviest pollution load and highest concentrations of measured constituents. For City sites, a one time series water sample was collected for storm drain sites. While the budget allowed for only one sample collected for lab analysis, field measurements and visual observations were conducted during all three time series at City storm drain sites.

Field measurements included the following: conductivity was measured using an Oakton EC Testr; water temperature was measured using a spirit bulb or digital thermometer; pH was measured using Macherey-Nagel non-bleeding pH strips; and transparency was measured using 120 cm transparency tubes. Physical observations such as trash, odor, bubbles, scum, and oil sheen were also recorded on the field data sheets. pH and transparency are measured only during daylight hours; as the First Flush 2011 occurred at night volunteers were instructed to perform only physical observations, conductivity and water temperature field measurements. Sample containers were filled with storm drain discharges for laboratory analysis of nitrate, orthophosphate, *E. coli*, enterococcus, total coliform, copper, lead, zinc, hardness, and total suspended solids (TSS). All collected water samples were analyzed as a grab sample rather than a composite of samples.

Data Analysis

Lab results were compared to ambient water quality standards to provide an indication of relative pollutant levels. These standards apply only to ambient concentrations within “receiving waters”, i.e., a stream, lake, or ocean—they do not apply directly to end-of-pipe applications such as storm drain discharges. Nonetheless, absent any other standard, they provide some means of comparison for the results. Bacteria and metals results were compared to the Central Coast Basin Plan Water Quality Objectives (WQOs) for the protection of aquatic life. Nitrate, orthophosphate, and total suspended solids (TSS) results were compared with the Central Coast Ambient Monitoring Program's (CCAMPs) attention levels. These attention levels indicate receiving water concentrations at which pollutants may impact cold-water fish or human health. Again, both the Basin Plan water quality objectives and CCAMP attention levels are established for receiving waters and *not* for end of pipe discharges. Dilution via mixing with ambient water usually occurs in the receiving waters within a short distance of each storm drain outfall.

Water Quality Objectives (WQOs) and Method Detection Limits (MDLs) are noted in Table 1 for each constituent. The MDL is the minimum concentration that a laboratory procedure can detect for a given analyte. For "non-detect" results, the data point is placed on the graph at zero, although the actual value is in fact nominally at some level between zero and the MDL.

Table 1: Regulatory Objectives & Method Detection Limits (MDL)**

Parameter	Water Quality Objectives/Attention Level	Method Detection Limits (MDL)	Source of WQO/AL
Nitrate as N (NO_3-N)	**not to exceed 2.25 mg/L**	**0.05 mg/L**	**CCAMP Attention Level**
Orthophosphate as P (PO_4-P)	**not exceed 0.12 mg/L**	**0.05 mg/L**	**CCAMP Attention Level**
E.coli	**not to exceed 235 MPN/100 mL**	**20 MPN/100mL**	**CCRWQCB Basin Plan**
Total Coliform	**not to exceed 10,000 MPN/100mL**	**20 MPN/100mL**	**CCRWQCB Basin Plan**
Enterococcus	**not to exceed 104 MPN/100 mL**	**20 MPN/100mL**	**CCRWQCB Basin Plan**
Copper (Cu)	**<30 µg/L or <10 µg/L ***	**4 µg/L**	**CCRWQCB Basin Plan**
Lead (Pb)	**<30 µg/L**	**5 µg/L**	**CCRWQCB Basin Plan**
Zinc (Zn)	**<200 µg/L**	**10 µg/L**	**CCRWQCB Basin Plan**
Total suspended solids (TSS)	**<500 mg/L**	**5 mg/L**	**CCAMP Attention Level**
Water temperature	**no more than 22ºC**	**N/A**	**Basic Plan Objective for Cold Water Fish**
pH	**no lower than 6.5 and no greater than 8.5**	**N/A**	**CCRWQCB Basin Plan**
*Copper receiving water WQO is Hardness dependent			
**(Urea, Conductivity, Magnesium, Calcium, and Calcium Carbonate ($CaCO_3$) do not have a specific receiving water WQO or Attention Level).			

Results/Discussion

The Dry Run field event was held on Saturday, September 10, 2011. Field measurements, observations and sample collections were performed at three storm drains. There was no water present at the remaining storm drain site (Arroyo Seco).

The 2011 First Flush event in the City of Santa Cruz occurred on October 4, 2011, during a large, early-season storm that approached from the North. Starting at approximately 11:30 PM First Flush teams were able to monitor a total of eleven sites across Santa Cruz County, including four storm drain sites within the City. Monitoring was completed in the early hours of October 5, 2011. The monitored First Flush was preceded by a smaller showery storm on October 3, 2011 that delivered light rainfall over a period of several hours, producing light runoff at some locations in the region.

The range of results obtained for each monitoring constituent is shown for both the Dry Run and the First Flush in Table 2. Tables 3 and 4 then show the specific results for each constituent at each site for the Dry Run and First Flush events, respectively.

For each parameter monitored, this section also includes a brief narrative summary and a plot showing the results for that parameter. All plots chart the results of the four storm drain sites in the City of Santa Cruz, as well as a line indicating the receiving water quality objective or attention level, for easy comparison of results to these useful values. The data labeled as “Time Series 1” are results from the samples collected upon arrival at the site. “Time Series 2” and Time Series 3” results are field measurements and visual observations, taken 30 and 60 minutes later, respectively.

Table 2: Range of Results for 2011 Monitoring Events

Parameter	Dry Run 2011	First Flush 2011
Nitrate as N (NO_3-N)	1.01 to 4.3 mg/L	0.15 to 0.98 mg/L
Orthophosphate as P (PO_4-P)	0.10 to 0.26 mg/L	0.03 to 0.21 mg/L
Urea	NA	15 to 100 µg/L
E.coli	104 to 2446 MPN/100mL	6,152 to 34,658 MPN/100mL
Total Coliform	2,708 to 8,703 MPN/100mL	>48,392 MPN/100mL
Enterococcus	346 to 518 MPN/100mL	18,417 to 68,667 MPN/100mL
Copper (Cu)	ND µg/L	12 to 27 µg/L
Lead (Pb)	ND	ND to 16 µg/L
Zinc (Zn)	ND to 21 µg/L	80 to 131 µg/L
Total suspended solids (TSS)	ND to11 mg/L	14 to 144 mg/L
Hardness as $CaCO_3$	164 to 236 µg/L	14 to 128 µg/L
Calcium	37 to 83 mg/L	4 to 43 mg/L
Magnesium	7 to 22 µg/L	1 to 5 µg/L
Water temperature	16.5 to 20.0 °C	15.0 to 17.7 °C
pH	6.5 to 7.5	NA
Conductivity	490 to 1520 µS	40 to 280 µS

Table 3: City of Santa Cruz Dry Run 2011 -Summary of Results

Parameter	Units	WQO/Attn Level:	SCSD-02 Merced	SCSD-03 Bay	SCSD-04 Woodrow	SCSD-05 Arroyo Seco
Nitrate-N (NO_3-N)	mg/L	<2.25	4.3	2.15	1.01	NA
Orthophosphate-P (PO_4-P))	mg/L	<0.12	0.26	0.10	0.25	NA
Urea-N	ug/L	NA	NA	N/A	NA	NA
E.coli	MPN/100mL	<235	2446	240	104	NA
Total Coliform	MPN/100mL	<10,000	8703	2708	7155	NA
Enterococci	MPN/100mL	<104	518	346	512	NA
Copper (Cu)	ug/L	<30 or <10 *	ND	ND	ND	NA
Lead (Pb)	ug/L	<30	ND	ND	ND	NA
Zinc (Zn)	ug/L	<200	ND	ND	21	NA
Total Suspended Solids (TSS)	mg/L	<500	ND	ND	11	NA
Hardness (as CaCO3)	mg/L	NA	183	236	164	NA
Calcium	mg/L	NA	37	83	49	NA
Magnesium	mg/L	NA	22	7	10	NA
Water Temperature	˚C	<22˚	20	16.5	17.1	NA
pH	units	6.5-8.5	6.5	7.5	7.0	NA
Electrical Conductivity	uS	<2000	840	1520	490	NA
Transparency	cm	NA	>120	>120	75.6	NA
Flow	H/M/L	NA	L	M	M	NA
Trash	T/F	NA	F	F	T	F
Sewage	T/F	NA	F	F	F	F
Oil Sheen	T/F	NA	F	F	F	NA
Scum	T/F	NA	F	F	F	NA

Shaded values indicate discharge value exceeds receiving water WQO or Attention Level

* Copper receving water WQO is Hardness dependent

Table 4: City of Santa Cruz First Flush 2011 – Summary of Results

			SCSD-02	SCSD-02	SCSD-02	SCSD-03	SCSD-03	SCSD-03	SCSD-04	SCSD-04	SCSD-04	SCSD-05	SCSD-05	SCSD-05
			Merced	Merced	Merced	Bay	Bay	Bay	Woodrow	Woodrow	Woodrow	Arroyo Seco	Arroyo Seco	Arroyo Seco
Parameter	**Units**	**WQO/Attn Level:**	**Time Series 1**	**Time Series 2**	**Time Series 3**	**Time Series 1**	**Time Series 2**	**Time Series 3**	**Time Series 1**	**Time Series 2**	**Time Series 3**	**Time Series 1**	**Time Series 2**	**Time Series 3**
Nitrate-N (NO_3-N)	mg/L	<2.25	0.15	NA	NA	0.98	NA	NA	0.17	NA	NA	0.19	NA	NA
Orthophosphate-P (PO_4-P))	mg/L	<0.12	0.10	NA	NA	ND	NA	NA	0.19	NA	NA	0.21	NA	NA
Urea-N	ug/L	N/A	63	NA	NA	15	NA	NA	100	NA	NA	97	NA	NA
E.coli	MPN/100mL	<235	34,658	NA	NA	6,152	NA	NA	14,540	NA	NA	6,511	NA	NA
Total Coliform	MPN/100mL	<10,000	48,392	NA	NA	48,392	NA	NA	48,392	NA	NA	48,392	NA	NA
Enterococci	MPN/100mL	<104	25,993	NA	NA	18,417	NA	NA	68,667	NA	NA	48,391	NA	NA
Copper (Cu)	ug/L	<30 or <10*	18	NA	NA	14	NA	NA	27	NA	NA	12	NA	NA
Lead (Pb)	ug/L	<30	ND	NA	NA	11	NA	NA	16	NA	NA	ND	NA	NA
Zinc (Zn)	ug/L	<200	131	NA	NA	80	NA	NA	127	NA	NA	81	NA	NA
Total Suspended Solids (TSS)	mg/L	<500	19	NA	NA	144	NA	NA	79	NA	NA	14	NA	NA
Hardness (as CaCO3)	mg/L	N/A	14	NA	NA	128	NA	NA	28	NA	NA	36	NA	NA
Calcium	mg/L	N/A	4	NA	NA	43	NA	NA	8	NA	NA	11	NA	NA
Magnesium	mg/L	N/A	1	NA	NA	5	NA	NA	2	NA	NA	2	NA	NA
Water Temperature	°C	<22°	16	16.0	15.0	16.4	15.2	15.3	16.8	16.4	16.2	15.5	17.7	16.7
pH	units	6.5-8.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Electrical Conductivity	uS	<2000	70	50	40	280	60	50	90	90	70	110	80	60
Transparency	cm	N/A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Flow	H/M/L	N/A	H	H	H	H	H	H	H	H	H	H	H	H
Trash	T/F	N/A	F	T	T	F	F	F	T	T	T	T	T	T
Sewage	T/F	N/A	F	F	F	F	F	F	T	T	T	F	F	F
Oil Sheen	T/F	N/A	F	F	F	F	F	F	F	F	F	F	F	F
Scum	T/F	N/A	T	T	T	F	F	F	F	F	F	T	F	F

Shaded values indicate discharge value exceeds receiving water WQO or Attention Level

* Copper receiving water WQO is Hardness dependent

Nutrients

Nitrogen and phosphorous are the two key nutrients which are essential for plant growth, but which at high levels in aquatic systems can cause excessive algae growth and eventually eutrophication.

Normally nitrate is not found in elevated concentrations within aquatic environments unless there is an anthropogenic source. Elevated nitrate levels can cause algal blooms which in turn impact water quality, most notably via decreased dissolved oxygen levels as the algae decay. Sources of nitrate may include runoff from fertilized lawns, farms, and construction sites, as well as leakage from septic systems and sanitary sewers. The CCAMP receiving water attention level for nitrate (NO_3-N) is 2.25 mg/L. The analytical laboratory's method detection limit (MDL) is 0.05 mg/L.

Nitrate levels in urban runoff discharges are shown for both dry weather (Dry Run) and wet weather (First Flush) in Figure 1. The Merced storm drain discharge concentration was nearly double the receiving water attention level for nitrate during the Dry Run event, with a result of 4.3 mg/L. During First Flush none of the monitored nitrate concentrations from City discharge sites were higher than the receiving water attention level for nitrate. The highest wet weather concentration detected was 0.98 mg/L at the Bay site.

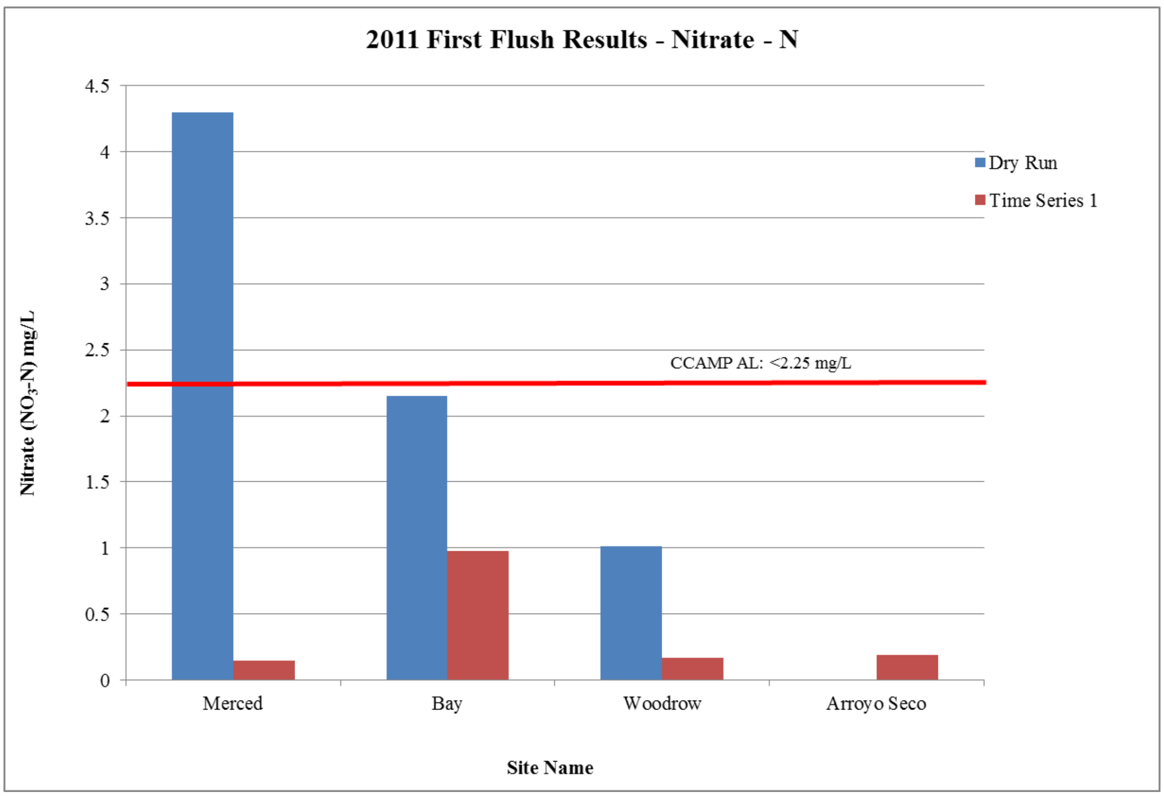

Figure 1: City of Santa Cruz Dry Run and First Flush Results: Nitrate as Nitrogen at Merced, Bay, Woodrow & Arroyo Seco storm drain sites.

Similar to nitrate, phosphate is also a necessary nutrient for plant growth, and is rarely found in elevated levels in the environment unless there is an anthropogenic source. The CCAMP receiving water attention level for orthophosphate (PO_4-P) is 0.12 mg/L. The laboratory analytical MDL is 0.05 mg/L. The CCAMP receiving water attention level for orthophosphate was exceeded in samples taken at the Merced (Dry Run only), Woodrow (Dry Run and First Flush event) and Arroyo Seco (First Flush event only) discharge sites, as shown in Figure 2.

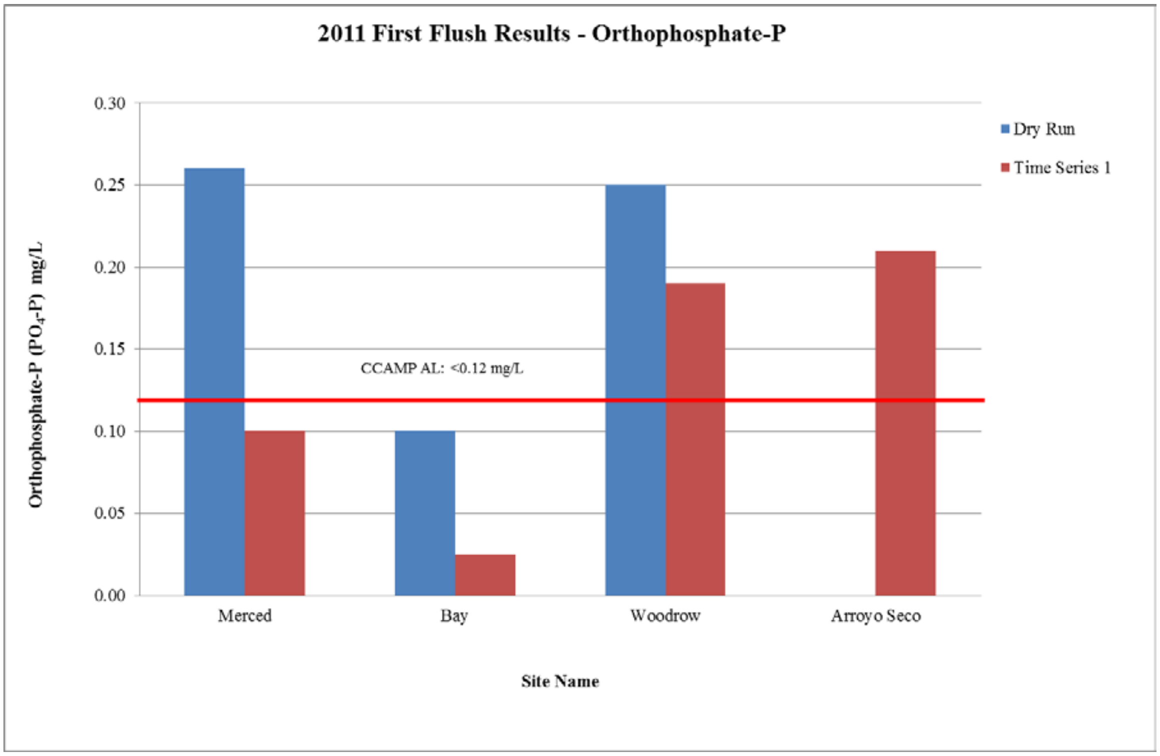

Figure 2: City of Santa Cruz Dry Run and First Flush Results: Orthophosphate as Phosphate at Merced, Bay, Woodrow & Arroyo Seco storm drain sites.

Urea is an organic compound containing nitrogen. It is one of the compounds found in nature as part of the nitrogen cycle. Mammals metabolize nitrogen into urea and excrete it in urine. The toxicity of urea and ammonia in aquatic systems depends on the pH, temperature and salinity, which control its form and availability. There are no CCAMP receiving water attention levels specifically for urea or ammonia. Urea, not ammonia, was measured during First Flush, with a laboratory analytical MDL of 0.05 µg/L. Figure 3 shows the urea results for First Flush.

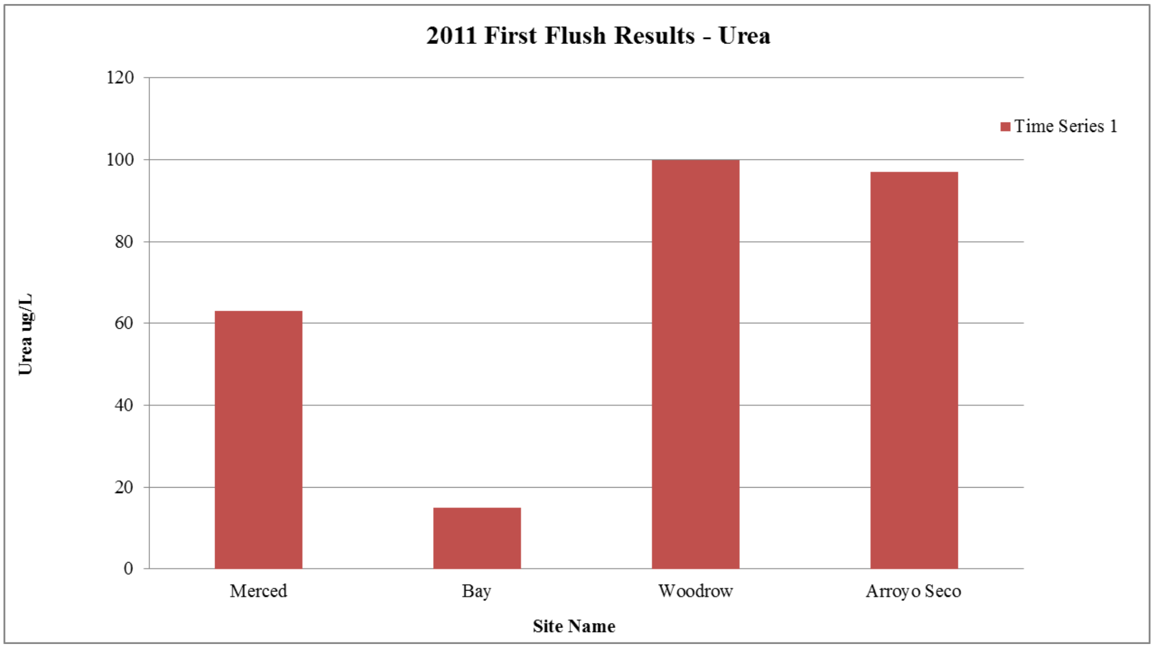

Figure 3: City of Santa Cruz First Flush Results: Urea as Nitrogen at Merced, Bay, Woodrow & Arroyo Seco storm drain sites. There is no established WQO for urea.

Bacteria

Bacteria are microscopic, single-celled organisms that are ubiquitous throughout the environment and have essential functions within watersheds, including functioning as decomposers by breaking down plant and animal remains. While many bacteria perform beneficial functions in healthy natural systems, some forms of bacteria cause disease in humans and other organisms. *E.coli*, total coliform and enterococcus are each common types of bacteria whose presence at elevated levels suggests the possible presence of disease-causing bacteria. As such, stormwater professionals and public health officials consider these to be “indicator” bacteria, and measure them during events such as First Flush.

The Basin Plan Water Quality Objective for *E.coli* is 235 MPN/100mL and the laboratory analytical MDL is 20 MPN/100mL. For total coliform, the Basin Plan WQO is 10,000 MPN/100mL and the laboratory analytical MDL is 20 MPN/100mL. For enterococcus, the Basin Plan WQO is 104 MPN/100mL and the analytical MDL is 20 MPN/100mL.

Results for *E. coli* (Figure 4) show that samples at Merced and Bay storm drain discharges exceeded the Basin Plan WQO during the Dry Run and all discharge sites exceeded the Basin Plan WQO during the First Flush. Total coliform (Figure 5) results showed all discharge sites exceeded the Basin Plan WQO during the First Flush; no samples exceeded the Basin Plan WQO during the Dry Run. Enterococcus results (Figure 6) show that samples at all discharge sites exceeded the Basin Plan WQO during both the Dry Run and First Flush.

These levels are generally consistent with urban runoff discharge data throughout the U.S. The more highly elevated bacteria levels indicate possible contributions to stormwater from potential sources such as leaky sewage pipes or septic systems, fecal waste from pets, feces from birds and other wild animals, and/or runoff from livestock areas.

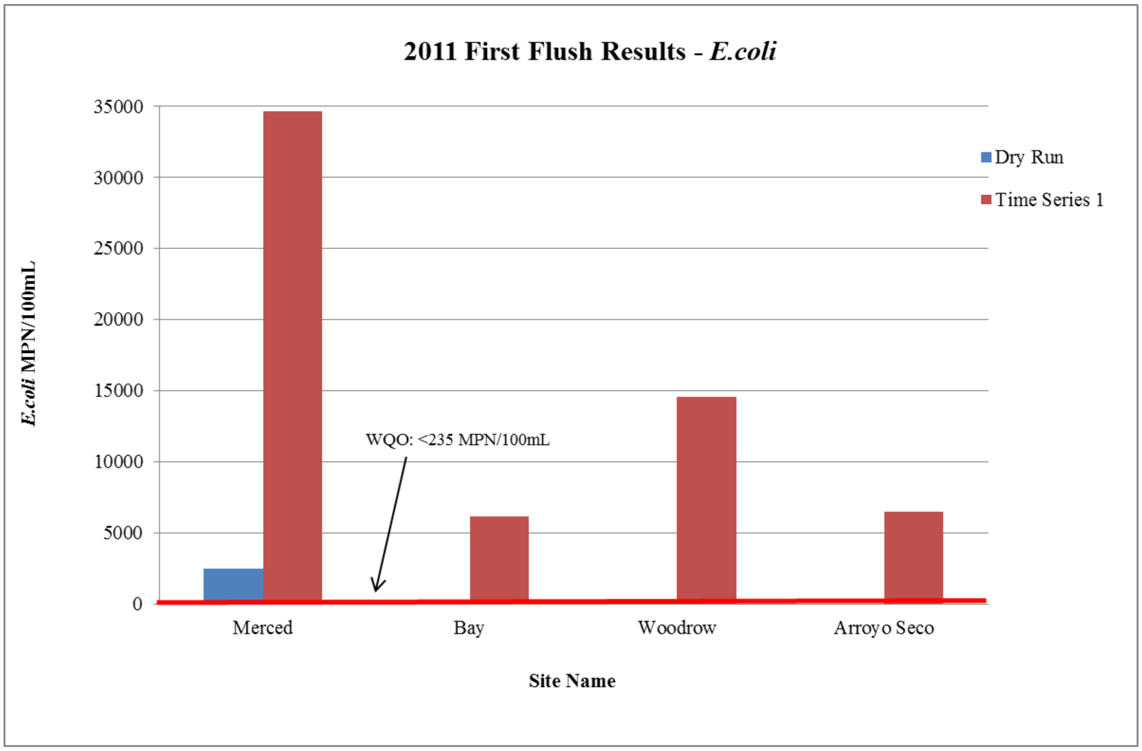

Figure 4: City of Santa Cruz Dry Run and First Flush Results: *E.coli* levels at Merced, Bay, Woodrow & Arroyo Seco storm drain sites.

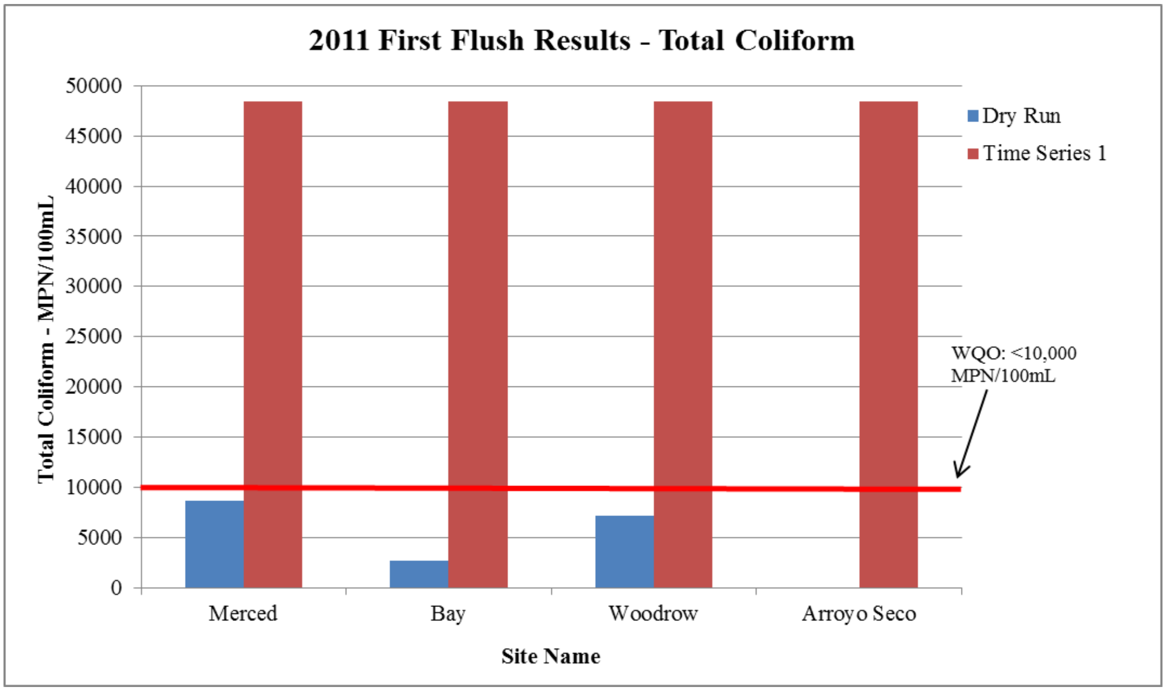

Figure 5: City of Santa Cruz Dry Run and First Flush Results: total coliform levels at Merced, Bay, Woodrow & Arroyo Seco storm drain sites.

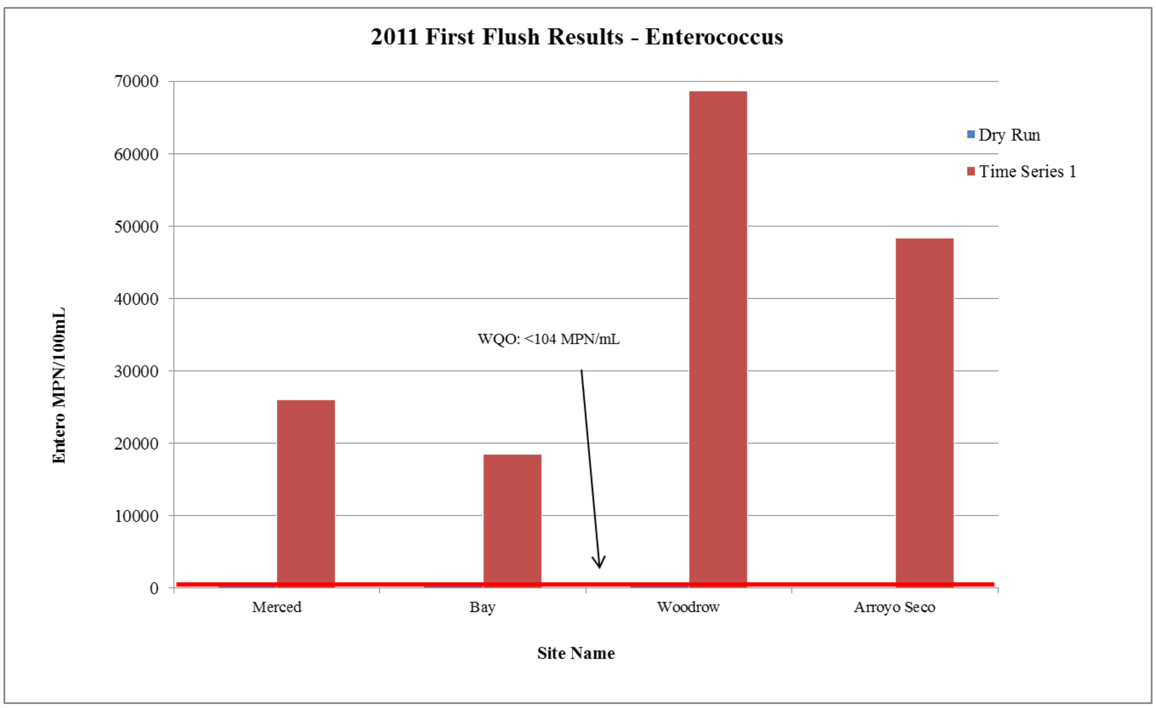

Figure 6: City of Santa Cruz Dry Run and First Flush Results: Enterococcus levels at Bay, Woodrow & Arroyo Seco storm drain sites.

Metals

Copper is a naturally-occurring mineral element; however it is also used in many industrial applications, and is a common urban runoff pollutant, with a wide range of sources in urban environments. Lead is a metal found in natural deposits and zinc is found naturally in water. Surface runoff and stormwater flows pick up copper and zinc from brake and tire wear, vehicle wash-water, and building materials. For the First Flush, samples were analyzed for total copper (Cu), total lead (Pb) and total zinc (Zn).

Copper

The Basin Plan Water Quality Objective for copper is <30 µg/L. The laboratory analytical MDL is 4 µg/L. Figure 7 shows the copper results for the urban runoff discharge sites during First Flush.

The copper Basin Plan WQO is dependent on receiving water hardness levels. When the receiving water hardness level is >100 µg/L then the Basin Plan WQO is < 30 µg/L; when hardness levels are <100 µg/L then the Basin Plan WQO is <10 µg/L.

Urban runoff discharge hardness results are shown in Figure 11, for both dry weather (Dry Run) and wet weather (First Flush). Dry weather runoff hardness values tend to run higher than 100 mg/L, while wet weather runoff values tend to run lower than 100 mg/L. Data from nearby receiving waters in Santa Cruz County indicate that typical late summer/early fall receiving water hardness concentrations fall in the 144-240 mg/L range. Based upon these estimated receiving water hardness results, no samples exceeded the Basin Plan WQO for copper during the Dry Run or First Flush events.

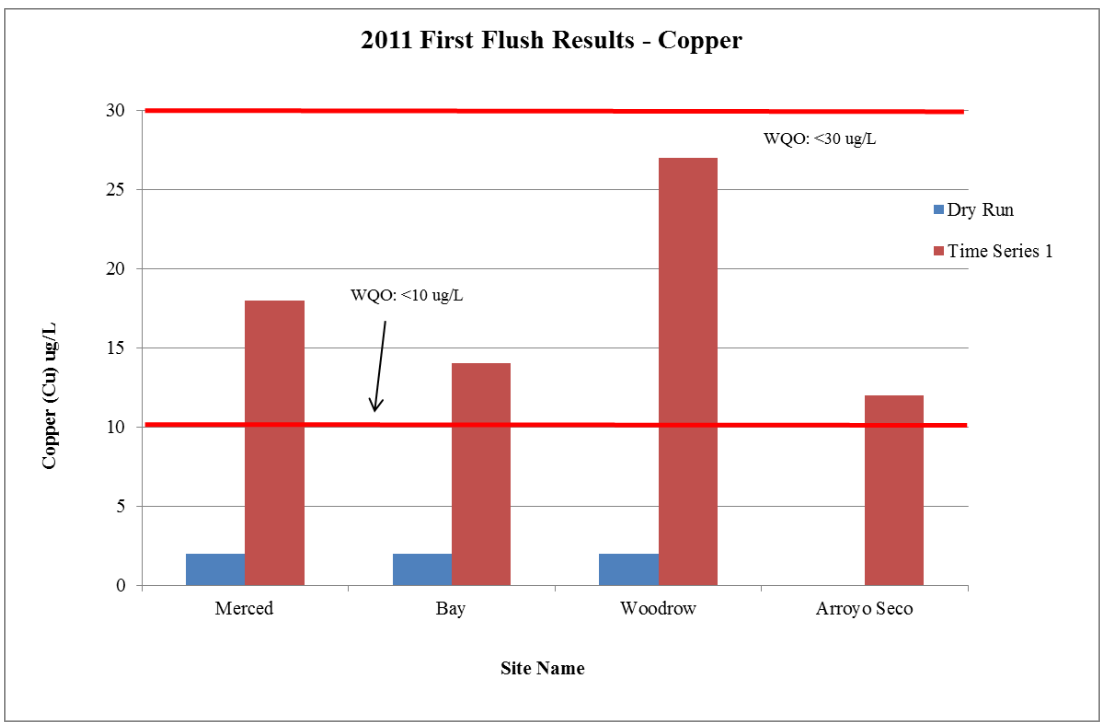

Figure 7: City of Santa Cruz Dry Run and First Flush Results: Copper levels at Merced, Bay, Woodrow & Arroyo Seco storm drain sites.

Lead
The Basin Plan Water Quality Objective for lead is <30 µg/L. The laboratory analytical MDL is 5 µg/L. Figure 8 shows the lead results for the First Flush.

There were no exceedances of the Basin Plan WQO for lead in urban runoff discharges during the Dry Run or First Flush events.

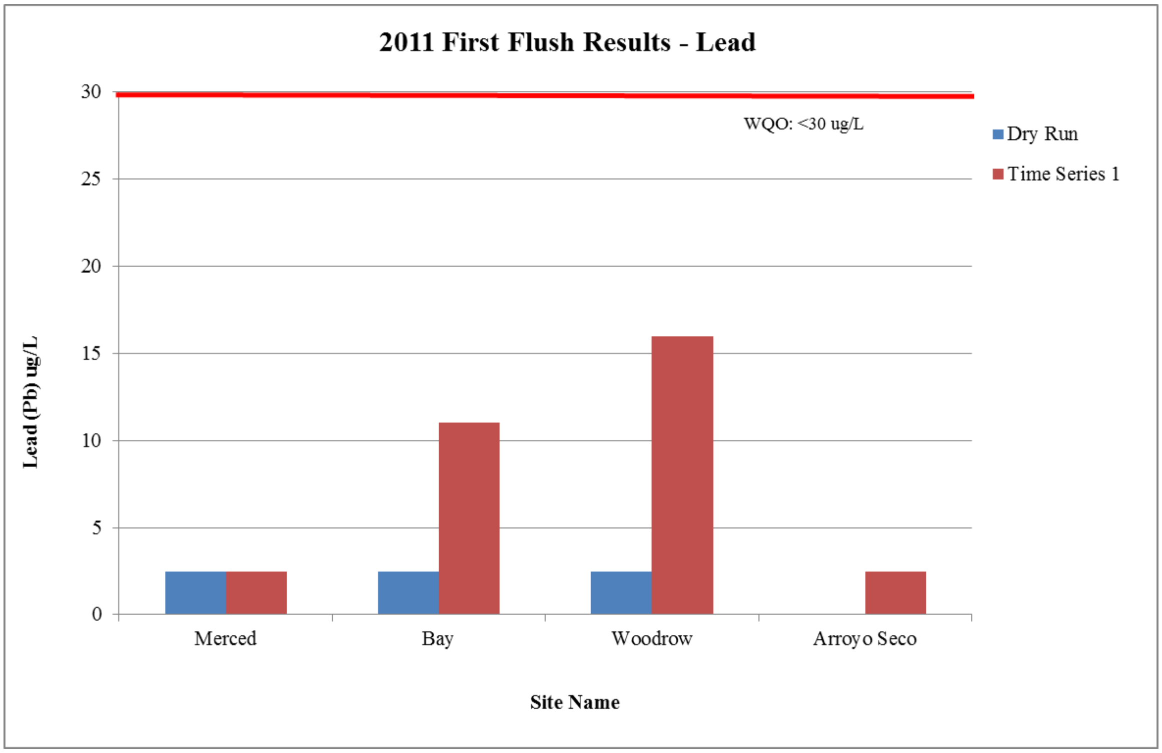

Figure 8: City of Santa Cruz Dry Run and First Flush Results: Lead levels at Merced, Bay, Woodrow & Arroyo Seco storm drain sites.

Zinc
The Basin Plan Water Quality Objective for zinc is <200 µg/L. The laboratory analytical MDL is 10 µg/L. Figure 9 shows the zinc results for the First Flush.

There were no exceedances of the Basin Plan WQO for zinc in urban runoff discharges during the Dry Run or First Flush events.

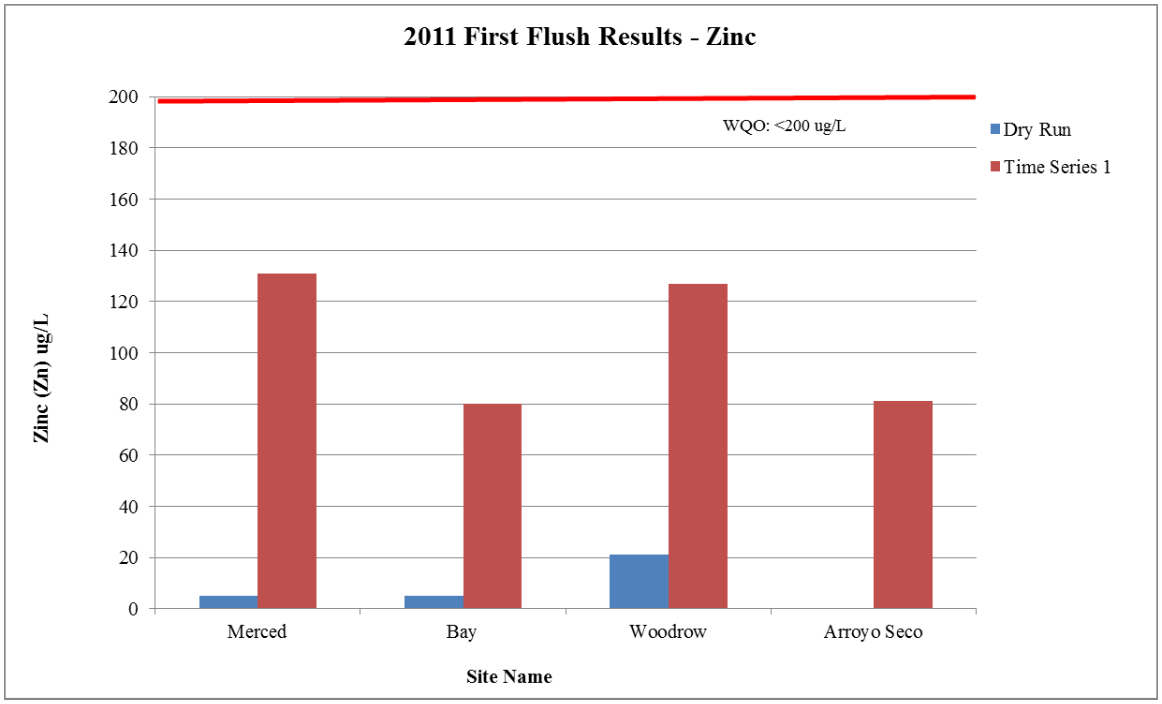

Figure 9: City of Santa Cruz Dry Run and First Flush Results: Zinc levels at Merced, Bay, Woodrow & Arroyo Seco storm drain sites.

Total Suspended Solids

Suspended solids derive from particulate matter that can include plankton, algae, organic detritus, and inorganic sand, silt and clay particles. There are many sources of solids within the urban environment, including soil erosion and particulate matter generated by both natural and anthropogenic processes. Certain toxic compounds, including some commonly-used urban pesticides, adsorb to the surface of solid particles, making elevated total solids levels a concern for watershed health. During First Flush, hardness and total suspended solids (TSS) were measured. For TSS, the CCAMP receiving water attention level is 500 mg/L; the analytical MDL is 5 mg/L. Figure 10 shows the discharge monitoring TSS results for First Flush.

There were no exceedances of the CCAMP receiving water attention level for TSS in urban runoff discharges during the Dry Run or First Flush event.

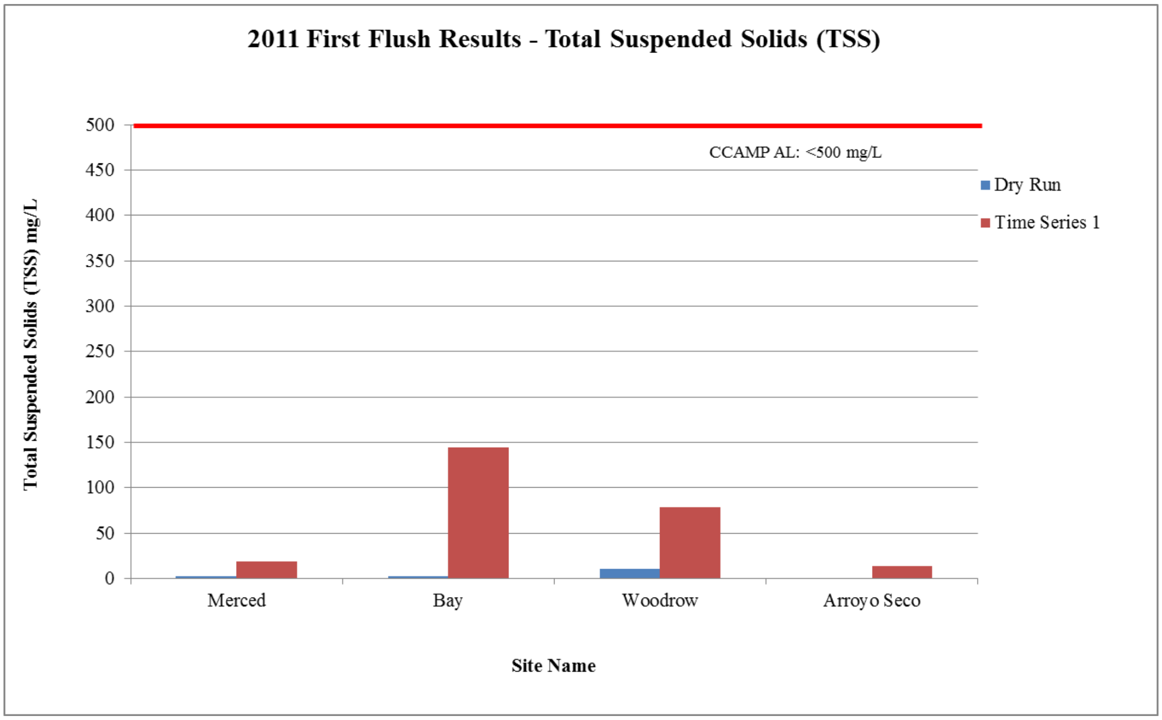

Figure 10: City of Santa Cruz Dry Run and First Flush Results: TSS levels at Merced, Bay, Woodrow & Arroyo Seco storm drain sites.

Hardness

Hardness is measured analytically as the sum of calcium and magnesium, and is used to help interpret the Basin Plan water quality objectives for metals. Calcium is abundant naturally in rocks and soil throughout much of the earth, and is a vital mineral in animal and plant cellular, metabolic and nervous system functions. Magnesium is necessary for photosynthesis and basic cell functions for living organisms and is found in both fresh and salt water. Sources of magnesium include fertilizers, water softeners and soaps/detergents. No Basin Plan, CCAMP or other attention levels exist for calcium, magnesium, or hardness; the MDL is 1 µg/L. Figure 11 shows the hardness results for First Flush.

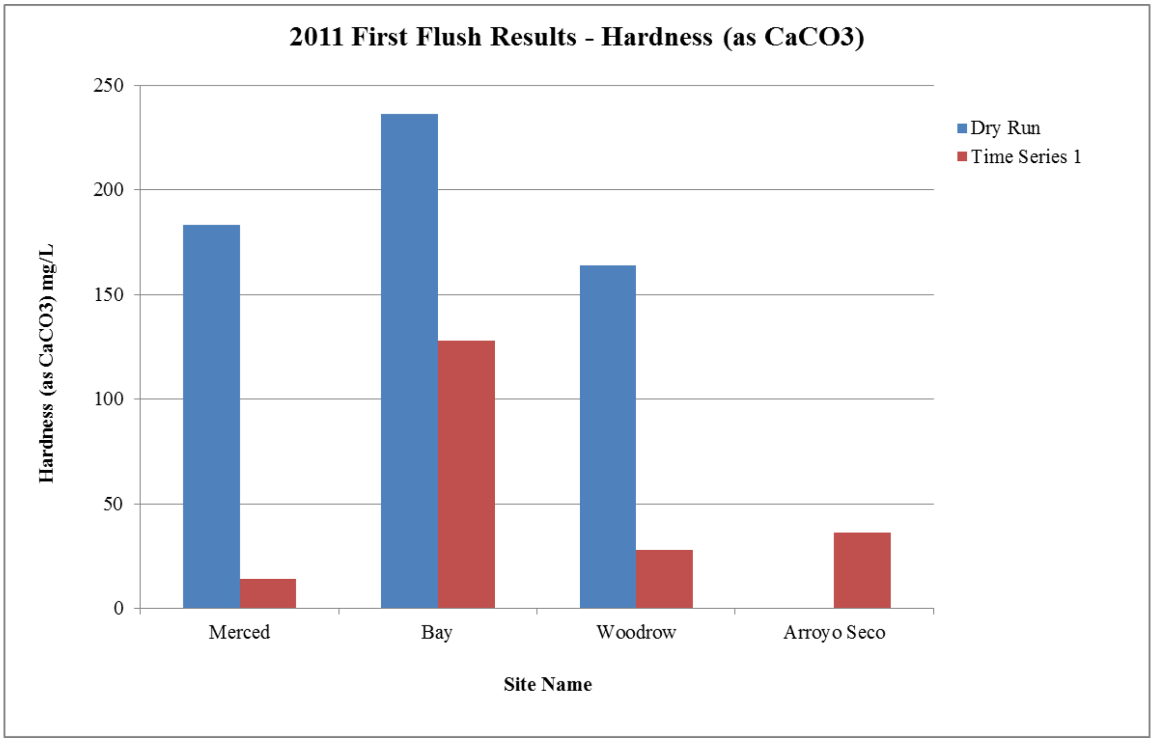

Figure 11: City of Santa Cruz Dry Run and First Flush Results: Hardness levels at Merced, Bay, Woodrow and Arroyo Seco storm drain sites.

Visual Observations

At each of the four discharge sites monitored during the 2011 Dry Run and First Flush, volunteers observed and recorded whether there was any trash, sewage (sited or smelled), oil sheen, or scum present. Trash was sighted at the Woodrow discharge site during the Dry Run and during the First Flush at the Merced, Woodrow and Arroyo Seco discharge sites. The Woodrow discharge site recorded sewage smell during all three time series of the First Flush. There were no observations of oil sheen during the Dry Run or First Flush; scum was recorded at the Merced discharge site during each of the three time series and at the Arroyo Seco discharge site during the first time series only for First Flush.

During the Dry Run flow levels were “low” at the Merced discharge site, “moderate” at the Bay and Woodrow discharge sites and “no water present” at the Arroyo Seco discharge site. During the First Flush, flow levels were recorded as “high” at all discharge sites during each of the three time series.

Conclusions

This report summarizes results for the 2011 First Flush Program conducted in fall 2011 for the City of Santa Cruz. First Flush teams monitored a total of eleven sites across Santa Cruz County, including four storm drain sites within the City of Santa Cruz, during the 2011 First Flush event on October 4, 2011. This event was a large, early-season storm that approached from the North.

Exceedances of receiving water quality objectives or attention levels were documented in urban runoff discharges for nutrients (both nitrate and orthophosphate), bacteria (*E.coli*, total coliform and enterococcus), metals (copper, lead and zinc) and total suspended solids (TSS) at the four City discharge sites. These results indicate a mixed message about nutrients, which historically have been measured at excessive levels in this region. While the levels of phosphate in urban runoff discharges exceeded the CCAMP receiving water Attention Level at the Merced and Woodrow discharge sites during the Dry Run, and at the Woodrow and Arroyo Seco discharge sites during the First Flush, nitrate levels were well within safe levels at all four discharge sites during the First Flush, and only the Merced discharge site exceeded the CCAMP receiving water Attention Level during the Dry Run.

For pathogen indicators, all types of indicator bacteria (*E.coli*, total coliform and enterococcus) were measured at levels that were an order of magnitude higher than the receiving water quality objectives in urban runoff from all four discharge monitoring sites during the First Flush. During the Dry Run, *E.coli* levels exceeded the receiving water WQO in dry weather discharges from the Merced and Bay discharge monitoring sites. Dry weather urban runoff from the Merced, Bay and Woodrow discharge monitoring sites also exceeded the receiving water WQO for enterococcus during the Dry Run.

Results for metals show that there were no exceedances of Basin Plan WQOs during the Dry Run or First Flush events.

While Basin Plan Water Quality Objectives (WQOs) and CCAMP Attention Levels apply only to receiving waters (such as named creeks, rivers, and the Bay), and not directly to urban runoff discharges, comparisons of urban runoff monitoring results to WQOs and ALs can be used to identify potential areas of concern. However, while a storm drain outfall that discharges into a creek might have elevated levels of a given constituent, once the discharge enters the receiving waters (i.e., creek, river, lake or ocean) it may be diluted, provided the receiving water has lower levels of that constituent.

The City's approach of partnering with other organizations and engaging local residents is an excellent example for other communities to follow. Potential benefits of the First Flush program include improved water quality, improved habitat for aquatic and marine life, fewer instances of beach postings and closures, fewer incidences of nuisance from pollution, less litter and a more inviting setting, a more educated and active citizenry, scientific data for decision-making, greater visibility for the City's non-point source pollution prevention efforts, and preservation of critical watersheds that sustain the local and regional economy and quality of life.