



**Monterey Bay Sanctuary Citizen Watershed Monitoring Network**  
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# First Flush

## 2007 Monitoring Report

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Made Possible by the Stormwater & Education Alliance

## **Introduction**

Volunteers have been collecting water quality data in the Monterey Bay area for ten years as part of the First Flush Program. This year, First Flush was expanded by the Stormwater and Education Alliance (SEA) as part of an expanded monitoring program. Eleven new sites were added, bringing the total number of sites monitored in Monterey County to 20. Twenty-nine sites were monitored in total, in Half Moon Bay, Santa Cruz, Capitola, Seaside, Monterey, Pacific Grove and Carmel.

The First Flush program draws volunteers from all over San Mateo, Santa Cruz and Monterey Counties for training in water quality sampling during the first significant rain event of the season. Volunteers are trained in both the classroom and the field. They learn basic water quality sampling methods, including water temperature, pH, electrical conductivity, and transparency measurements. They also learn the proper way to collect water samples for lab analysis. Volunteers are divided into groups, given a sampling site, asked to choose a group leader, and placed “on call” until the coordinator calls for mobilization during the first significant storm of the season. When mobilization occurs, volunteers must get to their sites for sampling.

2007 was an interesting year for First Flush. Usually, a Dry Run field training day for volunteers is conducted just after the classroom training the last weekend in September. The Dry Run serves as a field-training for volunteers as well as dry weather data for comparison to First Flush. That’s what was scheduled for 2007. However, the rains came early this year, so veteran volunteers were mobilized at 10:00a.m. Saturday, September 22<sup>nd</sup>, without a volunteer training or a Dry Run.. All cities (Half Moon Bay, Santa Cruz, Capitola, Seaside, Monterey, Pacific Grove and Carmel) mobilized except Santa Cruz, which waited until after their training. They mobilized during the next significant event on October 10<sup>th</sup>. Even with the short notice on September 22<sup>nd</sup>, over 30 volunteers were able to monitor 20 outfalls (see Figure 1). Approximately 0.3 inches of rain had fallen when volunteers mobilized.

### **First Flush Range of Results**

Conductivity (90 – 920 $\mu$ S)	Escherichia coli ( <i>E. coli</i> ) (202-241,960 MPN/100ml)
pH (6 – 7.5)	Enterococcus (948 – 141,361 MPN/100ml)
Total copper (14 – 388 $\mu$ g/l)	total lead (3 – 123 $\mu$ S)
total zinc (71 - 485 $\mu$ g/l)	nitrate as N (0.17 – 2.01 mg-N/l)
orthophosphate as P (<.05 – 3.8 mg-P/l)	total suspended solids (TSS) (11 – 485 mg/l)
urea (135 – 2495 $\mu$ g/l)	



Figure 1: Map of Santa Cruz County Sites

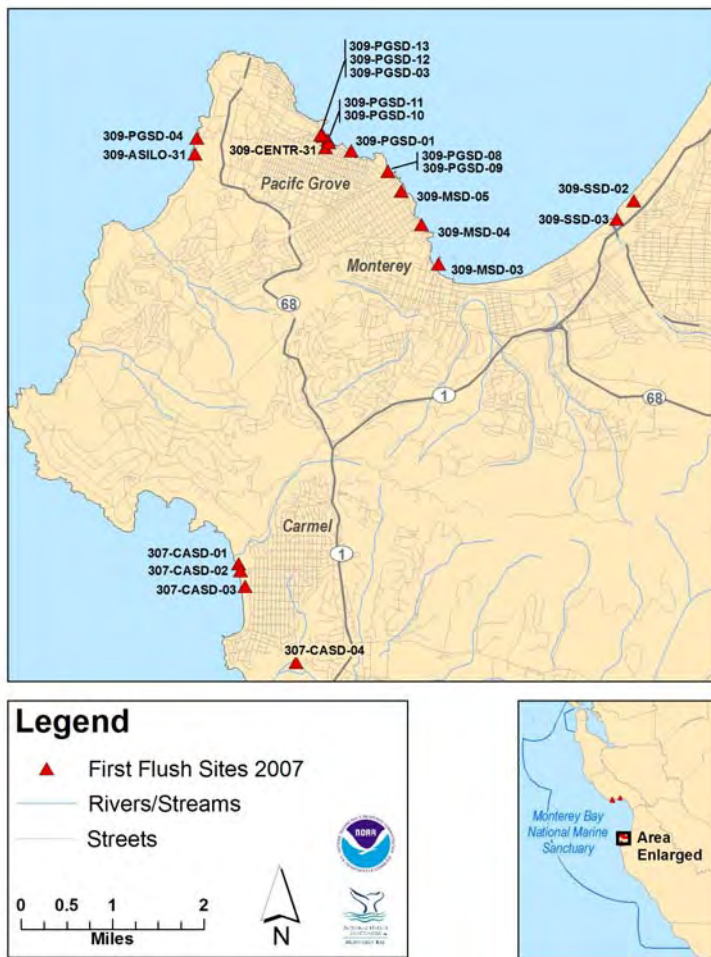


Figure 2: Map of Monterey County Sites

## **Methods**

Coordinators closely monitored the weather leading up to the First Flush, and notified volunteers of approaching storms. For this early rain, coordinators placed experienced volunteers “on call.” Mobilization criteria included sheeting rain on streets, conductivity levels less than 1000 micro Siemens ( $\mu\text{S}$ ), and heavy flow through the storm drain system.

Because no training took place, volunteers were instructed where to report to pick up equipment and the site to monitor. Veteran volunteers were divided into the largest groups possible; given a set of equipment that included a sampling bucket, thermometer, pH strips, electrical conductivity meter, transparency tube, gloves and sample bottles; then assigned a designated site for monitoring. Sampling began at approximately 10:30a.m. in Monterey and San Mateo Counties and 11:30a.m. in Santa Cruz County.

At the sites, field measurements and samples were conducted at 30 minute intervals. A field data sheet was used for each measurement to ensure consistent information was being collected. Conductivity was measured using either an Oakton ECTester 3 or 4. Water temperature was measured using a spirit bulb or digital thermometer. pH was measured using Macherey-Nagel non-bleeding pH strips. Physical observations such as trash, odor, bubbles, scum, and oil sheen were also recorded on the data sheet. Sample bottles were filled with water for later analysis at a lab.

Lab analysis included time series samples for nitrate as nitrogen, orthophosphate as phosphorus, *E. coli*, enterococcus, total zinc, total copper, total lead, hardness and total suspended solids (TSS). Additionally, one sample per site was analyzed for urea and volatile organics.

## **Results/Discussion**

Results were compared to receiving water standards as established by the Central Coast Regional Water Quality Control Board. These standards target ambient concentrations for a stream, lake, or ocean—they are not meant for end-of-pipe applications like this, but lacking any other standard, they provide some means of perspective for the results.

Metal results were compared to the Central Coast Basin Plan Water Quality Objectives (WQO) for the protection of marine aquatic life. *E. coli*, nitrate, orthophosphate, and total suspended solids (TSS) results were compared with the Central Coast Ambient Monitoring Program’s (CCAMP) attention levels (see Table 1). These attention levels are set for receiving water concentrations at which pollutants may impact cold-water fish or human health. Both the Basin Plan water quality objectives and CCAMP attention levels are established for receiving waters and NOT for discharge waters; a significant amount of dilution and/or mixing usually occurs in the receiving waters within a short distance of each outfall.

**Table 1: Water Quality Objectives (not listed are Urea and Volatile Organics)**

<b><u>Parameter (reporting units)</u></b>	<b><u>Water Quality Objectives</u></b>	<b><u>Source of Objective</u></b>
<b>pH</b>	<b>Not lower than 6.5 or greater than 8.5</b>	<b>General Basin Plan Objective</b>
<b>Water Temperature (°C)</b>	<b>Not more than 22</b>	<b>Basin Plan Objective for Cold Water Fish</b>
<b>Transparency (cm)</b>	<b>Not less than 25</b>	<b>Central Coast Ambient Monitoring Program (CCAMP)</b>
<b>Nitrate as N (ppm)</b>	<b>Not to exceed 2.25</b>	<b>Central Coast Ambient Monitoring Program (CCAMP)</b>
<b>Orthophosphate as P (ppm0)</b>	<b>Not to exceed 0.12</b>	<b>Central Coast Ambient Monitoring Program (CCAMP)</b>
<b><i>E. coli</i> (MPN/100ml)</b>	<b>Not to exceed 400</b>	<b>EPA Ambient Water Quality Criteria</b>
<b>Enterococcus (MPN/100ml)</b>	<b>Not to exceed 104</b>	<b>EPA Ambient Water Quality Criteria</b>
<b>Zinc (ppb)</b>	<b>Not to exceed 200</b>	<b>Basin Plan Objective</b>
<b>Copper (ppb)</b>	<b>Not to exceed 30</b>	<b>Basin Plan Objective</b>
<b>Lead (ppb)</b>	<b>Not to exceed 30</b>	<b>Basin Plan Objective</b>
<b>Total Suspended Solids (TSS) (ppm)</b>	<b>Not to exceed 500</b>	<b>Basin Plan Objective</b>

**Nutrients**

Although nitrogen and phosphate are elements needed for plant growth, they are not natural in elevated concentrations in aquatic systems. Nitrate sources include runoff from fertilized lawns, agricultural and pasture lands, construction sites and septic sewer system leachate. The CCAMP attention level for nitrate as N (NO<sub>3</sub>-N) is 2.25 mg-N/l.

Phosphorus is an essential element for plant growth. Orthophosphate is a kind of phosphorus commonly found bound to soil particles, in sewage, fertilizers, and some detergents. Orthophosphate is readily taken up by algae and other aquatic plants, and an excess of the nutrient can cause large algal blooms, degrading the water quality to toxic conditions. The CCAMP attention level for orthophosphate (PO<sub>4</sub>-P) is 0.12 mg-P/l.

During First Flush, all sites were below the attention level for nitrate. Nitrate concentrations are generally lower during large rain events because of dilution. From 2000-2006, most nitrate average concentrations were below the WQO, except for Bay Street in Seaside (Figure 1). \*\*Note: The following graphs display time series average concentrations for each site.

Nitrate Concentrations Compared to Previous Year's Average Concentrations

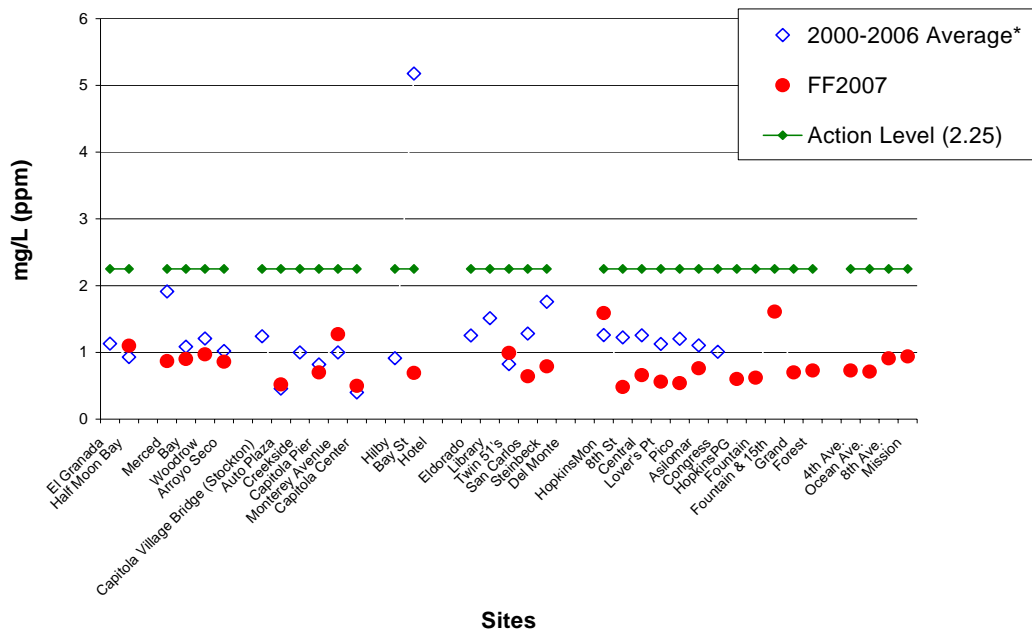


Figure 3. Sites grouped by city from north to south (El Granada, HMB, Santa Cruz, Capitola, Seaside, Monterey, Pacific Grove, Carmel). The CCAMP attention level for nitrogen is 2.25 mg-N/l and is represented in green. Average time series concentrations are represented. \*Not all sites were monitored each year from 2000-2006.

During FF, HopkinsMon had the highest average time series concentrations of orthophosphates, just below 3.5 mg-P/l. Steinbeck Plaza came in second with an average time series concentration of 2.69 mg-P/l. This is the six year running that all Monterey and Pacific Grove sites have exceeded the attention levels.

Time Series Average of Orthophosphate Concentrations Compared with 2000-2006 Average Concentrations

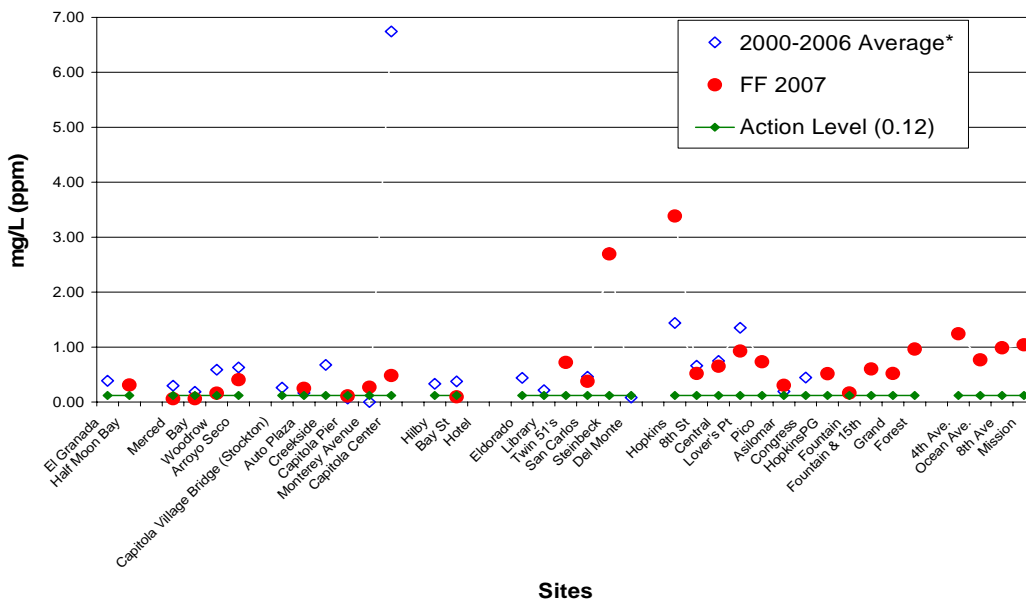


Figure 4. Sites grouped by city from north to south (El Granada, HMB, Santa Cruz, Capitola, Seaside, Monterey, Pacific Grove, Carmel). The CCAMP attention level for orthophosphate is 0.12 mg-P/l and is

represented in green. Average time series concentrations are represented. \*Not all sites were monitored each year from 2000-2006.

## Urea

This was only the second year that urea was analyzed at FF sites. Urea is an organic compound that is extremely soluble in water, therefore it is an excellent fertilizer and is often used for agricultural application. Some research shows that excess urea can cause toxic algal blooms ([www.en.wikipedia.org](http://www.en.wikipedia.org)), and that urea from fertilizer runoff may be the main culprit.

There is no water quality objective for urea, but during this year's First Flush, only two sites had urea concentrations over 1000 ppb as opposed to last year's four. The two sites were Steinbeck in Monterey and HopkinsMon in Pacific Grove. However, the concentrations at both of these sites were lower than last year (Figure 5).

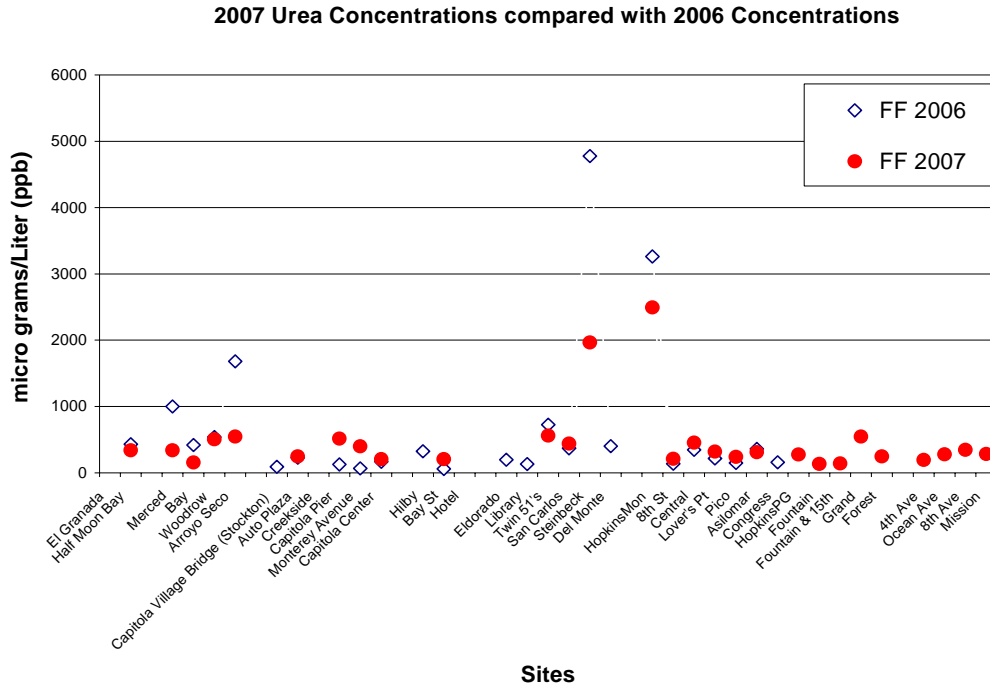


Figure 5. Sites grouped by city from north to south (El Granada, Half Moon Bay, Santa Cruz, Capitola, Seaside, Monterey, Pacific Grove, and Carmel).

## Bacteria

*Escherichia coli* (*E. coli*) and Enterococcus are two forms of indicator bacteria. While they don't necessarily cause disease in humans, their presence indicates the presence of waste and the pathogens associated with it. *E. coli* is a member of the fecal coliform group, a subset of the total coliform group. The U.S. Environmental Protection Agency criterion for *E. coli* is 400 MPN/100ml; for Enterococcus, the criterion is 104 MPN/100ml.

Both types of bacteria were high in all cities, at all sites. Enterococcus was lowest in Carmel, but averages were still above the water quality objective. For *E. coli*, only one time series measurement at Fountain & 15<sup>th</sup> was below the EPA criteria. *E. coli* values reached as high as 165,301 MPN/100ml at Twin's in Monterey, and 241,959 MPN/100ml

at Monterey Avenue in Capitola (Figure 6). Enterococcus values reached as high as 112,902 MPN/100ml at Steinbeck and 91,787 MPN/100ml at HopkinsMon (Figure 7).

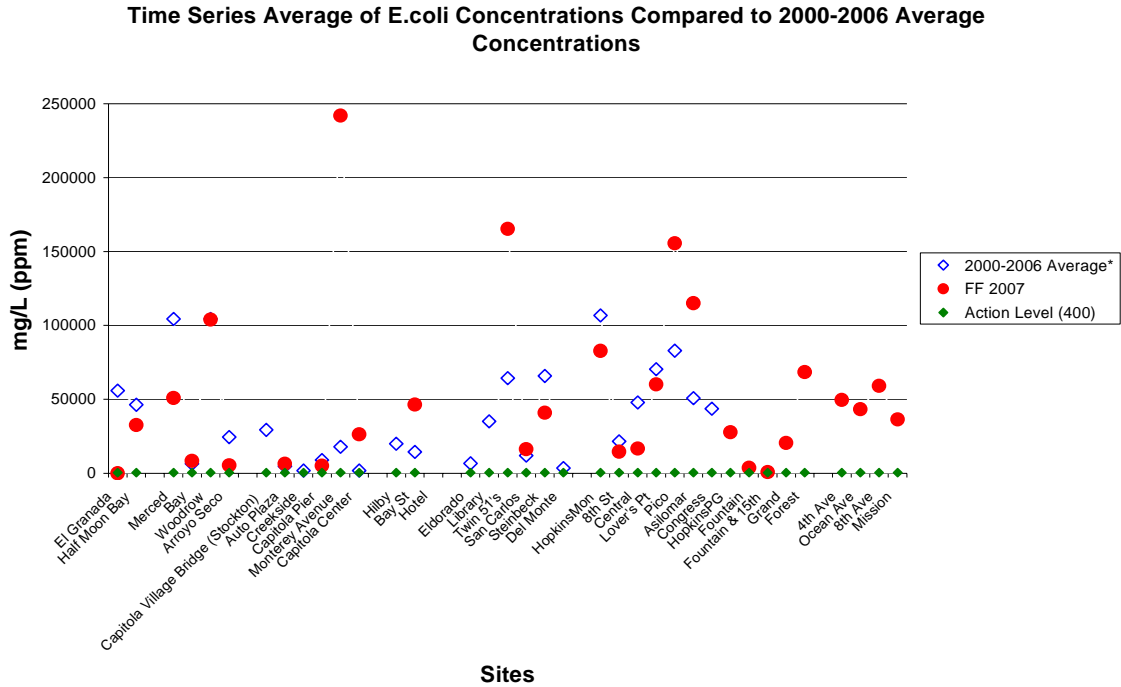


Figure 6. Sites are grouped north to south by city (El Granada, Half Moon Bay, Santa Cruz, Capitola, Seaside, Monterey, Pacific Grove and Carmel). The water quality objective for *E. coli* is 400 MPN/100ml and is represented in green.

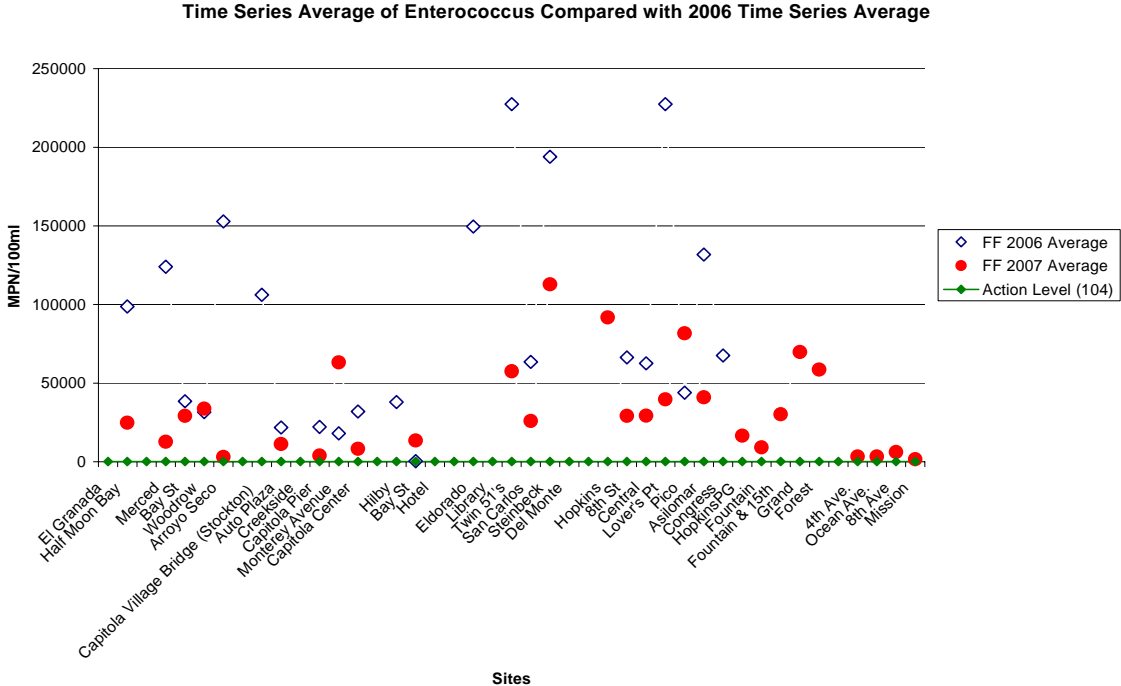


Figure 7. Sites are grouped north to south by city (El Granada, Half Moon Bay, Santa Cruz, Capitola, Seaside, Monterey, Pacific Grove and Carmel). The water quality objective for Enterococcus is 104 MPN/100ml and is represented in green.



## Metals

Storm water runoff in coastal urban areas has been known to produce significant toxicity to early life stages of aquatic organisms due to the presence of trace minerals. The effects include reduced reproduction, developmental deformities, and mortality. In this monitoring event, samples were analyzed for total zinc (Zn), total copper (Cu), and total lead (Pb). The California Basin Plan has established the water quality criteria for these metals. Common sources of metals include automobile brake pads, industrial waste, and metal roofs or downspouts.

The background concentration for zinc (Zn) in seawater on the Central Coast is 8.0 micrograms per liter ( $\mu\text{g/l}$ ). The Basin Plan water quality objective for Zn is  $<200 \mu\text{g/l}$ . This year, 54% of sites exceeded the WQO for Zinc, which is up from 48% last year. Exceedances were spread between the cities this year, from Half Moon Bay to Carmel (Figure 8).

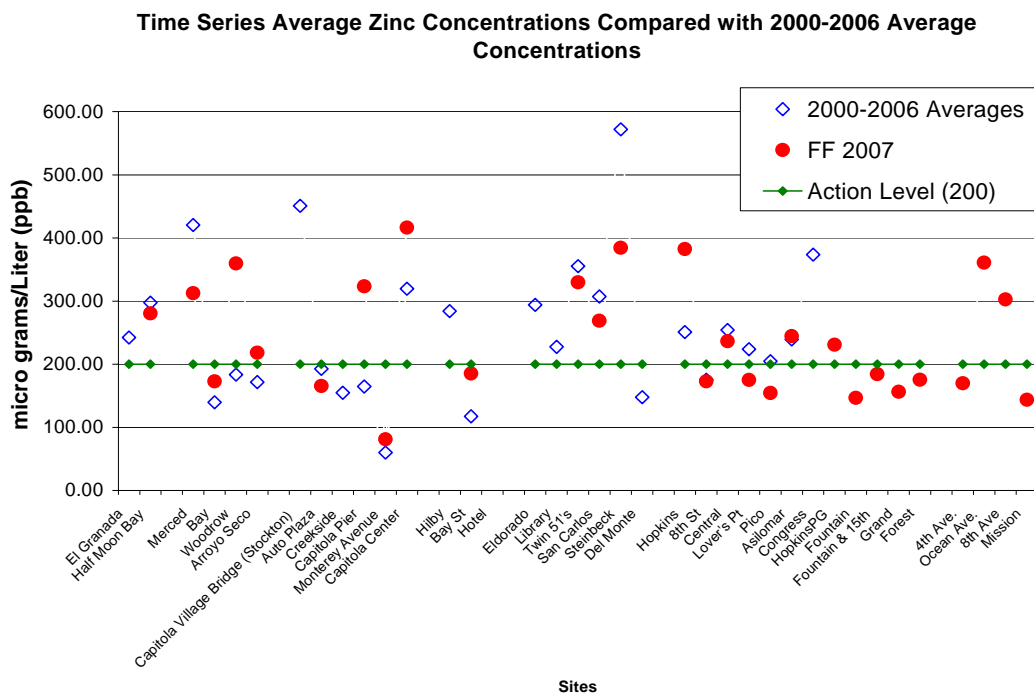
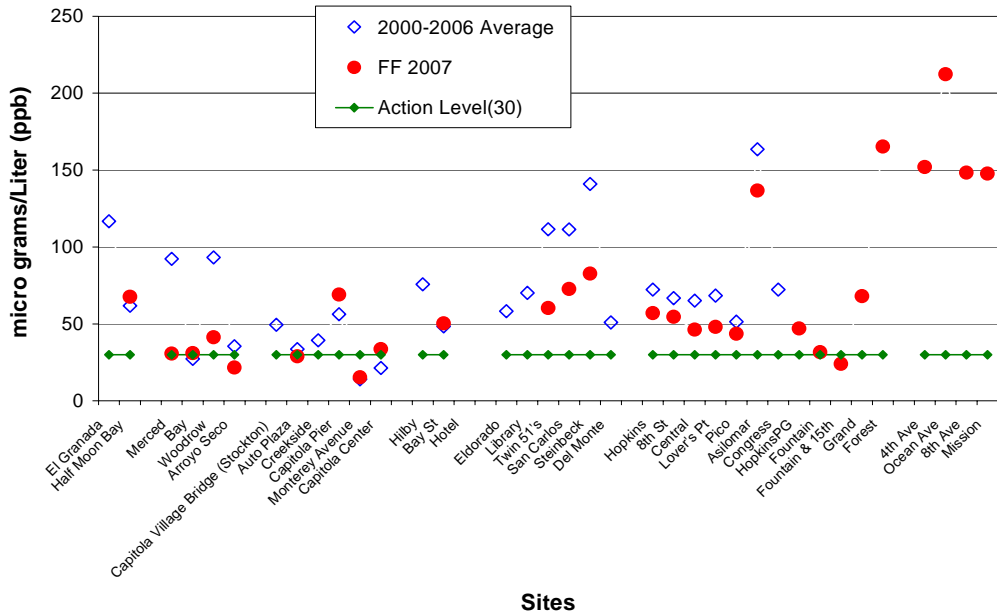


Figure 8. Sites are grouped north to south by city (El Granada, Half Moon Bay, Santa Cruz, Capitola, Seaside, Monterey, Pacific Grove and Carmel). The WQO for Zinc is  $200 \mu\text{g/l}$  and is represented in green.

The background concentration for copper (Cu) in sea water is  $2.0 \mu\text{g/l}$ . The Basin Plan standard established for Cu is  $30 \mu\text{g/l}$ . During First Flush, 79% of sites exceeded this limit, and most exceedances occurred in the southern end of the bay. In Pacific Grove, Asilomar and the Forest site averaged higher than others. Especially high were the Carmel sites, which are new sites this year. All Carmel sites averaged over  $145 \mu\text{g/l}$  and Ocean Avenue averaged  $212 \mu\text{g/l}$  (Figure 9).

Average Time Series Copper Concentrations Compared with 2000-2006 Average Concentrations

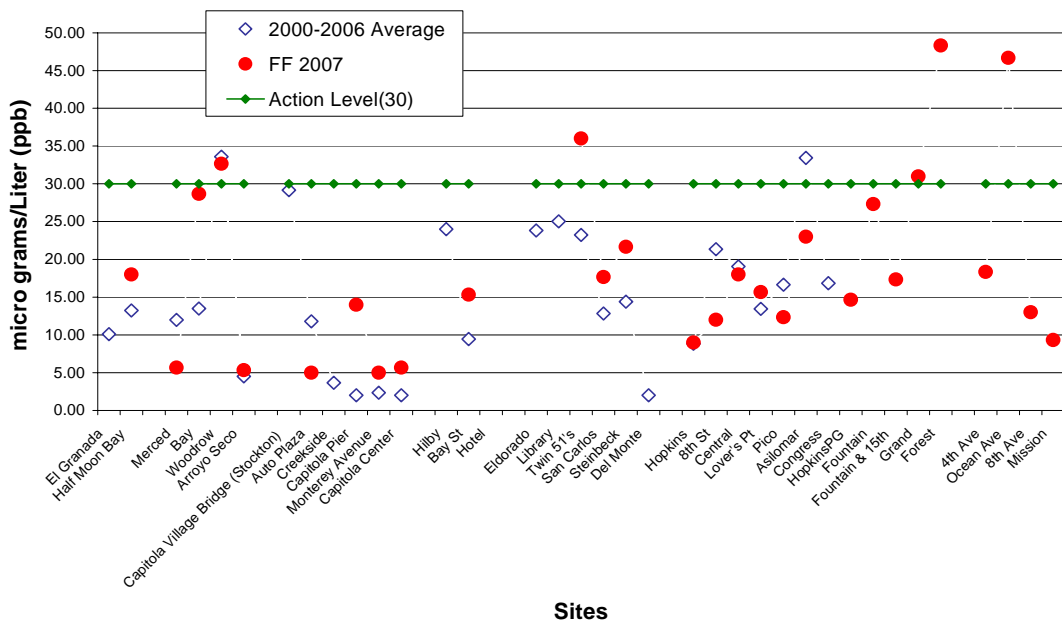


Sites

Figure 9. Sites are grouped north to south by city (El Granada, Half Moon Bay, Santa Cruz, Capitola, Seaside, Monterey, Pacific Grove and Carmel). The WQO for Copper is 30µg/l and is represented in green.

The Basin Plan water quality objective for lead (Pb) is 30 µg/l. Only five sites had exceedances for lead, one each in Santa Cruz, Monterey, and Carmel, and two site in Pacific Grove. The highest average time series concentration for lead was at the Forest site in Pacific Grove, with a value of 48 µg/l (Figure 10).

Time Series Average Lead Concentrations Compared with 2000-2006 Average Concentrations



Sites

Figure 10. Sites grouped north to south by city (El Granada, Half Moon Bay, Seaside, Monterey, Pacific Grove and Carmel). The WQO for lead is 30 µg/l and is represented in green.

## Total Suspended Solids (TSS)

Total suspended solids (TSS) are important to measure because suspended solids carry pollutants. Since suspended solids carry a polar charge, they provide a media to attract contaminants. High amounts of sediment can harm fish populations by destroying habitat, suffocating eggs in freshwater systems, and limiting the food supply. TSS can also clog gills or impair an organism's vision when feeding.

The attention level for TSS is 500mg/l. Similar to 2006, no sites exceeded this attention level for TSS. In 2005, Asilomar and Pico exceeded this limit. This year, the highest concentration of TSS was in Santa Cruz at the Bay Street site, at 409.33mg/l (Figure 11).

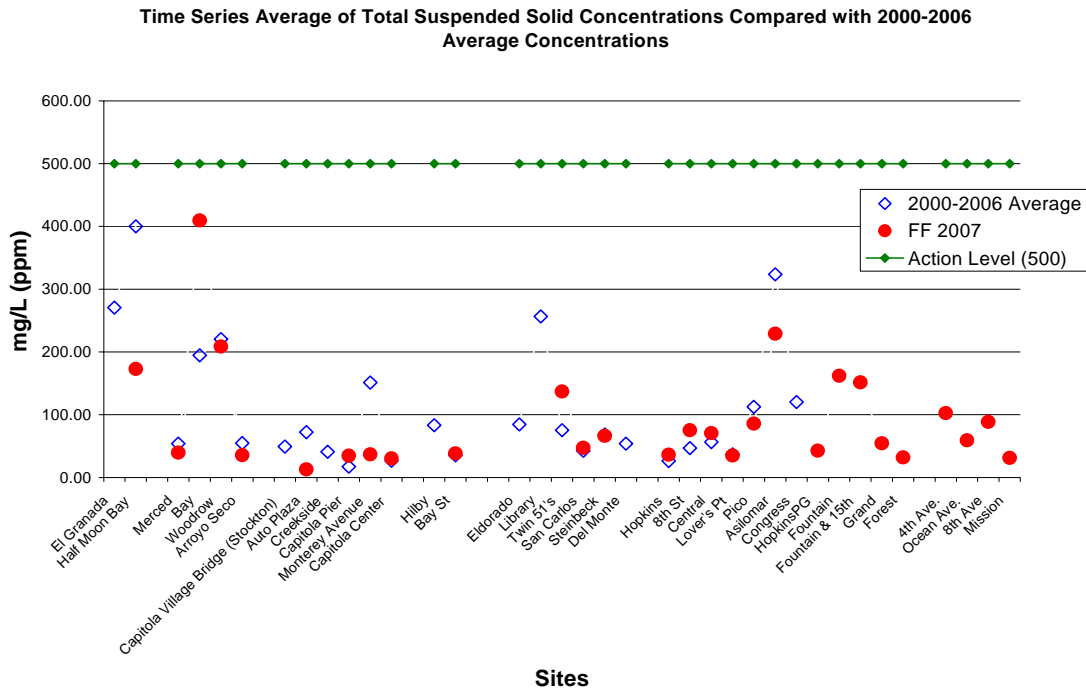


Figure 11. Sites are grouped north to south by city (El Granada, Half Moon Bay, Santa Cruz, Capitola, Seaside, Monterey, Pacific Grove and Carmel). The WQO for TSS is 500 mg/l and is represented in green.

## Volatile Organic Aromatics

Seventy-one volatile organics were measured during the first time series at each site. Most were non-detect. Those that had detections included 524.2 Surro Toluene-d8, 524.2 Surro: Dibromofluoromethane, Methylene Chloride, 524.2 Surro: 4-Bromofluorobenzene, Toluene, Methyl-t-Butyl Ether-MtBE, Carbon Disulfide, 2-Butanone – MEK 4-Methyl-2-Pentanone-MIBK and p-Isopropyltoluene. The last two on this list were observed the most. Detections were found in Capitola, Santa Cruz, Monterey, Pacific Grove and Carmel.

## Visual Observations

At each site during the FF, volunteers recorded the presence of trash, sewage (sited or smelled), oil sheen, and scum. Trash was observed during the FF at eight sites—three in Santa Cruz, one in Capitola, one in Monterey, and three in Pacific Grove. There were observations of oil sheen and bubbles under general comments on spreadsheet. That should be captured.

## Results by City

### Half Moon Bay

The Half Moon Bay team mobilized around 11:00a.m. on Saturday morning and began sampling at 11:20a.m on September 22<sup>nd</sup>. There is only one site in Half Moon Bay; it is found under the Main Street Bridge at Pilarcitos Creek. All copper and zinc samples exceeded the water quality objective, with maximum concentrations of 73 and 339ppb, respectively, as did the orthophosphate concentrations, which had a maximum of 0.39mg/L; all of these measurements were observed in the first time series. Lead concentrations remained constant between time series and were below the water quality objective. All three nitrate concentrations were below the WQO. *E. coli* and enterococcus were both above their WQO's, with maximums of 38,732 and 48,844 MPN/100ml, respectively (Figure 12).

What about observations, urea and VOAs?

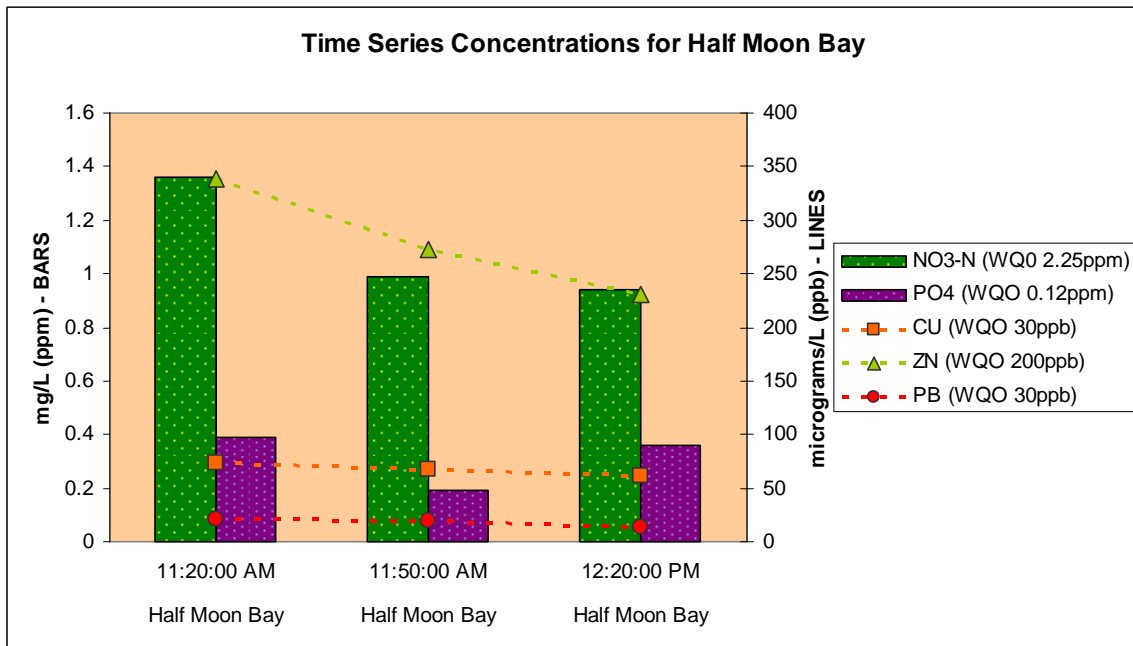


Figure 12. First Flush results at the Half Moon Bay site for each time series. Bars (NO<sub>3</sub>-N and PO<sub>4</sub>-P) are read on the primary y-axis; lines (Cu, Zn, and Pb) are read on the secondary y-axis.

## Santa Cruz

Santa Cruz teams mobilized on October 10<sup>th</sup> at about 12:30a.m. and began monitoring at 1:10a.m. None of the nitrate concentrations exceeded the WQO, but all orthophosphate concentrations at Arroyo Seco and two of three at Woodrow exceeded the WQO of 0.12mg/l. Woodrow and Merced were the only sites where all three time series measurements exceeded the WQO for Zinc, and Woodrow, Bay Street, and Merced all had at least one time series measurement above the WQO for copper. Woodrow and Bay Street were the only sites with exceedances for lead (Figures 13, 14, 15 & 16). *E. coli* and enterococcus exceeded their WQO for every time series at each site.

There were similar time series patterns in Santa Cruz for analyte concentrations. Most nitrate concentrations dropped as time went on, as did most metal concentrations. Since the rainfall amount of a storm varies with time, it is important to take time series measurements to capture changes in pollutant concentration.

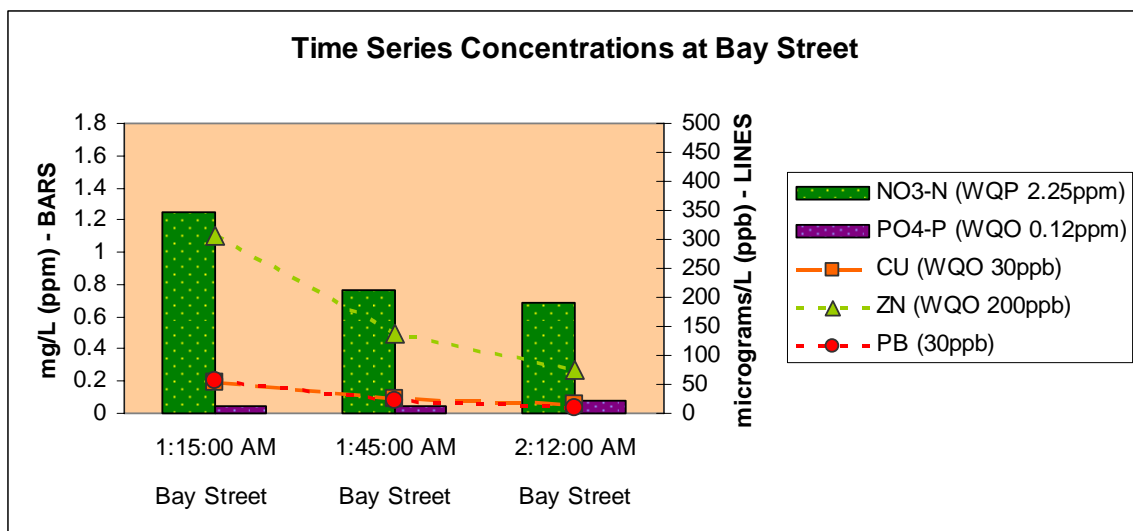


Figure 13. First Flush results at Bay Street for each time series. Bars (NO3-N and PO4-P) are read on the primary y-axis; lines (Cu, Zn, and Pb) are read on the secondary y-axis.

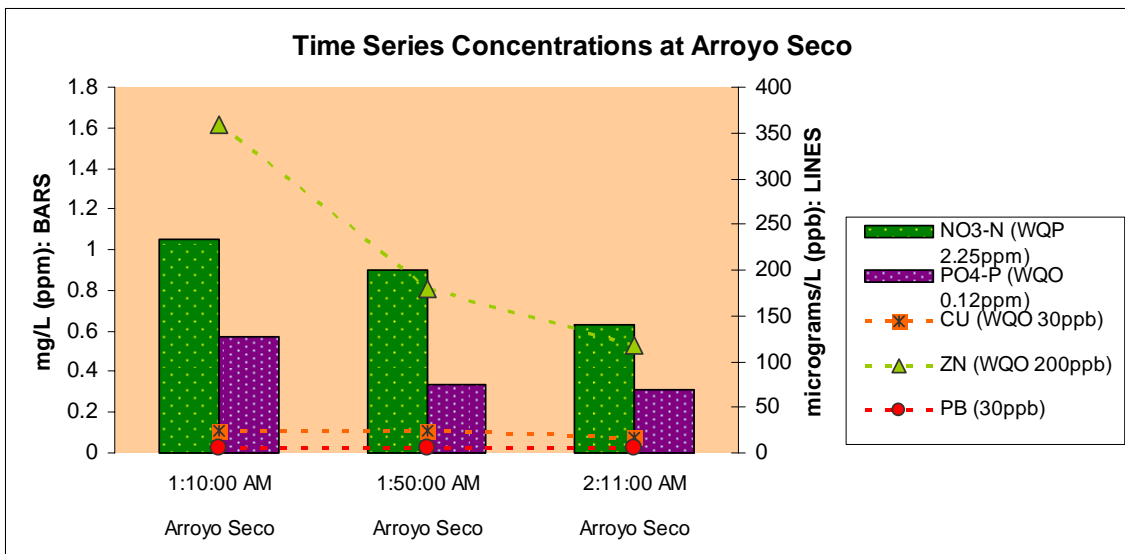


Figure 14. First Flush results at Arroyo Seco for each time series. Bars (NO3-N and PO4-P) are read on the primary y-axis; lines (Cu, Zn, and Pb) are read on the secondary y-axis.

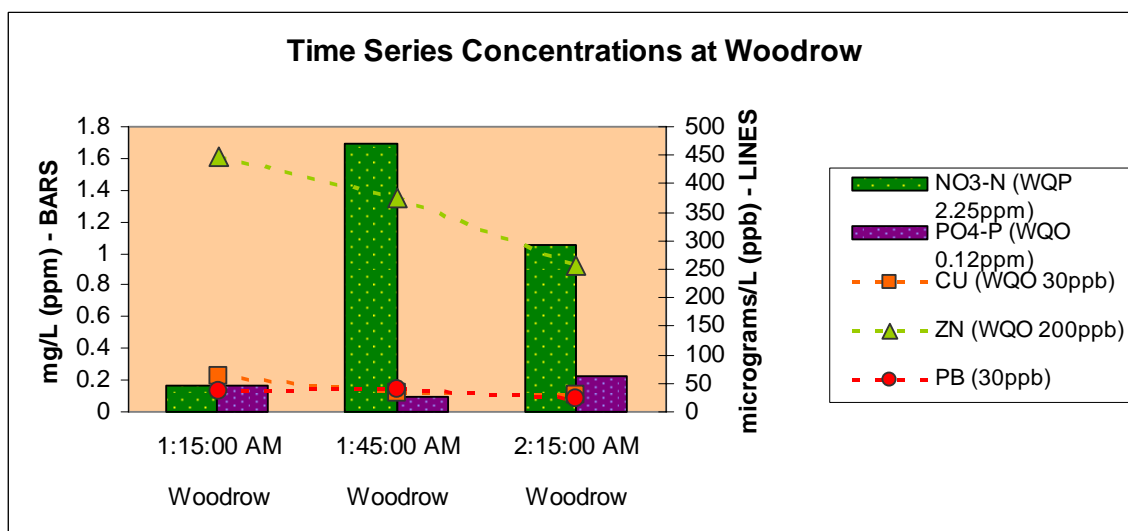


Figure 15. First Flush results at Woodrow for each time series. Bars (NO3-N and PO4-P) are read on the primary y-axis; lines (Cu, Zn, and Pb) are read on the secondary y-axis.

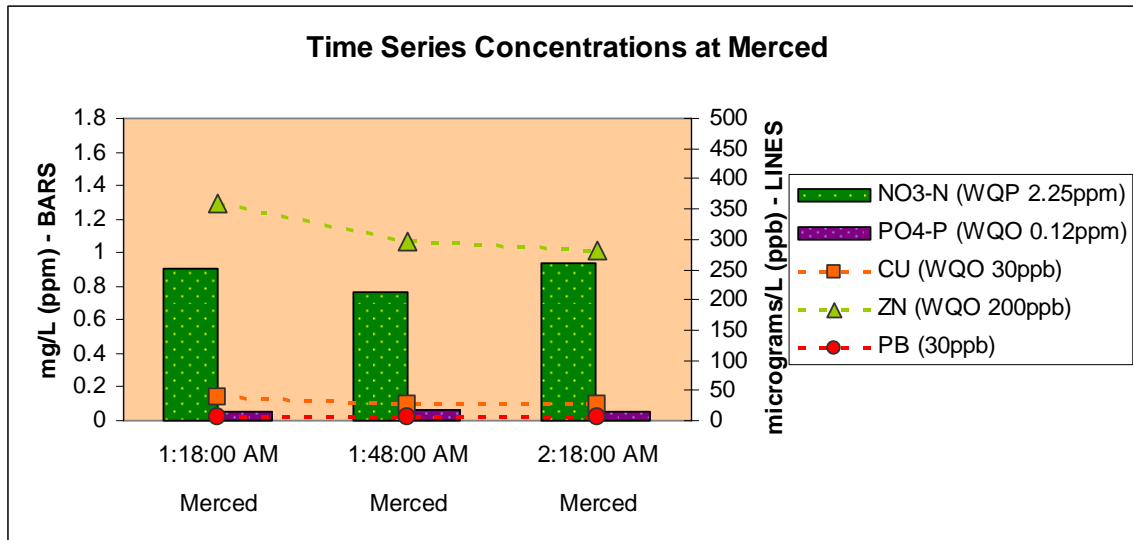


Figure 16. First Flush results at Merced for each time series. Bars (NO<sub>3</sub>-N and PO<sub>4</sub>-P) are read on the primary y-axis; lines (Cu, Zn, and Pb) are read on the secondary y-axis.

### Capitola

Capitola teams mobilized at 11:00am, and the earliest samples were taken at 11:27a.m. Like Santa Cruz, no sites had exceedances for nitrates. Orthophosphate concentrations exceeded the WQO for all but three time series measurements. The highest reading of orthophosphate was 0.49 mg/l at Capitola Center. There was at least one exceedance for copper and zinc at every site, but no exceedances for lead at any site. The highest reading of copper was 77ppb at Capitola Pier, and the highest reading of zinc was 485ppb at the Monterey Pier (Figures 17, 18, 19 & 20).

*E. coli* and enterococcus concentrations were high everywhere, and averaged 69,972 and 19,154 MPN/100ml, respectively.

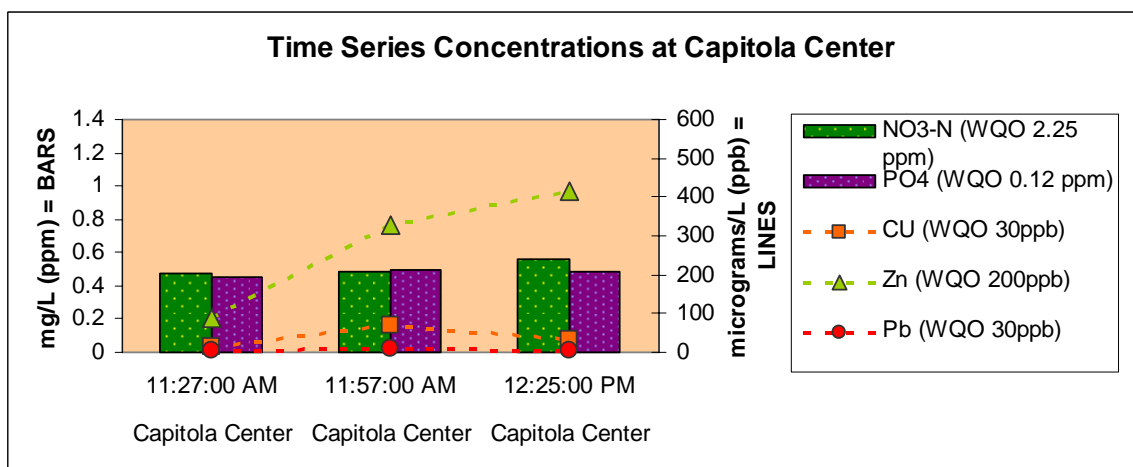


Figure 17. First Flush results at Capitola Center for each time series. Bars (NO<sub>3</sub>-N and PO<sub>4</sub>-P) are read on the primary y-axis; lines (Cu, Zn, and Pb) are read on the secondary y-axis.

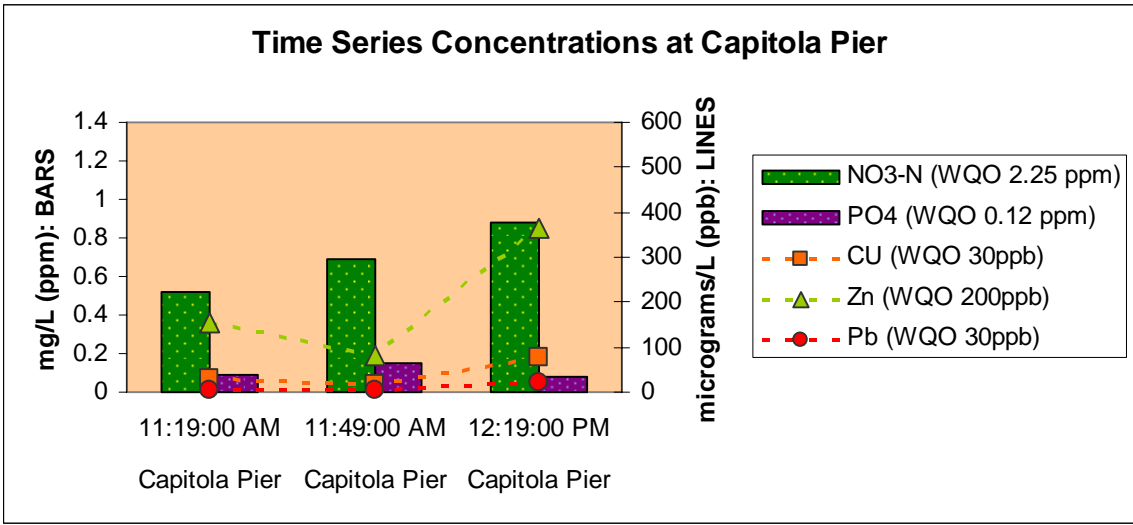


Figure 18. First Flush results at Capitola Pier for each time series. Bars (NO<sub>3</sub>-N and PO<sub>4</sub>-P) are read on the primary y-axis; lines (Cu, Zn, and Pb) are read on the secondary y-axis.

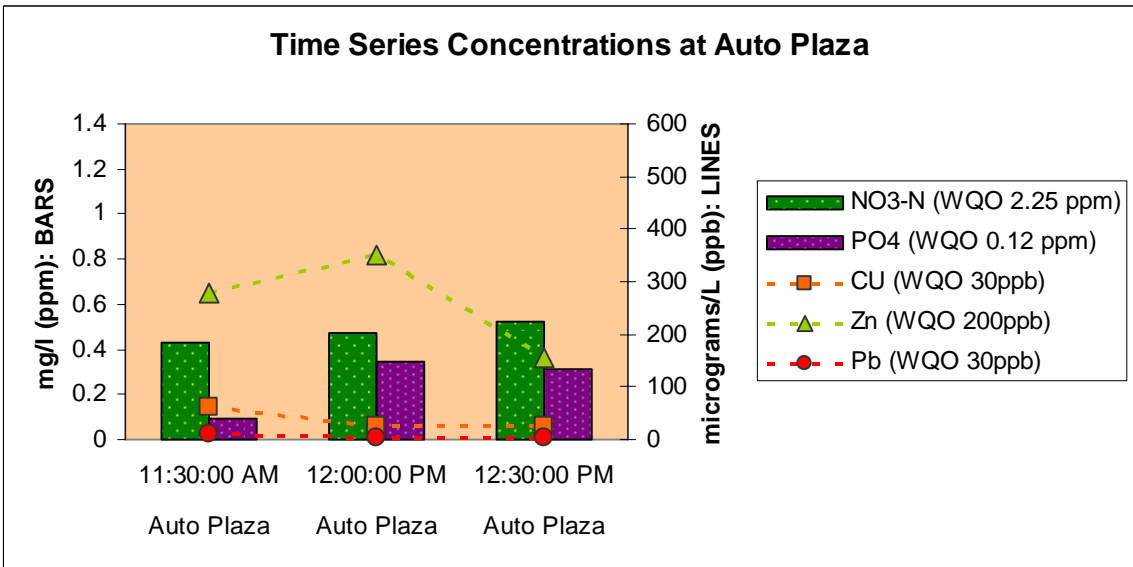


Figure 19. First Flush results at Auto Plaza for each time series. Bars (NO<sub>3</sub>-N and PO<sub>4</sub>-P) are read on the primary y-axis; lines (Cu, Zn, and Pb) are read on the secondary y-axis.



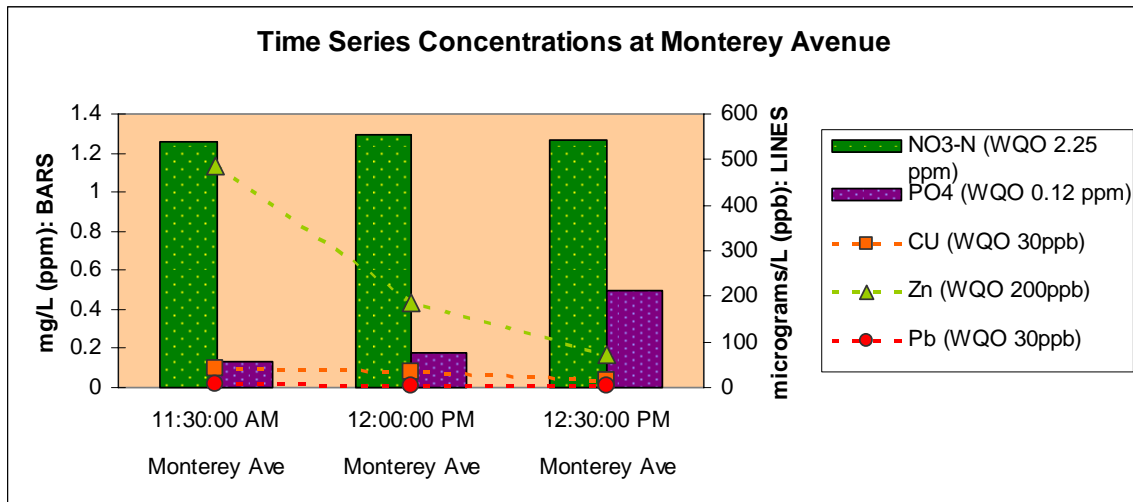


Figure 20. First Flush results at Monterey Avenue for each time series. Bars (NO<sub>3</sub>-N and PO<sub>4</sub>-P) are read on the primary y-axis; lines (Cu, Zn, and Pb) are read on the secondary y-axis.

### Seaside

This year, the only monitoring sites in Seaside were Bay Street and Hotel; however, due to high surf and sea water mixing, Hotel was not sampled this year. Hotel is a large box culvert that opens to the bay on the beach next to the Monterey Beach Hotel; in high surf, it is very exposed and too dangerous to sample.

Nutrient results at Bay Street were very low. The site was below the WQO for nitrate for each time series, and just at the WQO for the first time series concentration of orthophosphate. All of Bay Street's copper concentrations were above the WQO, averaging 50ppb, and just one of the sites zinc measurements was over the WQO at 204ppb (Figure 21). There were no exceedances for lead. Both *E.coli* and enterococcus exceeded the WQO during each time series concentration. *E.coli* had a max of 64,882 MPN/100ml during the first time series and enterococcus had a max of 15,286 MPN/100ml during the second time series.

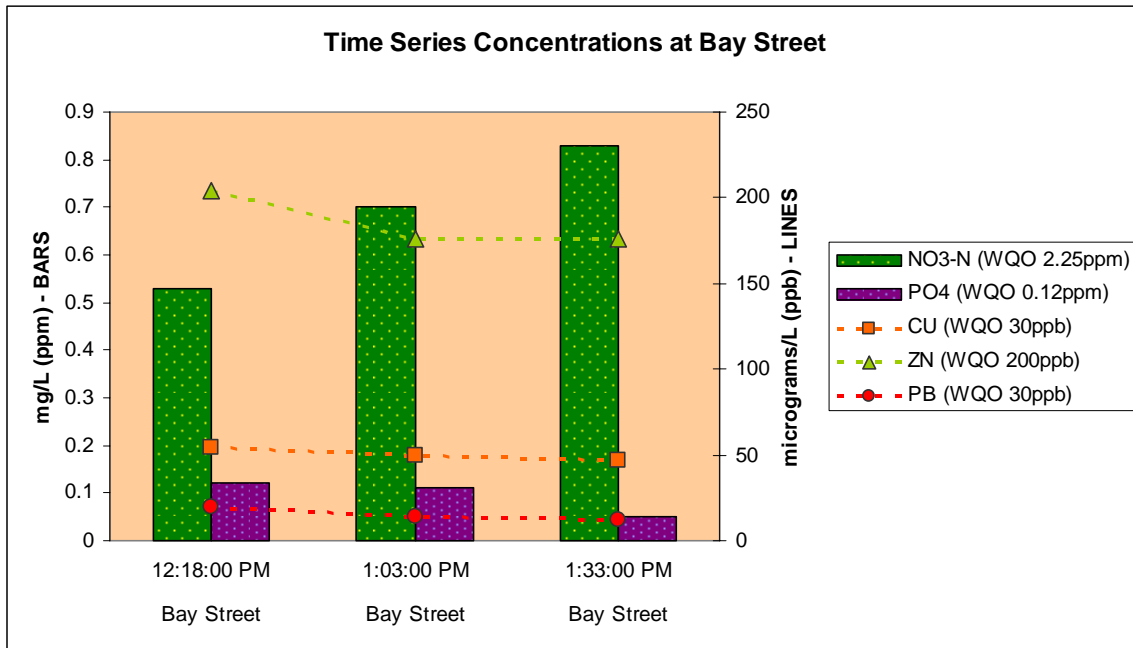


Figure 21. First Flush results at Bay Street for each time series. Bars (NO<sub>3</sub>-N and PO<sub>4</sub>-P) are read on the primary y-axis; lines (Cu, Zn, and Pb) are read on the secondary y-axis.

### Monterey

This year in Monterey, only three sites were monitored: Twin's, San Carlos, and Steinbeck. None of the sites had nitrate concentrations in exceedance of the WQO. All time series measurements at all sites exceeded the WQO of 0.12mg/l for orthophosphate. The maximum reading for orthophosphate was 3.24mg/l at Steinbeck during the first time series. This is consistent with historical First Flush orthophosphate values from Steinbeck—they are consistently much higher than orthophosphate values at any other site in the region.

All times series measurements at all sites also exceeded the WQO for copper and zinc, with maxes of 99ppb of copper at Steinbeck during the first time series and 444ppb of zinc at Twin's during the first time series. The only two exceedances for lead were at Twin's, with concentrations of 44 and 39ppb (Figures 22, 23 & 24). *E. coli* and enterococcus concentrations were all over the WQO and averaged 74,177 and 65,501 MPN/100ml.

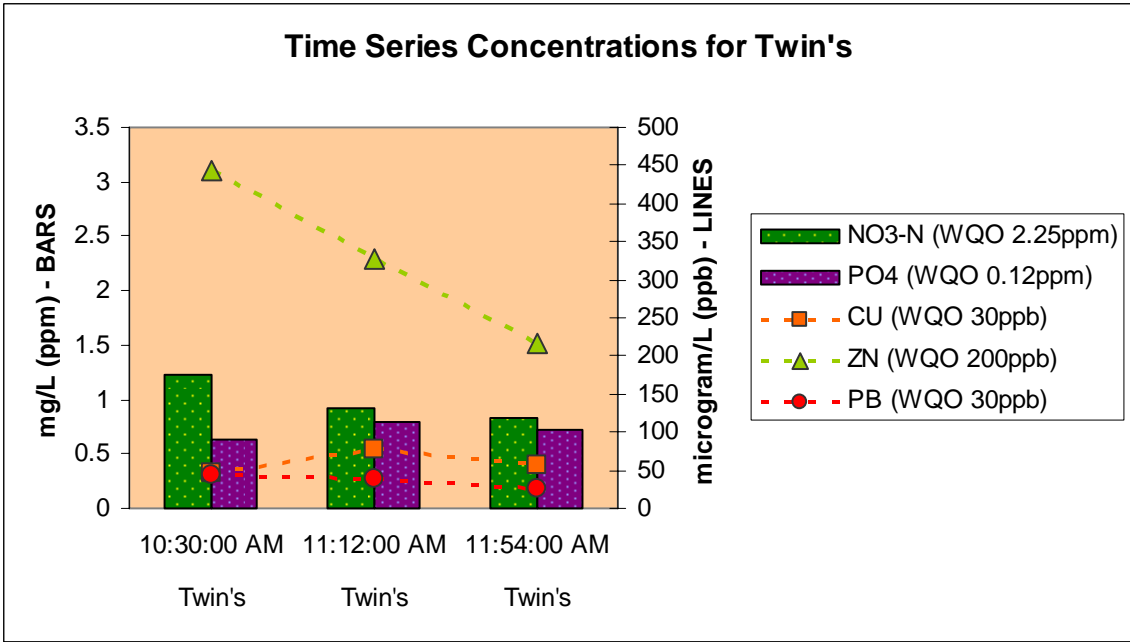


Figure 22. First Flush results at Twin's for each time series. Bars (NO3-N and PO4-P) are read on the primary y-axis; lines (Cu, Zn, & Pb) are read on the secondary y-axis.

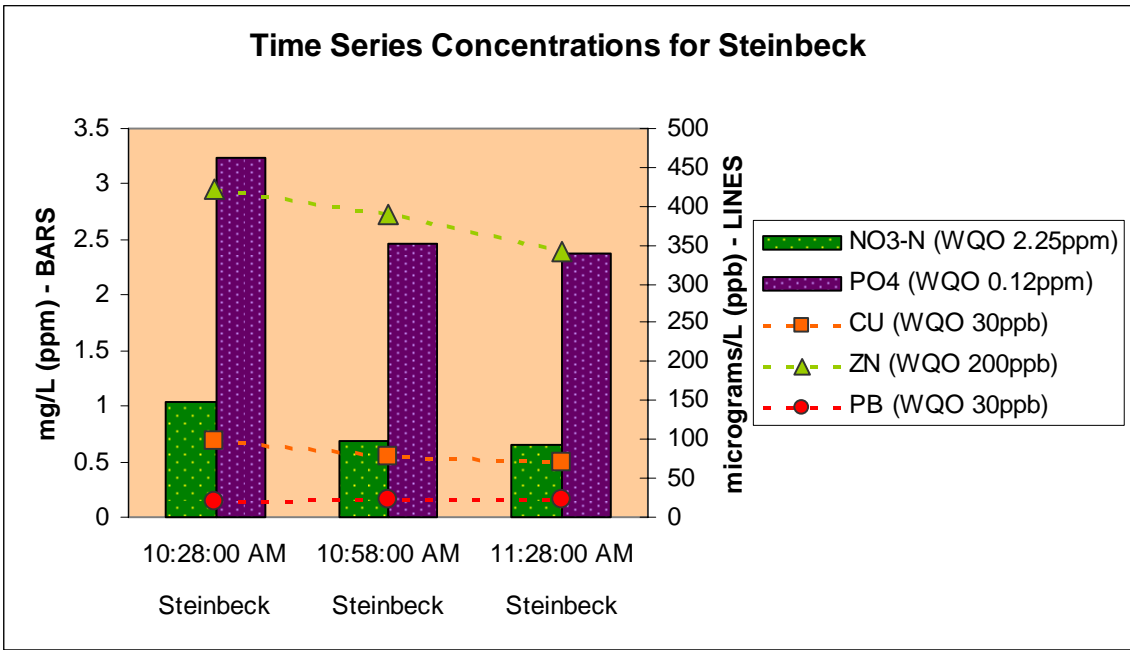


Figure 23. First Flush results at Steinbeck for each time series. Bars (NO3-N and PO4-P) are read on the primary y-axis; lines (Cu, Zn, & Pb) are read on the secondary y-axis.

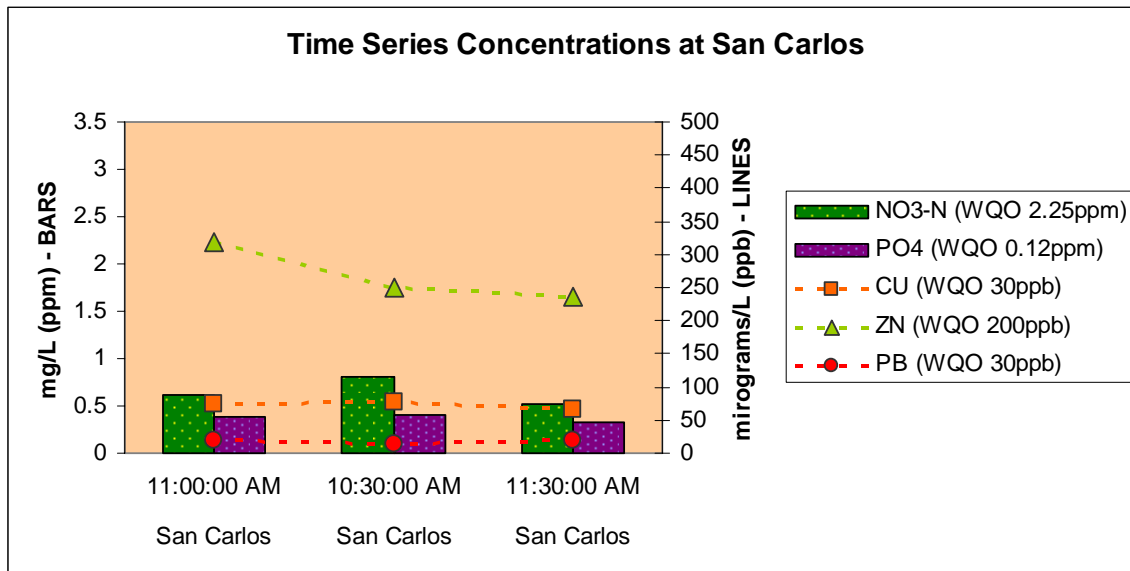


Figure 24. First Flush results at San Carlos for each time series. Bars (NO<sub>3</sub>-N and PO<sub>4</sub>-P) are read on the primary y-axis; lines (Cu, Zn, & Pb) are read on the secondary y-axis.

## Pacific Grove

Pacific Grove had the most sites of all the cities. Teams mobilized for Pacific Grove on September 22nd at 10:00a.m. and began monitoring by 11:00a.m. No sites exceeded the WQO for nitrates, however all 11 sites exceeded the WQO for orthophosphate. The average orthophosphate concentration was 0.84mg/l (Figure 25). There were zinc exceedances at HopkinsMon, Greenwood Park, Asilomar, and Hopkins PG, and copper exceedances everywhere except Fountain and 15<sup>th</sup>. Lead concentrations exceeded the WQO at Forest (Figure 26). *E. coli* and enterococcus concentrations averaged 51,467 and 45,186 MPN/100ml, respectively, and were above the WQO each time except one time series at Fountain and 15<sup>th</sup>.

There are two items that are important to note for FF in Pacific Grove. First, the City of Pacific Grove had been diverting their dry weather flow from Lover's Point, 17<sup>th</sup> Street, and 8<sup>th</sup> Street outfalls to the Monterey Regional Water Pollution Control Agency. The diversion was still in effect during the storm, so the water sampled by volunteers was overflow from the holding sumps. Second, there was a misunderstanding of the location of the Forest outfall; what volunteers sampled was a combination of Forest and Lover's Point drainages. Results from Forest and Lover's Point are different, however, because the Lover's Point samples do not contain Forest water, but the Forest samples contain Forest plus Lover's Point water. Because there were so many sites, the time series are not represented in Figures 25 and 26.

In sum, there were very high orthophosphate and Zn at HopkinMon. Copper was high at Forest and Asilomar, although copper has been historically higher at Asilomar.

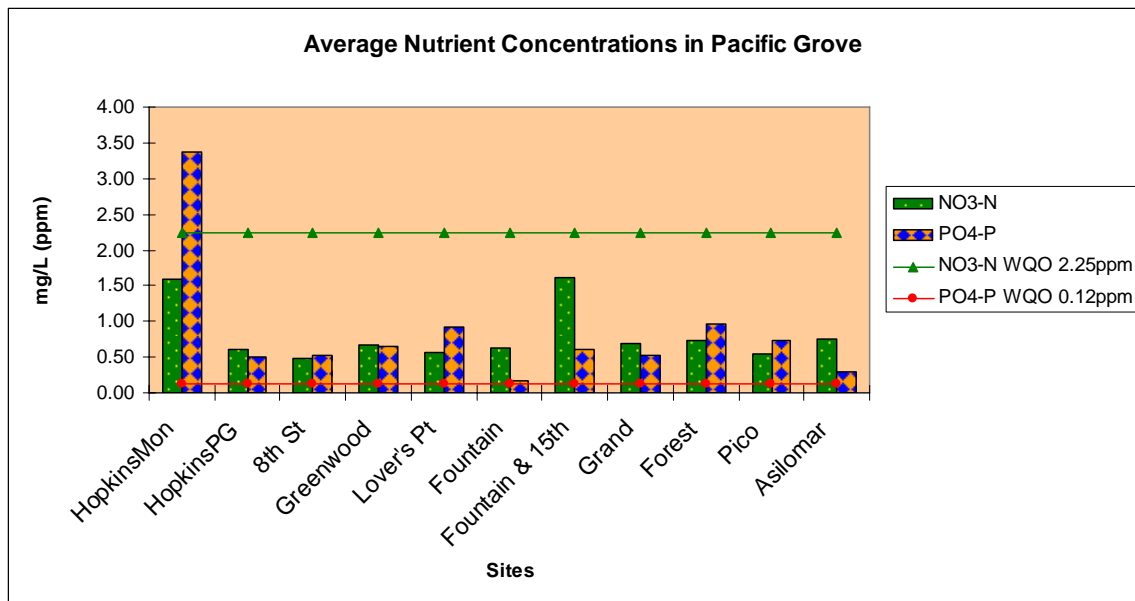


Figure 25. First Flush nitrate results for Pacific Grove with time series averaged.

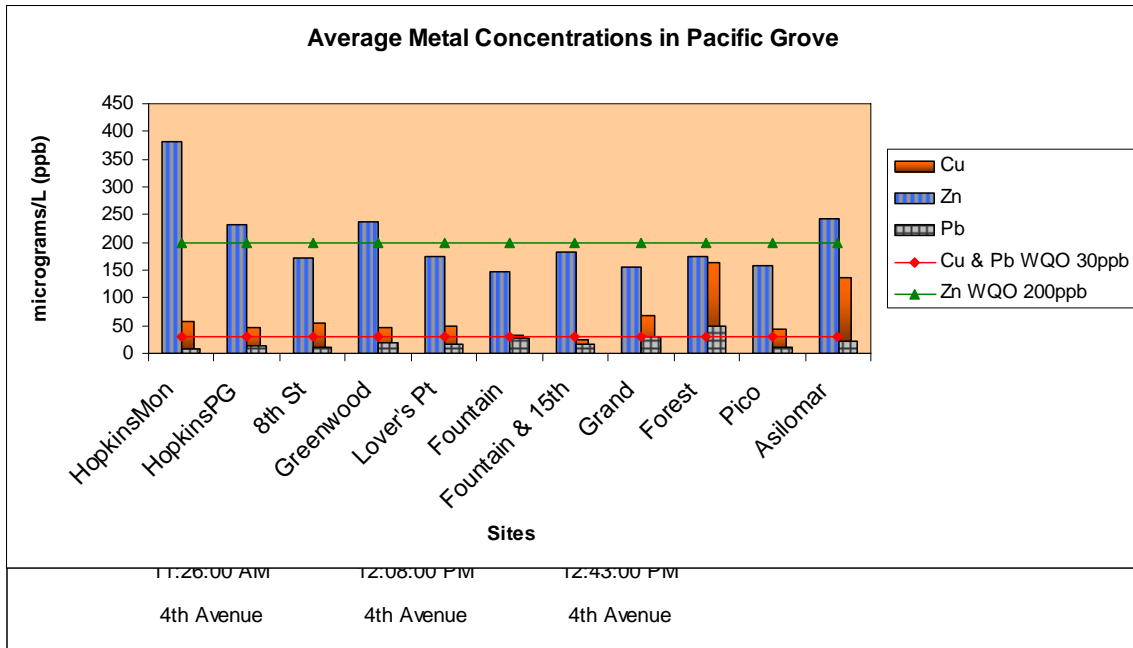


Figure 26. First Flush metal results for Pacific Grove with time series averaged.

### Carmel

This was the first year that Carmel was included in the FF. Like all cities, there were no nitrate exceedances in Carmel; however, orthophosphate exceeded the WQO for each time series at every site. The average orthophosphate concentration was 1.00mg/l. Carmel also had some of the highest concentrations of copper found during the FF; all time series samples at all sites exceeded the WQO. The average copper concentration was 165ppb, much higher than the WQO of 30ppb. Zinc concentrations exceeded the WQO at Ocean Avenue, 8<sup>th</sup> Avenue, and once at 4<sup>th</sup> Avenue. The average zinc concentration was 244ppb. Lead exceeded its WQO once at Ocean Avenue with a concentration of 111ppb on the third time series (Figures 27, 28, 29 & 30). *E. coli* and enterococcus were both far above their WQO's with average concentrations of 47,115 and 3,612 MPN/100ml, respectively. Most all concentrations for each parameter were stable through the time series.

Figure 27. First Flush results at 4<sup>th</sup> Avenue for each time series. Bars (NO<sub>3</sub>-N and PO<sub>4</sub>-P) are read on the primary y-axis; lines (Cu, Zn, and Pb) are read on the secondary y-axis.

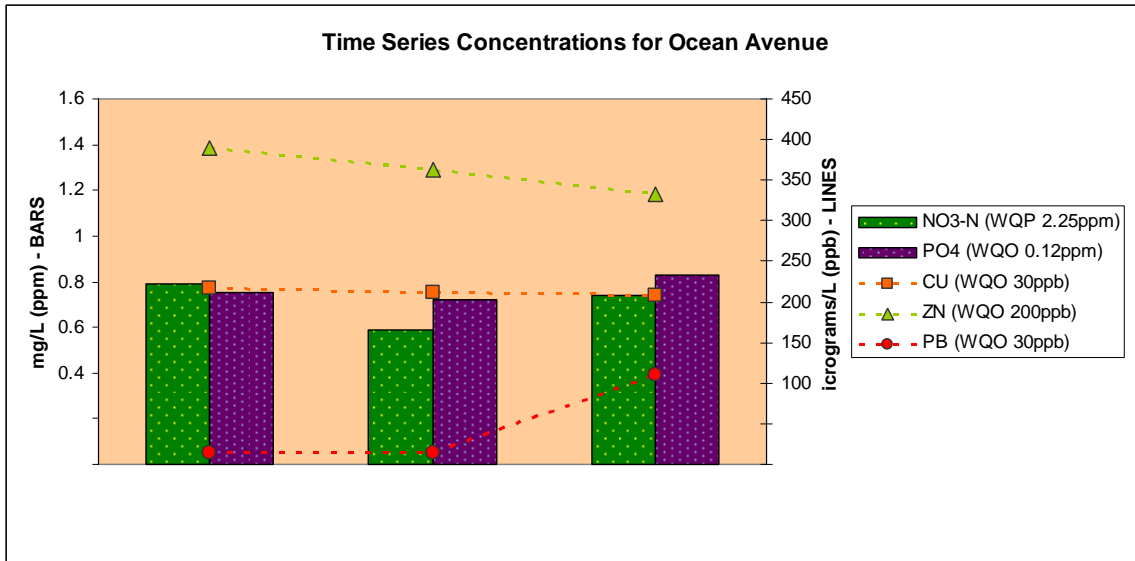


Figure 28. First Flush results at Ocean Avenue for each time series. Bars (NO3-N and PO4-P) are read on the primary y-axis; lines (Cu, Zn, and Pb) are read on the secondary y-axis.

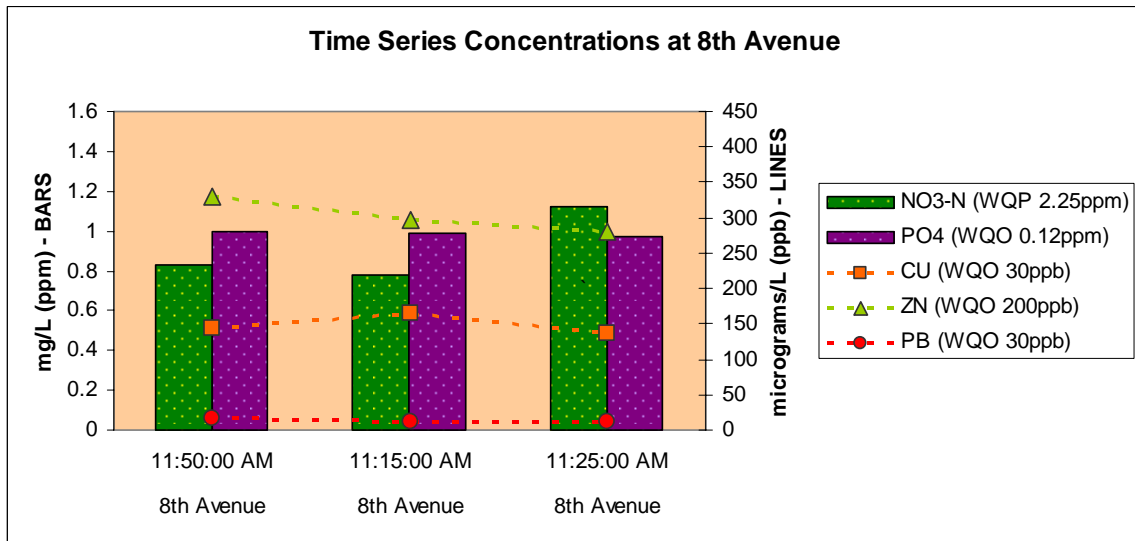


Figure 29. First Flush results at 8<sup>th</sup> Avenue for each time series. Bars (NO3-N and PO4-P) are read on the primary y-axis; lines (Cu, Zn, and Pb) are read on the secondary y-axis.

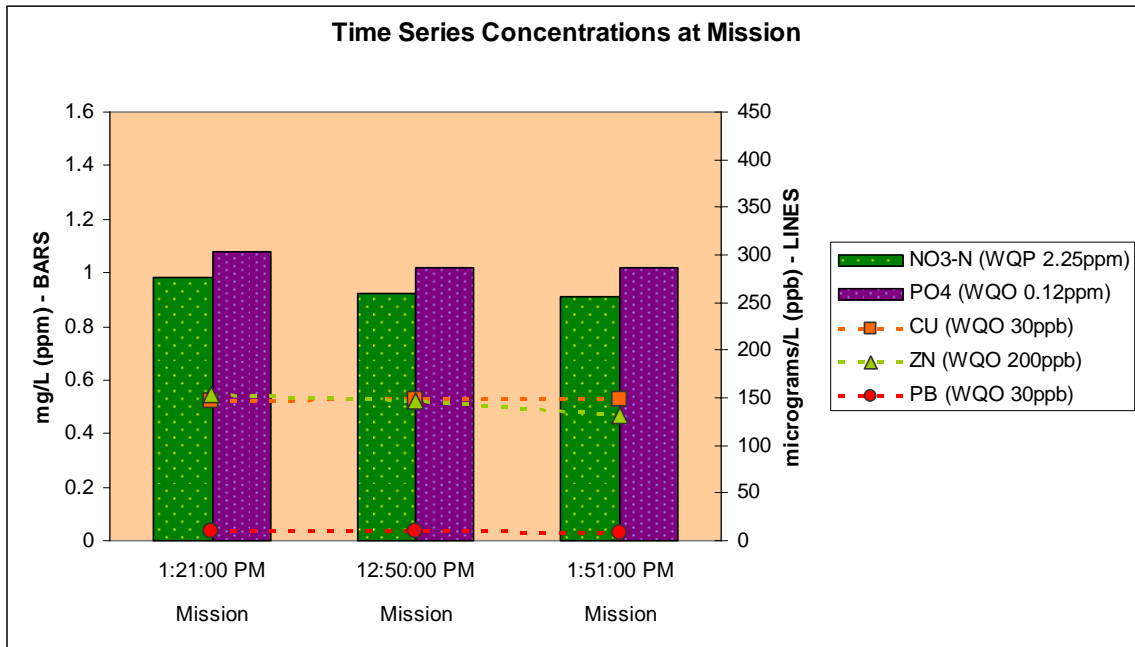


Figure 30. First Flush results at Mission for each time series. Bars (NO3-N and PO4-P) are read on the primary y-axis; lines (Cu, Zn, and Pb) are read on the secondary y-axis.



## Conclusion

For the past seven years, First Flush has provided Monterey Bay and Half Moon Bay area residents and municipalities with valuable information about the quality of water running from the storm drains to the ocean during the first major rain event of the season. Results from this year's event show that

- Nitrate concentrations are lower than previous years' averages and rarely exceed the water quality objective.
- Orthophosphate concentrations reflect comparable values from previous years and usually always exceed the water quality objective. Upstream source tracking of orthophosphates is recommended for locating sources of contamination.
- *E. coli* and enterococcus are high everywhere; enterococcus is not as high as in previous years. A thorough upstream source tracking of bacteria, including an extensive survey of the existing sewer system, may be a useful activity to locate bacteria sources.
- Zinc concentrations this year reflected those of previous years. Zinc concentrations are split above and below the water quality objective.
- Most copper concentrations were lower than in previous years. Carmel had some of the highest levels of copper.
- Lead remained relatively low but exceeded the water quality objective in Santa Cruz, Monterey, Pacific Grove, and Carmel once each.
- Total suspended solid concentrations reflected those of previous years and were below the water quality objective.
- Urea measurements were generally less than 1000ppb, with two exceptions: Steinbeck and HopkinsMon, which were greater than 2000ppb.

These results repeatedly highlight watersheds that report exceptionally high concentrations of particular pollutants; these watersheds should be focused on by local jurisdictions to determine possible sources of pollution. Additionally, managers should begin to study the intertidal area in order to determine if there is an impact from these urban pollutants flowing into the sea.

The addition of new sites this year is valuable for broadening base of First Flush data knowledge. While limited in scope, First Flush does an excellent job of pointing out problem sites and parameters. While the project design may be insufficient to answer questions about the long term improvement, or lack there of, of water quality in the area, it is useful for identifying drainages that need more attention from water quality managers.

**Attachment 1: Site name and location**

<u>Station Name</u> (Cities listed in order from North to South)	<u>Station ID</u>	<u>Drainage Area</u> (acres)	<u>Primary Land Use</u>	<u>Description</u>	<u>Location</u>	<u>Receiving Water</u>
Half Moon Bay	HMB1			Concrete pipe	Storm drain in Half Moon Bay at Main Street and Pilarcitos Creek	Ocean
Merced Ave (Santa Cruz)	SCSD2	1289	40% residential 10% commercial 50% open space	Concrete pipe	On S. side of W. Cliff Dr. at Merced Ave.	Ocean
Bay Street (Santa Cruz)	SCSD3	285	95% commercial 5% residential	Surface drainage	On S side of W. Cliff Dr. at Bay St.	Creek
Arroyo Seco (Santa Cruz)	SCSD5					
Woodrow (Santa Cruz)	SCSD4	736	80% residential 10% commercial 10% open space	Surface drainage	On S side of W. Cliff Dr. at Woodrow Ave.	Ocean
Auto Plaza (Capitola)	CSD-03		2% residential 98% commercial	Corrugated metal pipe	Corrugated metal pipe discharging to a cement box culvert w/dissipater	Creek
Stockton Bridge (Capitola)	CSD-04		100% residential	Corrugated metal pipe		Creek
Capitola Center (Capitola)	CSD-05					
Monterey Ave. (Capitola)	CSD-08					
Capitola Pier (Capitola)	CSD-09		100% residential	Cement culvert (metal 'flap' gate)		Ocean
Bay Ave. (Seaside)	SSD2			Concrete box culvert	At the end of Bay Ave. and Sand Dunes Rd.	Ocean
Hilby (Seaside)	SSD1			Concrete pipe	At the south side of intersection of Hilby Ave and Canyon Del Rey Blvd.	Lake
Eldorado (aka Major Sherman) (Monterey)	MSD1		80% residential 20% commercial	Surface drainage	Intersection of Major Sherman Lane and El Dorado Street	Lake
Twin's (Monterey)	MSD3	365	90% residential 10% commercial	Two 51" diameter concrete pipes	Below walking path at Heritage Harbor-	Ocean

					adjacent to Wharf I, west ~500ft.	
San Carlos (Monterey)	MSD4	70	40% commercial 35% residential 25% public land	36" diameter concrete pipe	On the beach adjacent to the west side of Coast Guard pier.	Ocean
Steinbeck (Monterey)	MSD5	37	90% commercial 10% residential	36" diameter concrete pipe	At Steinbeck Plaza on Cannery Row at the end of Prescott Street.	Ocean
Library (Monterey)	MSD6	467	100% residential	Drainage ditch	665 Pacific Street adjacent to the Monterey Public Library on the Northeast side of Pacific Street	Ocean
Hopkins (Pacific Grove)	PGSD7			Concrete pipe	Located high on the beach between the Monterey Bay Aquarium and Hopkins Marine facility	Ocean
8 <sup>th</sup> Street (Pacific Grove)	PGSD1	35	100% residential	Concrete pipe	West of Oceanview Blvd. between 7 <sup>th</sup> and 8 <sup>th</sup> Street.	Ocean
Central & 13 <sup>th</sup> (aka Greenwood) (Pacific Grove)	PGSD2	250	90% residential 10% commercial	Concrete pipe	Greenwood Park at the corner of 14 <sup>th</sup> and Central Ave.	Ocean
Lover's Pt (Pacific Grove)	PGSD3	222	90% residential 10% commercial	Concrete pipe	At the top of the cliff on the SE side of the main beach at Lover's Pt	Ocean
Pico (Pacific Grove)	PGSD4	131	100% residential	Concrete pipe	On the W side of Sunset Drive approx. 60 ft N. of Pico St.	Ocean
Asilomar (Pacific Grove)	PGSD5	94	90% residential 10% commercial	Drainage ditch	On the W side of Sunset Drive due W of the Asilomar Convention Ctr.	Ocean
Congress (Pacific Grove)	PGSD6	37	90% residential 10% commercial	Concrete pipe	Approx. 300 yards S of Congress and Sunset Blvds.	Riparian area flows to ocean

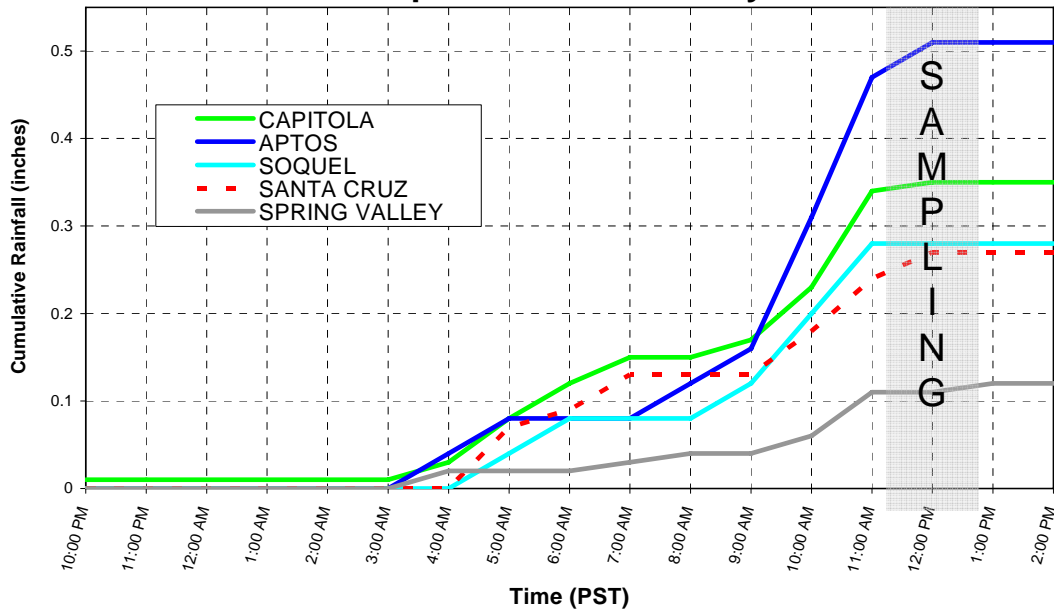
**Attachment 2: Page 1 of Field Data Sheet**

<b>Monterey Bay National Marine Sanctuary</b>				
<b>First Flush 2004</b>				
<b>Field Data Sheet</b>	<b>Date:</b>			
<b>City</b>			<b>Arrival Time</b>	
<b>Station ID</b>			<b>Departure Time</b>	
<b>Time Rain Began</b>		<b>Station Name</b>		
<b>Team Members with phone #'s</b>				
1			4	
2			5	
3			6	
<b>Detailed description of weather conditions (drizzle, rain, wind, visibility, cloud cover, darkness, etc.):</b>				
<b>Field Measurements:</b>		<b>Time</b> <b>Bucket Filled</b> ____ : ____ am / pm		
<b>Instrument ID:</b>	<b>Person taking Measurement</b>	<b>Parameter</b>	<b>Measurement</b>	<b>Replicate</b>
		H2O Temp	F or C	F or C
		pH		
		Conductivity	$\mu S$	$\mu S$
		Transparency	cm	cm
<b>Notes</b> (include any observations from back side, ie. types of trash, biological observations, etc.)				



Attachment 3: Rainfall Maps

First Flush 2007 - September 22  
Capitola/Half Moon Bay



First Flush 2007 - September 22  
Pacific Grove/Monterey/Seaside

