



Monterey Bay Sanctuary Citizen Watershed Monitoring Network

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2005 Dry Run & First Flush Monitoring Report

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Made Possible by:

Monterey Bay National Marine Sanctuary; Central Coast Regional Water Quality Control Board; Santa Cruz County; San Mateo County; Cities of Scotts Valley, Santa Cruz, Live Oak, Capitola, Seaside, Monterey, and Pacific Grove; Coastal Watershed Council; Monterey Bay Sanctuary Foundation; Monterey Regional Water Pollution Control Agency; Sewer Authority Mid-Coastside, Gulf of the Farallones National Marine Sanctuary

Executive Summary

Citizen volunteers have been collecting valuable water quality data in the Monterey Bay since 1997 through the unique Urban Watch and First Flush (FF) programs. By monitoring water quality from storm drains, these programs are providing valuable data for a source of water pollution that is not usually analyzed by traditional programs. This monitoring is developing a core dataset that is establishing trends, identifying hot spots for follow up action, and establishing a baseline to which future data can be compared against. Ultimately, these programs will provide a feedback mechanism on current urban runoff control efforts.

In preparation for the First Flush event, a single Dry Run monitoring event took place on Saturday, September 24, 2005 in Scotts Valley, Santa Cruz, Live Oak, Capitola, Seaside, Monterey, and Pacific Grove. Samples were collected for the same analysis as First Flush to determine the concentrations of pollutants in the runoff prior to the first rains, while providing training for the volunteers and data on dry-weather flows. Nineteen of the twenty-seven sites had flowing water to sample. Half Moon Bay did not participate because they had their First Flush earlier in the week.

Dry Run Range of Results¹

◆ conductivity (500 – 3,300 µS)	◆ Escherichia coli (<i>E. coli</i>) (20 – 48,391 MPN/100ml)
◆ water temperature (7 °C – 20°C)	◆ zinc (<20 – 382 µg/l)
◆ pH (7.0 – 7.5)	◆ copper (<20 – 127 µg/l)
◆ nitrate as N (<0.05 – 6.16 mg-N/l)	◆ lead (<5 – 12 µg/l)
◆ orthophosphate as P (<0.05 – 1.26 mg-P/l)	◆ total suspended solids (TSS) (<5 – 2358 mg/l)
◆ total coliform (1,108 - >241,957 MPN/100 ml)	◆ total dissolved solids (TDS) (310 – 1800 mg/l)

On September 20th, the San Mateo coast received an early rain of approximately 0.25 inches and volunteers mobilized at approximately 4:00 PM. The First Flush event didn't occur in Santa Cruz, Live Oak, Capitola, Monterey, and Pacific Grove until Tuesday, November 8th. The volunteers mobilized at approximately 2:30 AM in Santa Cruz county and 4:30 AM in Monterey County. A second storm arrived the following day which mobilized the teams in Seaside at 7:30 AM and Scotts Valley at 4:30 PM (see Attachment 4). The rain events were not very intense and were sporadic in each city producing between 0.1 and 0.3 inches of rain within a 3-hour time period. In total, ninety-six volunteers monitored thirty-two storm drain outfalls. Those statistics are up from sixty-four volunteers and twenty-three storm drain outfalls in 2004.

First Flush Range of Results¹

◆ conductivity (100 – 2,400 µS)	◆ Escherichia coli (<i>E. coli</i>) (844 – >241,920 MPN/100ml)
◆ water temperature (4.5°C – 16.9°C)	◆ zinc (33.0 – 920 µg/l)
◆ pH (6.5 – 8.0)	◆ copper (<20 – 407 µg/l)
◆ nitrate as N (<0.05 – 2.31 mg-N/l)	◆ lead (<5.0 – 87 µg/l)
◆ orthophosphate as P (<0.05 – 2.27 mg-P/l)	◆ total suspended solids (TSS) (4.8 – 897 mg/l)
◆ total coliform (4,611 - >241,960 MPN/100 ml)	◆ total dissolved solids (TDS) (73 – 1400 mg/l)

The findings indicate that the concentrations of pollutants are lower in the dry weather versus wet weather. Some sites show higher concentrations of pollutants than others, and those warrant follow-up investigations. Finally, these programs are valuable to detect trends and to evaluate program effectiveness, but at the same time, caution is urged in their interpretation.

¹ All of the sites (see Attachment 1 for more information) were monitored for the parameters listed. Beside each parameter in parenthesis is the range of concentrations that were detected during each of the events. Units are represented as milligrams per liter (mg/l), micrograms per liter (µg/l), Most Probable Number per 100 milliliters (MPN/100 ml), and micro Siemens (µS)

Introduction

Volunteer monitoring was spawned from the fact that resource agencies suffer from chronic funding shortages and that citizen volunteers can play a vital role in helping them assess water quality. The lack of funding restricts long-term ambient monitoring of rivers and streams, and omits characterization of the numerous outfalls that collect storm water and dry weather runoff from the urban landscape that discharge into the Monterey Bay National Marine Sanctuary (MBNMS). Recognizing this fact in 1997, the Coastal Watershed Council (CWC) initiated the Urban Watch (UW) volunteer monitoring program that for the past nine years has been characterizing the quality of water from these sources. In 2000, the Monterey Bay Sanctuary Citizen Watershed Monitoring Network (Network) started the First Flush (FF) monitoring program to characterize the water flowing into the MBNMS during the first storm of the season.

UW measures pollutant concentrations in dry season storm drain outflows, and FF compliments UW by measuring pollutant concentrations from the same locations as UW, but during the first storm of the year that generates significant runoff. This monitoring is developing a core dataset that is establishing trends, identifying hot spots for follow up action, and establishing a baseline to which future data can be compared against. Ultimately, these programs will provide a feedback mechanism on current urban runoff control efforts

Methods

The same storm drain outfalls that are regularly monitored by the UW volunteers were also monitored for the Dry Run and FF events. Every site in all nine cities had a designated team and set of equipment. Each team had a team leader responsible for the monitoring equipment and sample bottles. Three sets of water samples were taken at each of the sites except for Pico in Pacific Grove, where just two sets of samples were collected. (see Attachment 1 for more information about the sites).

In order to prepare for the actual FF event, volunteers in Santa Cruz and Monterey counties participated in a dry-run training event. This occurred on September 24th, and during the event volunteers collected one suite of samples using the same methods as FF (while UW monitors the same outfalls, that program utilizes different collection and analysis methods).

For the FF event, the Network and CWC Coordinators closely monitored the weather, notifying volunteers early of approaching storms. When a given storm had the potential to generate enough rainfall for the event, the Coordinators placed volunteers on standby until the mobilization criteria were met.

The criteria used for mobilization included sheeting water on the roadways, heavy flow through the storm drain system and conductivity levels less than 1000 microSiemens (μS). Conductivity measures the amount of ions in water, and because rainfall is relatively free of ions, lower conductivity measurements indicate rainfall runoff as opposed to dry-weather baseflow. When the volunteers arrived at their designated site, conductivity measurements were taken to determine when sampling should begin. When conductivity fell below 1000 μS the following process was implemented.

Three suites of samples were gathered at 30 minute intervals along with continuous visual observations. An automated water sampler was deployed at two locations, Hilby in Seaside and Lover's Point in Pacific Grove. The water sampler was an ISCO 2900 (Lincoln, NE) provided by the

Monterey Regional Water Pollution Control Agency. Teams were also at these locations to record physical parameters and document visual observations.

The field data sheet was used by all monitoring teams to follow a standard protocol (See Attachment 2-Field Data Sheet). The volunteers measured conductivity using either an Oakton ECTester 3 or 4. Water temperature was measured using a spirit bulb thermometer. pH was measured using Macherey-Nagel non-bleeding pH test strips with a range of 4.5-10. Physical observations such as trash, odor, bubbles, scum, and oil sheen were also recorded on the field data sheet. As the on-site measurements were collected, sample bottles were filled for analysis at a certified laboratory. Lab analysis included nitrate as nitrogen, orthophosphate as phosphorus, total coliform, *E. coli*, total zinc, total copper, total lead, hardness, total suspended solids (TSS) and total dissolved solids (TDS). Additionally, one composite sample for oil and grease, and one polynuclear aromatic hydrocarbon sample were also analyzed in each city (see Attachment 3 for analytical methods). In Half Moon Bay and El Granada, TSS, TDS, and polynuclear aromatic hydrocarbon analysis were not conducted.

Quality Assurance/Quality Control

- All volunteers were trained in the use of monitoring equipment and protocols for collecting water samples.
- The conductivity meters were calibrated before being assigned to each team.
- Standardized field data sheets were provided with written instructions on how to complete them so that each team followed the same protocols.
- Each sample had a unique sample identification number.
- Field replicates and container blanks were collected.
- All lab data was reviewed for Quality Assurance /Quality Control (QA/QC) and validated by the Network Coordinator.
- All data and meta-data is stored in an Access database file.

Results and Discussion

No standards currently exist for stormwater discharges, therefore to evaluate the data, results are compared with receiving water standards established by the Central Coast Regional Water Quality Control Board. Receiving water standards are target ambient concentrations for a given waterbody, such as a stream, lake or ocean. They are not designed for end-of-pipe applications such as this. However, lacking any other standard, they serve as the only means by which perspective can be provided for the results.

Metal results were compared to the Central Coast Basin Plan Water Quality Objectives (WQO) for the protection of marine aquatic life. Because there are no numerical water quality objectives in the Basin Plan for total coliform, *E. coli*, nitrate, orthophosphate, total suspended solids (TSS), and total dissolved solids (TDS), those results were compared with the Central Coast Ambient Monitoring Program's (CCAMP) action levels. CCAMP's action levels are benchmarks that are set at levels, for receiving water concentrations at which pollutants may impact cold-water fish or human health, and are typically either levels representing existing regulatory standards, levels derived from the literature or other agency references, or levels that are elevated relative to the data distribution for that parameter on the Central Coast. It is important to note that both Basin Plan water quality objectives and CCAMP action levels are established for receiving waters and NOT for discharge waters, and a significant amount of dilution usually occurs in the receiving waters within a short distance of each outfall.

Nutrients

Nitrogen and phosphate are elements needed for plant growth. Sources of **nitrate** include runoff from fertilized lawns, agricultural and pasture lands, construction sites and septic and sewer system leachate. The action level established by CCAMP for nitrate (NO₃-N) is 2.25 mg-N/l.

The nitrate results for the Dry Run event were higher than during the First Flush. Creekside in Capitola had the highest nitrate concentration for Dry Run at 6.16 mg-N/L. Merced in Santa Cruz, had the second highest concentration of 4.97 mg-N/L during the dry weather flow (Merced had the highest Dry Run concentration in 2004). Woodrow had the third highest nitrate concentration at 3.05 mg-N/L measured during the Dry Run event (Woodrow had the third highest concentration in 2004 also).

During the First Flush, all of the sites were well below the action level except for the Capitola Village Bridge which reported a concentration of 2.31 mg-N/L collected during the 3rd time series. Nitrate concentrations typically are lower in large rain events because of dilution. Over the past six years, the nitrate concentrations averaged below the action level at the majority of sites (see Figure 1).

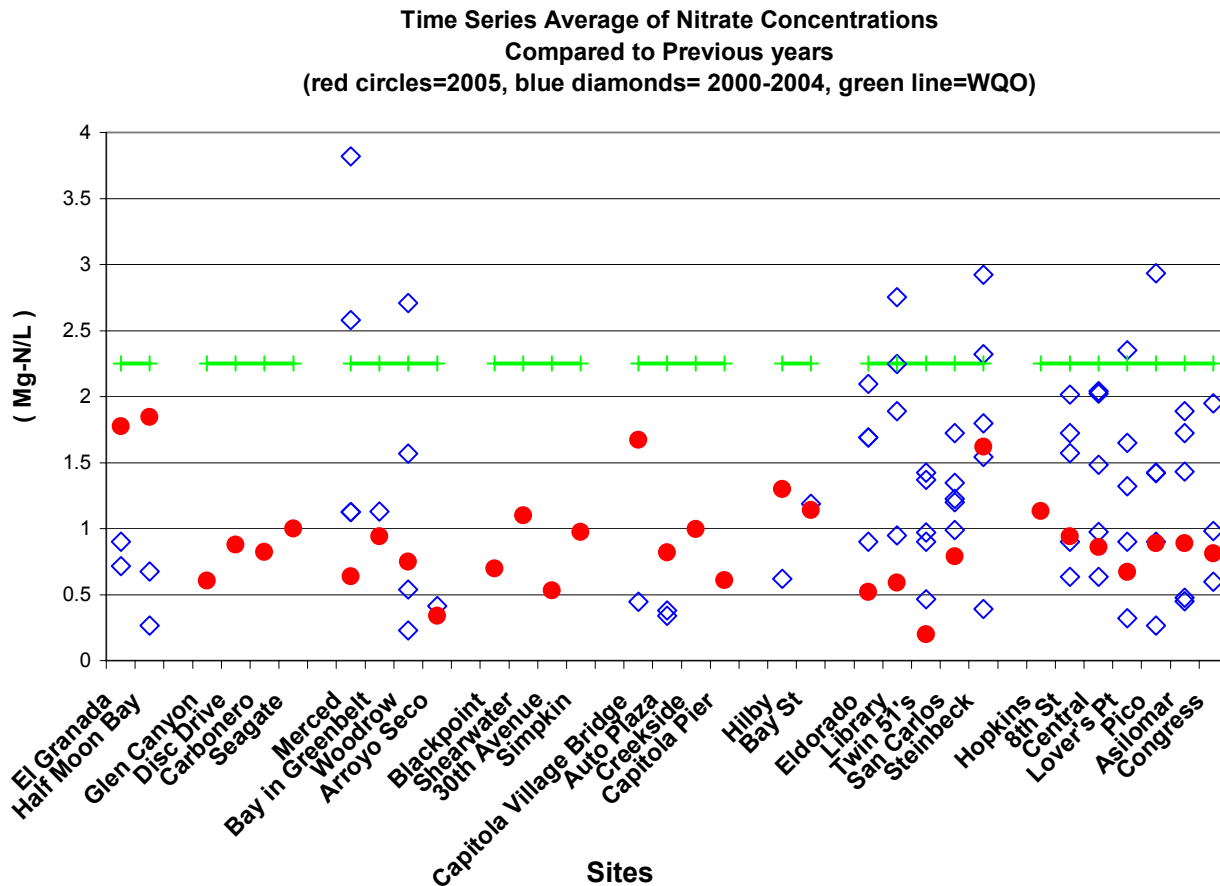


Figure 1. The sites are grouped by city from north to south(El Granada, HMB, Scotts Valley, Santa Cruz, Live Oak, Capitola, Seaside, Monterey, Pacific Grove). The CCAMP informal action level for nitrate as nitrogen is 2.25 mg-N/l. Graph of 6-year trend. Average First Flush time series concentrations are represented.

Phosphorus is an essential element for plant growth and can affect plant growth in low concentrations. **Orthophosphate** is a form of phosphorus commonly found bound to soil particles, in sewage, fertilizers, and in detergents that contain phosphates. In aquatic systems, orthophosphate is rapidly taken up by algae and aquatic plants. With excessive amounts present, large algal blooms can occur which can lead to degraded water quality conditions toxic to aquatic life. The CCAMP action level for orthophosphate ($\text{PO}_4^{3-}\text{-P}$) is 0.12 mg-P/l.

Sixteen of 29 samples exceeded the CCAMP action level for orthophosphate during the Dry Run. Eighth Street in Pacific Grove reported the highest value (1.26 mg-P/L). During the First Flush, Steinbeck Plaza in Monterey, had the three highest orthophosphate concentrations (T1²-2.27, T2-2.15, T3-1.29 mg-P/L). Creekside in Capitola had the next highest orthophosphate concentration (1.2 mg-P/L). Orthophosphate levels were much lower than the 2004 results, yet exceeded the CCAMP action level at 21 of the 32 sites. All of the Monterey and Pacific Grove sites exceeded the orthophosphate action level for the first five years of this program. In 2005, Eldorado, Library and Asilomar did not (see Figure 2).

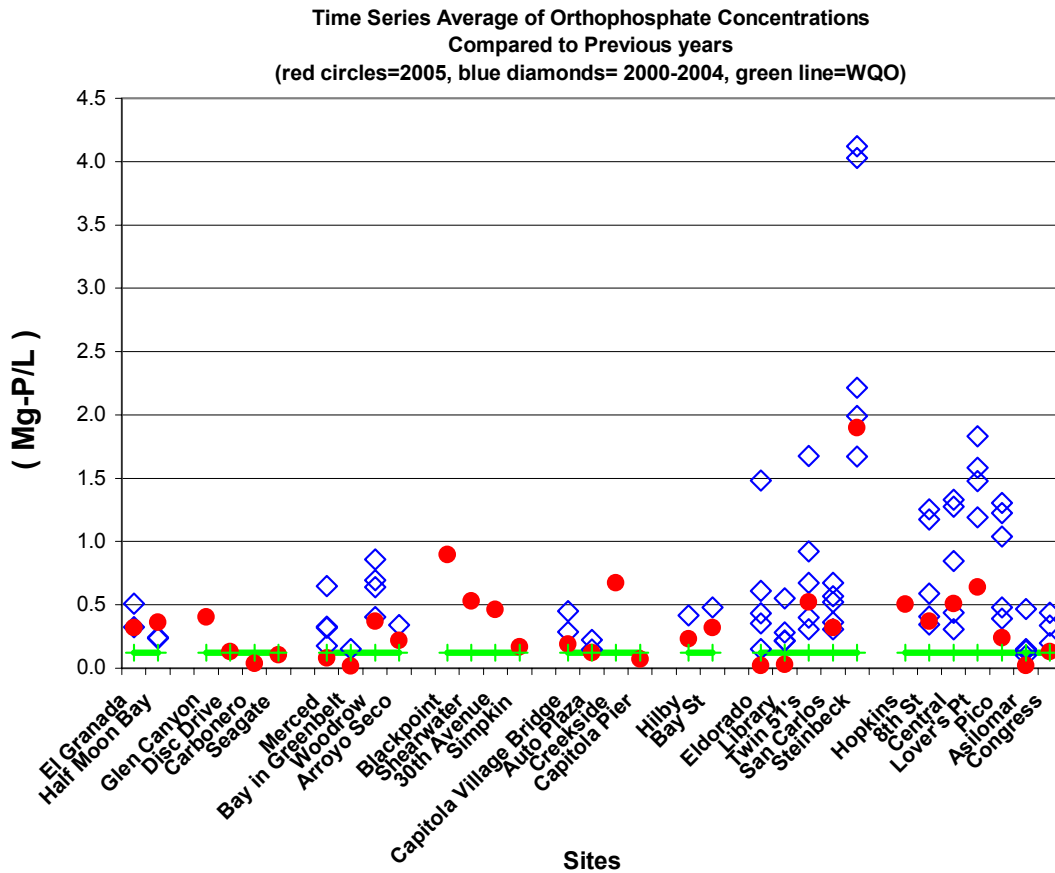


Figure 2. The sites are grouped by city from north to south(El Granada, HMB, Scotts Valley, Santa Cruz, Live Oak, Capitola, Seaside, Monterey, Pacific Grove). The CCAMP action level for orthophosphate as phosphorus is 0.12 mg-P/l. Graph of 6-year trend. Average time series concentrations are represented.

² T1 represents the first time series sample collected. T2 represents the second time series sample collected. T3 represents the third time series sample collected.

Bacteria

Total coliform and *Escherichia coli* (*E. coli*) are types of indicator bacteria. While they do not cause disease in humans, they are pollutants of concern because they indicate the presence of waste and the associated pathogens that can cause disease in humans and wildlife. *E. coli* is a member of the fecal coliform group, a subset of the total coliform group. The CCAMP action level for total coliform is 10,000 Most Probable Number (MPN)/100 ml and the action level for *E. coli* is 400 MPN/100 ml.

Twelve of nineteen sites exceeded the *E. coli* water quality objective of 400 MPN/100 ml during the Dry Run monitoring. These twelve exceedences were measured at 30th Avenue in Live Oak, Merced in Santa Cruz, Glen Canyon and Carbonero in Scotts Valley, all of the Monterey sites, and 8th St., Greenwood Park and Asilomar in Pacific Grove. Steinbeck Plaza in Monterey (48,931 MPN/100 ml) and Merced in Santa Cruz (39,726 MPN/100 ml) reported the highest concentrations. All of the sites exceeded the *E. coli* water quality objective of 400 MPN/100 ml during the First Flush. The Half Moon Bay site had the highest concentration greater than 241,000 MPN/100 ml. Lover’s Point, Pico and Congress in Pacific Grove and Woodrow in Santa Cruz all were greater than 100,000 MPN/100 ml. Pico and Woodrow reported the highest concentrations in 2004. The average concentrations in Scotts Valley and Capitola were commonly lower than the other cities (see Figure 3).

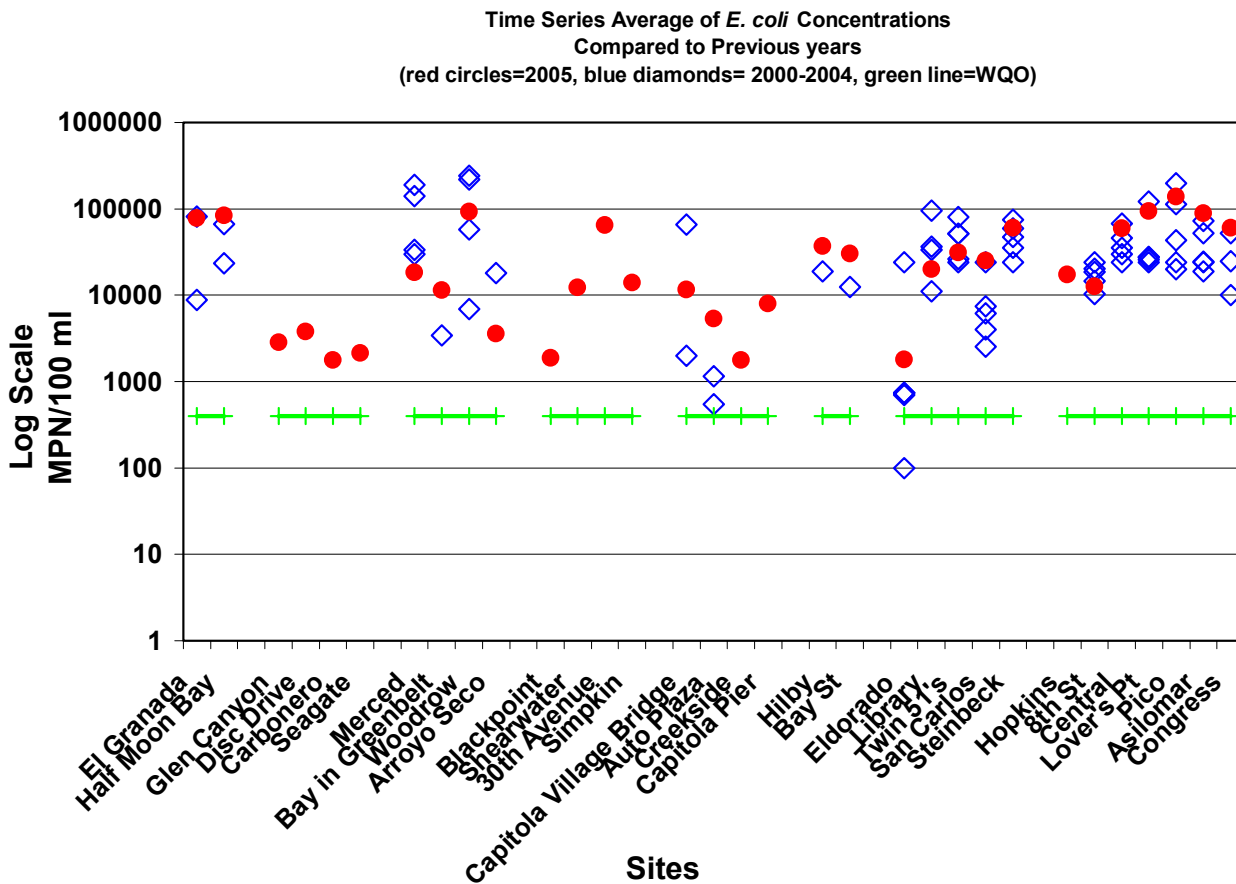


Figure 3. The sites are grouped by city from north to south(El Granada, HMB, Scotts Valley, Santa Cruz, Live Oak, Capitola, Seaside, Monterey, Pacific Grove). The EPA Water Quality Objective is 400 MPN/100 ml. Average time series concentrations for the past 6 First Flush events are represented.

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 metals. 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 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 $<200 \mu\text{g/l}$. The 8th Street outfall³ was the only site to exceed the zinc WQO at $382 \mu\text{g/l}$ for the Dry Run event. Zinc concentrations in the First Flush ranged from 33 – $920 \mu\text{g/l}$. Thirty-nine percent of the samples exceeded the Basin Plan WQO for zinc during the First Flush. This included all of the sites in Monterey, Seaside, Half Moon Bay and El Granada. Five of seven sites in Pacific Grove exceeded the Zn WQO. There was just one site each in Capitola (Capitola Village Bridge) and Live Oak (30th Avenue) to exceed the WQO for zinc. No sites in Santa Cruz or Scotts Valley had any exceedences for Zn. Twin 51s ($920 \mu\text{g/l}$) and Steinbeck Plaza ($508 \mu\text{g/l}$), both in Monterey, had the two highest zinc concentrations of all the sites this year. Both sites have historically had high zinc concentrations in previous First Flush events (see Figure 4).

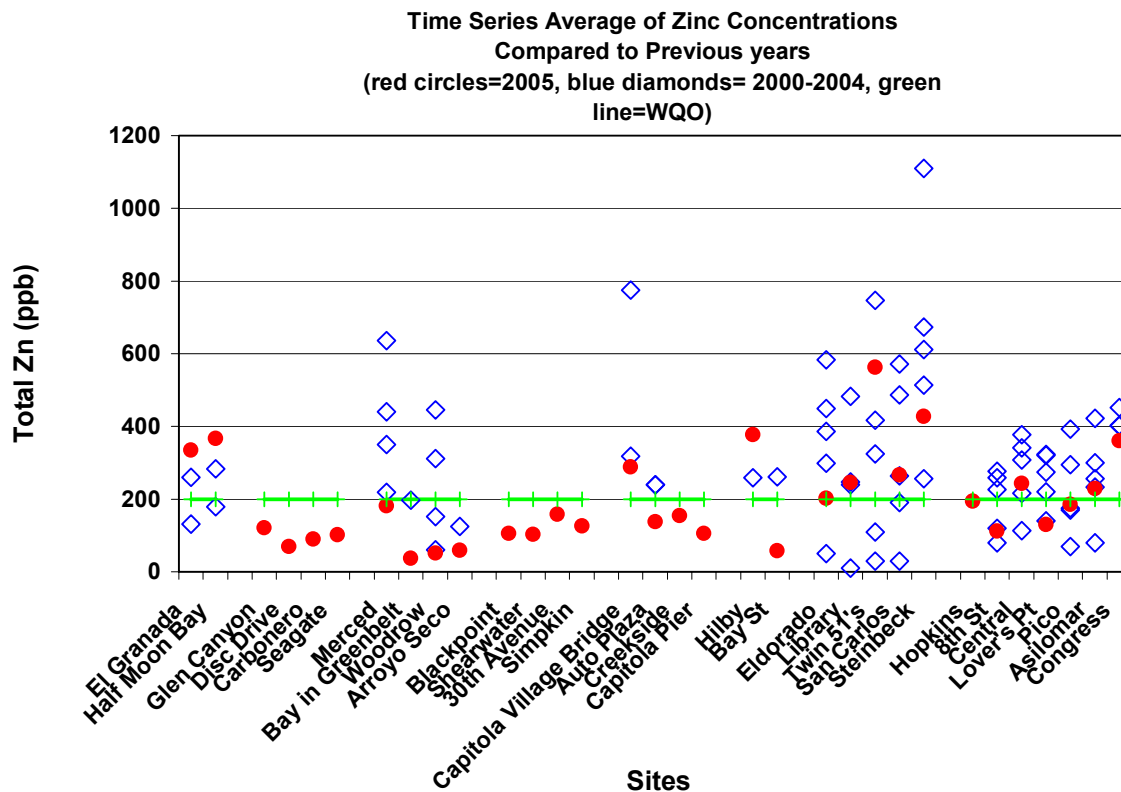


Figure 4. The sites are grouped by city from north to south(El Granada, HMB, Scotts Valley, Santa Cruz, Live Oak, Capitola, Seaside, Monterey, Pacific Grove). The Basin Plan Water Quality Objective for zinc is $200 \mu\text{g/l}$ (ppb). Graph of 6-year trend. Average time series concentrations are represented.

³ Two sets of samples were collected at 8th Street during the Dry Run, 10 minutes apart because while the volunteers were monitoring, the flow of water increased dramatically. The first sample had a concentration of $27 \mu\text{g/l}$ zinc.

The background concentration for **copper** in sea water is 2.0 µg/l. The Basin Plan standard established for Cu is 30 µg/l. Steinbeck Plaza and 8th Street⁴ outfalls were the only sites to have detectable copper concentrations, 35 and 127 µg/l respectively during the Dry Run event. Total copper concentrations in the First Flush samples ranged from <20 – 407 µg/l. Sixty percent of the First Flush samples exceeded the copper WQO. Similar to last year, all of the sites in Monterey, Pacific Grove, Seaside, Half Moon Bay and El Granada, exceeded the Basin Plan WQO for copper during the First Flush. Creekside and Capitola Pier in Capitola, Carbonero and Seagate in Scotts Valley, and 30th Avenue in Live Oak also exceeded the copper WQO. No site in Santa Cruz exceeded the copper WQO. Each year, Asilomar in PG has one of the highest copper concentrations. This year, it had the second highest concentration at 381 µg/l. Twin 51s in Monterey had the highest at 407µg/l and El Granada had the third highest at 317 µg/l. Copper concentrations in Santa Cruz and Capitola continue to be low (see Figure 5).

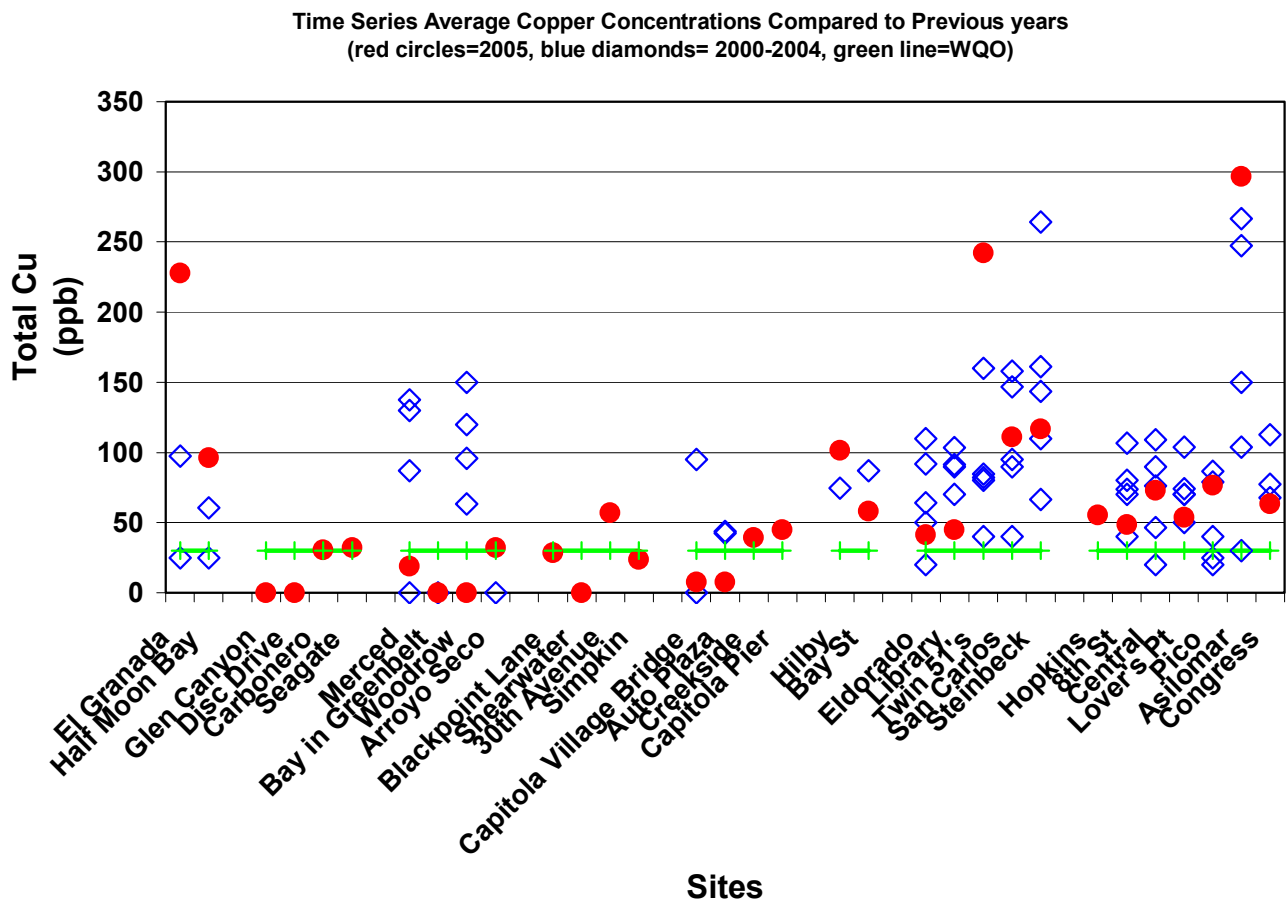


Figure 5. The sites are grouped by city from north to south(El Granada, HMB, Scotts Valley, Santa Cruz, Live Oak, Capitola, Seaside, Monterey, Pacific Grove). The Basin Plan Water Quality Objective for copper is 30 µg/l(ppb). Graph of 6-year trend. Time series average concentrations are represented.

⁴ Two sets of samples were collected at 8th Street during the Dry Run, 10 minutes apart because while the volunteers were monitoring, the flow of water increased dramatically. The first sample concentration was <20 µg/l for copper.

Total Lead The Basin Plan water quality objective for lead (Pb) is 30 µg/l. No site exceeded the Basin Plan WQO for lead during the Dry Run event. All of the sites reported < 5 µg/l except for 8th Street's⁵ second sample which was 12 µg/l. Lead concentrations ranged from < 5 - 87 µg/l during the First Flush. Eldorado (87 µg/l) and Twin 51s (62 µg/l) in Monterey had the highest concentrations. Hilby (57 µg/l) in Seaside and 30th Avenue in Live Oak (57 µg/l) had the third highest concentration. The sites in Half Moon Bay and Santa Cruz County all had very low lead concentrations except for the one Live Oak sample (see Figure 6).

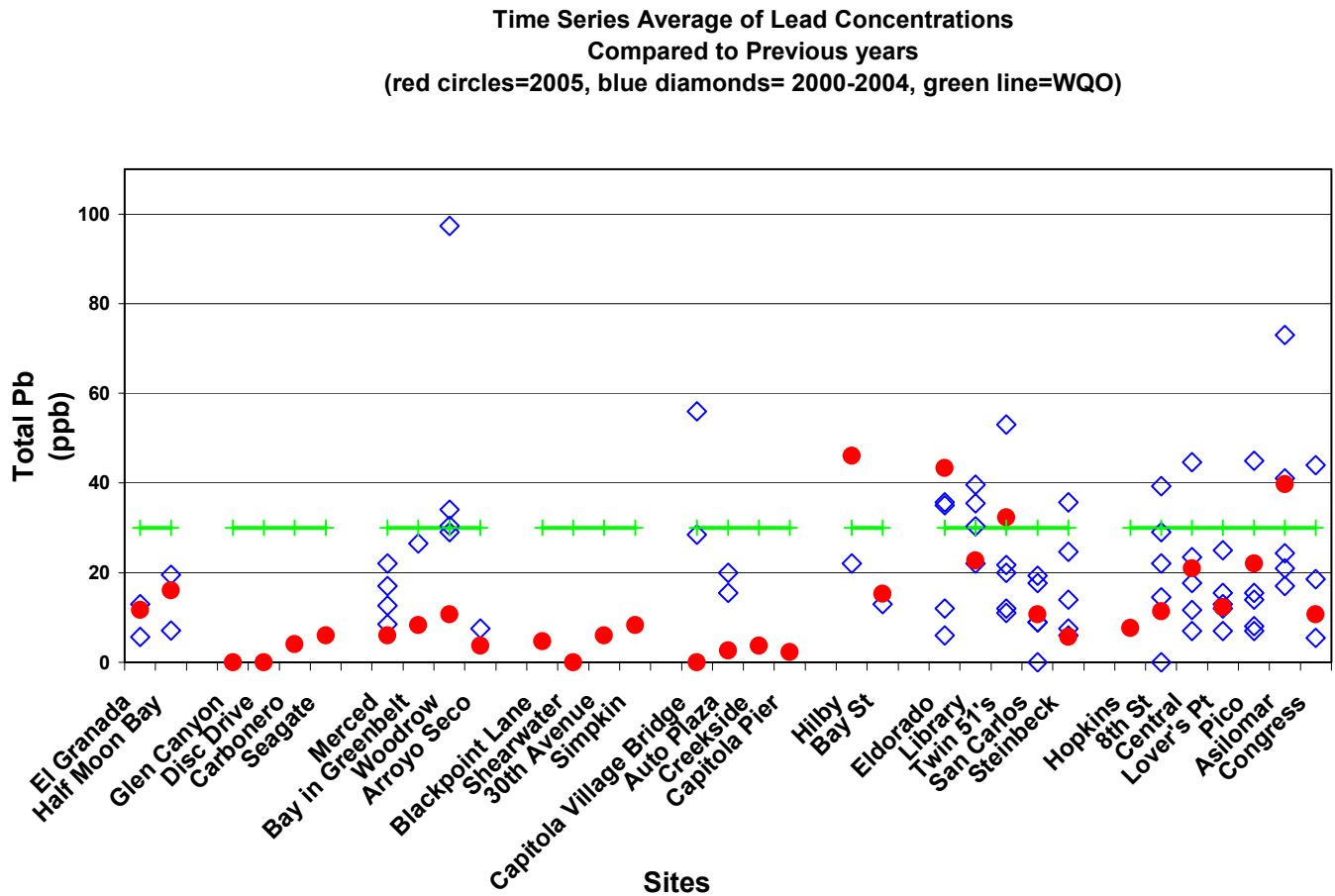


Figure 6. The sites are grouped by city from north to south(El Granada, HMB, Scotts Valley, Santa Cruz, Live Oak, Capitola, Seaside, Monterey, Pacific Grove). The Basin Plan Water Quality Objective for lead is 30 µg/l (ppb). Graph of 6-year trend. Time series average concentrations are represented.

⁵ Two sets of samples were collected at 8th Street during the Dry Run, 10 minutes apart because while the volunteers were monitoring, the flow of water increased dramatically. The first sample concentration was < 5 µg/l for lead.

Total Suspended Solids(TSS)

Total suspended solids (TSS) are important to measure because the suspended solids carry pollutants. The suspended solids provide a media or polar charge to attract contaminants. High amounts of sediment are harmful to fish populations because they destroy habitat, can suffocate eggs in fresh water systems, and/or limit the food supply. It also may clog gills or impair an organism’s vision when feeding. High TSS can mitigate metal toxicity.

Asilomar (618 mg/L (T2)⁶, 897 mg/L (T3)), and Pico (510 mg/L) in Pacific Grove, were the only sites to exceed the action level of 500 mg/l. TSS was lower at the majority of sites than previous years (see Figure 7).

Time Series Average of Total Suspended Solids Concentrations Compared to Previous years (red circles=2005, blue diamonds= 2000-2004, green line=WQO)

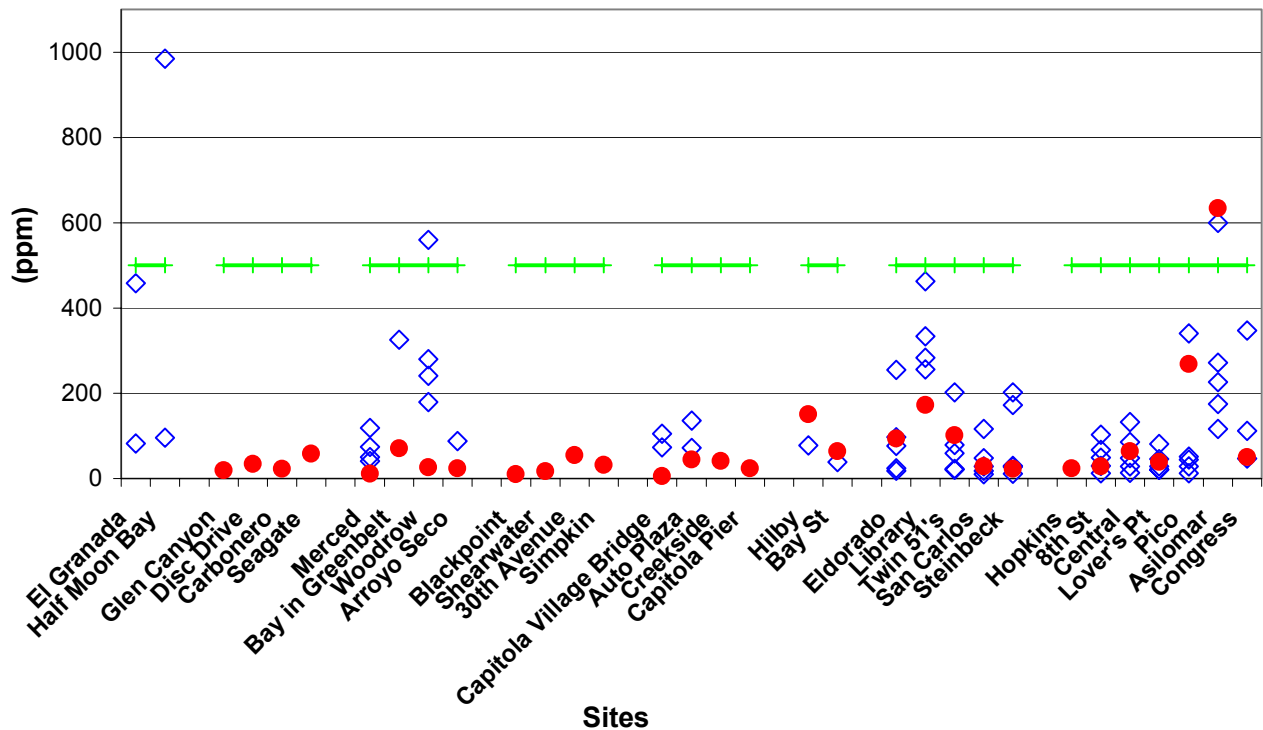


Figure 7. The sites are grouped by city from north to south(El Granada, HMB, Scotts Valley, Santa Cruz, Live Oak, Capitola, Seaside, Monterey, Pacific Grove). The CCAMP action level for TSS is 500 mg/l. Graph of 6-year trend. Average time series concentrations are represented

⁶ T1 represents the first time series sample collected. T2 represents the second time series sample collected. T3 represents the third time series sample collected.

Total Dissolved Solids (TDS)

Total dissolved solids are a measurement of the amount of very small particles ($< 0.45\mu\text{M}$), including salts such as sodium, chloride, calcium, carbonate, potassium, or magnesium in a sample of water. These dissolved ions are conductors of electricity and therefore the results can be compared to conductivity measurements taken with the pocket meter.

All of the total dissolved solids (TDS) samples except for the Library site in Monterey were below 1000 mg/l and decreasing during the First Flush. All but four of the sites were below 500 mg/l. The Library had the highest dissolved solids during its third time series. TDS increased from 617 mg/l (T1), then 668 mg/l (T2), increasing to 1400 mg/l (T3). In general, Scotts Valley, Santa Cruz, Live Oak, Capitola, and Seaside sites reported much lower TDS values than Monterey and Pacific Grove sites.

Visual Observations

At each site during the Dry Run and First Flush events, visual observations included trash, oil sheen, sewage (odor), and bubbles or scum. For the Dry Run event, trash was recorded at just one site (Woodrow), a sewage smell was reported at one site (Glen Canyon), oil sheen was not reported and bubbles/scum was reported at two sites (Merced and 30th Avenue). During the First Flush event, trash was observed at 7 sites, all in Santa Cruz County. The trash was identified as candy wrappers, plastic cups, bottles, and bags; cigarette butts, paper bag and a tennis ball. A sewage smell was reported during every time series at Black Point Lane and 30th Avenue in Live Oak. No oil sheen was reported at any sites and bubbles/scum was observed at six sites, all in Santa Cruz County.

Results by City

El Granada/Half Moon Bay

The First Flush occurred early in the season on the north coast of San Mateo County. The training for the volunteers was conducted on September 18th and the First Flush occurred two days later, on September 20th. Because of the early rain event, the Dry Run was not conducted in San Mateo County. The First Flush was truly the first rain of the season and approximately 0.25 inches of rain fell within a 6-hour window. The El Granada and Half Moon Bay teams both mobilized at approximately 4:00 PM. Total suspended solids analysis was not conducted on the samples. Nitrate concentrations fell well below the WQO of 2.25 ppm, while orthophosphate concentrations averaged about two times higher than the WQO of 0.12 ppm. Of the three metals that were analyzed, zinc (Zn) and copper (Cu) concentrations were above the WQO for every time series at both sites. Lead (Pb) concentrations were very low at both sites (see Figure 8). *E. coli* concentrations for all of the time series ranged between 92,000 to > 241,920 MPN/100ml at both sites. These were some of the highest concentrations measured at all of the sites during the First Flush events. Oil and grease samples were also analyzed by making a composite sample from each time series at each site. The El Granada site reported 1.8 ppm and the HMB site 3.5 ppm. These concentrations were the highest of all the sites as well.

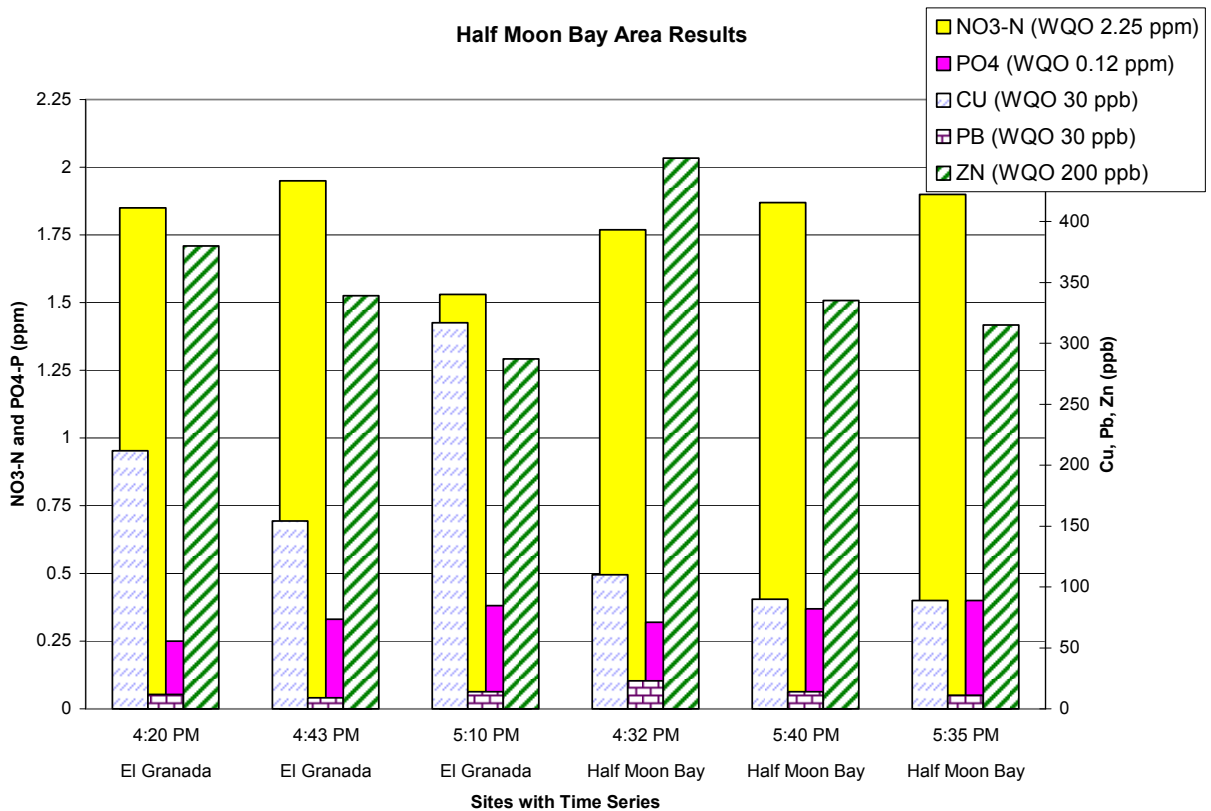


Figure 8. First Flush results at San Mateo county sites for each time series. Nitrate-N and orthophosphate-P results on the primary y-axis (left side) and Zn, Cu and Pb concentrations on the secondary y-axis (right side).

Scotts Valley

Four sites were monitored in the City of Scotts Valley both for the Dry Run event on September 24th and for the First Flush event on November 9th. During the Dry Run, there was flow at Glen Canyon, Disc Drive, and Carbonero, but not at Seagate. These sites had very low concentrations for all of the parameters during the Dry Run but orthophosphate. Orthophosphate values results were 0.15 mg-P/l at Glen Canyon, 0.44 mg-P/l at Carbonero and 0.68 mg-P/l at Disc Drive. Carbonero and Disc Drive orthophosphate results were the second and third highest concentrations detected during the Dry Run in all of the cities.

The First Flush was conducted a day later than the other Santa Cruz County sites. This was mostly due to the logistical constraints of no coordinator residing in Scotts Valley and lack of online weather reporting for that area. As in the other Santa Cruz County cities, Scotts Valley did experience several rain events prior to mobilizing on November 9th for the FF. With that said, nitrate concentrations were low during the FF but there was a significant spike in orthophosphate at the Glen Canyon site during the second time series sample. The concentration of 0.90 mg-P/l was in the top 10% of the highest concentrations in all cities during the FF. Zinc and lead concentrations were all below their WQOs, however, the copper WQO was exceeded in the first two time series at both the Carbonero and Seagate sites (see Figure 9). At the other two locations, copper and lead were not detected. Oil and grease was only detected at Glen Canyon (1.1 ppm) and at Carbonero (1.9 ppm). E. coli concentrations ranged between 2000 and 5000 MPN/ 100 ml.

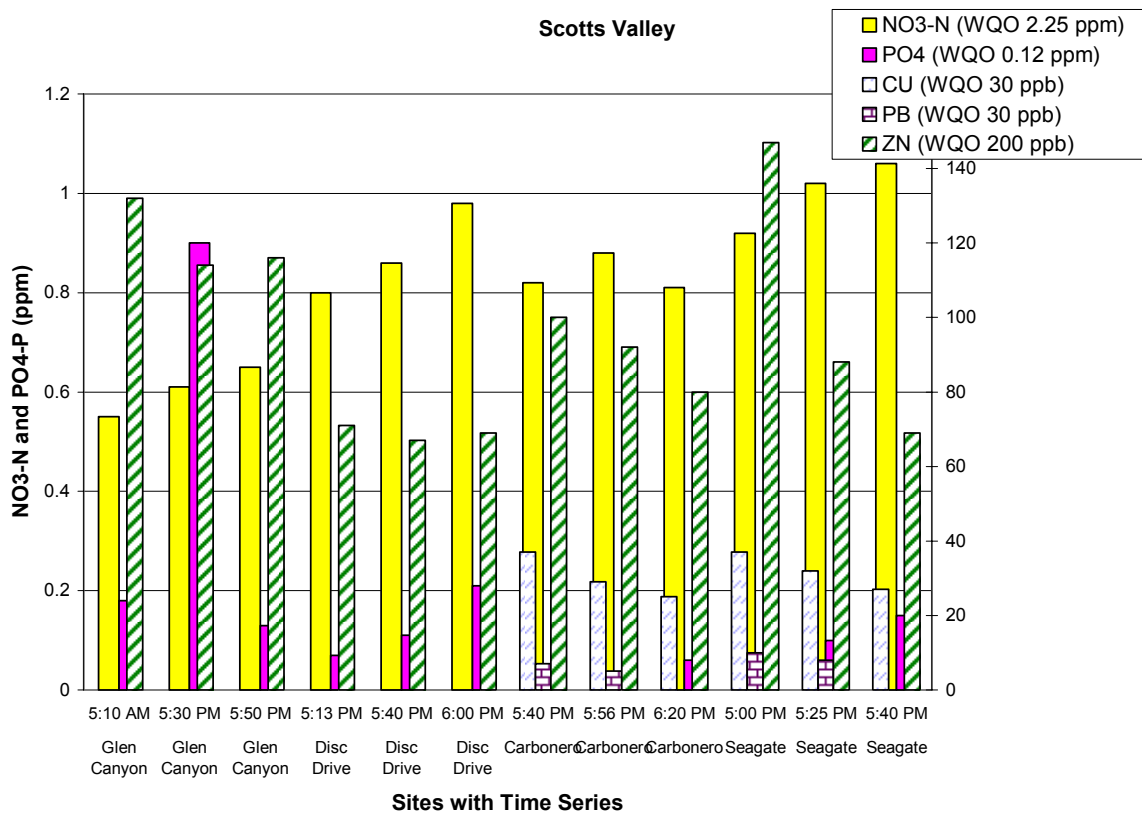


Figure 9. First Flush results at Scotts Valley sites for each time series. Nitrate-N and orthophosphate-P results on the primary y-axis (left side) and Zn, Cu and Pb concentrations on the secondary y-axis (right side).

Santa Cruz

Four sites were monitored in the City of Santa Cruz both for the Dry Run event on September 24th and for the First Flush event on November 8th. During the Dry Run, there was flow at Merced, Bay St Greenbelt and Woodrow. There was no flow at the Arroyo Seco site. Merced had the 2nd highest *E. coli* concentration (39,726 MPN/100ml) of all the cities during the Dry Run. All three Santa Cruz sites had elevated nitrate concentrations compared to other cities. The second highest concentration detected during the Dry Run was at Merced with a concentration of 4.97 mg-N/l.

The First Flush volunteers were finally mobilized after several false starts that began on October 14th. Five small rain events occurred within the Monterey Bay region in October and early November. None caused sheeting rain on the roadways and all were short in duration. Climatological data⁷ reported the City of Santa Cruz received 0.12 inches of rain in October.

The First Flush time series samples showed low concentrations of nitrate at all of the sites and concentrations of orthophosphate higher than the WQO at all of the sites except Woodrow. Metals concentrations were low in all samples at all of the sites (see Figure 10). *E. coli* concentrations during the FF were all well above the WQO with the highest being documented during the second time series at Woodrow at 129,965 MPN/100ml. This value falls within the top 10% of the highest concentrations detected during the FF. No Oil & Grease was detected at any site in Santa Cruz.

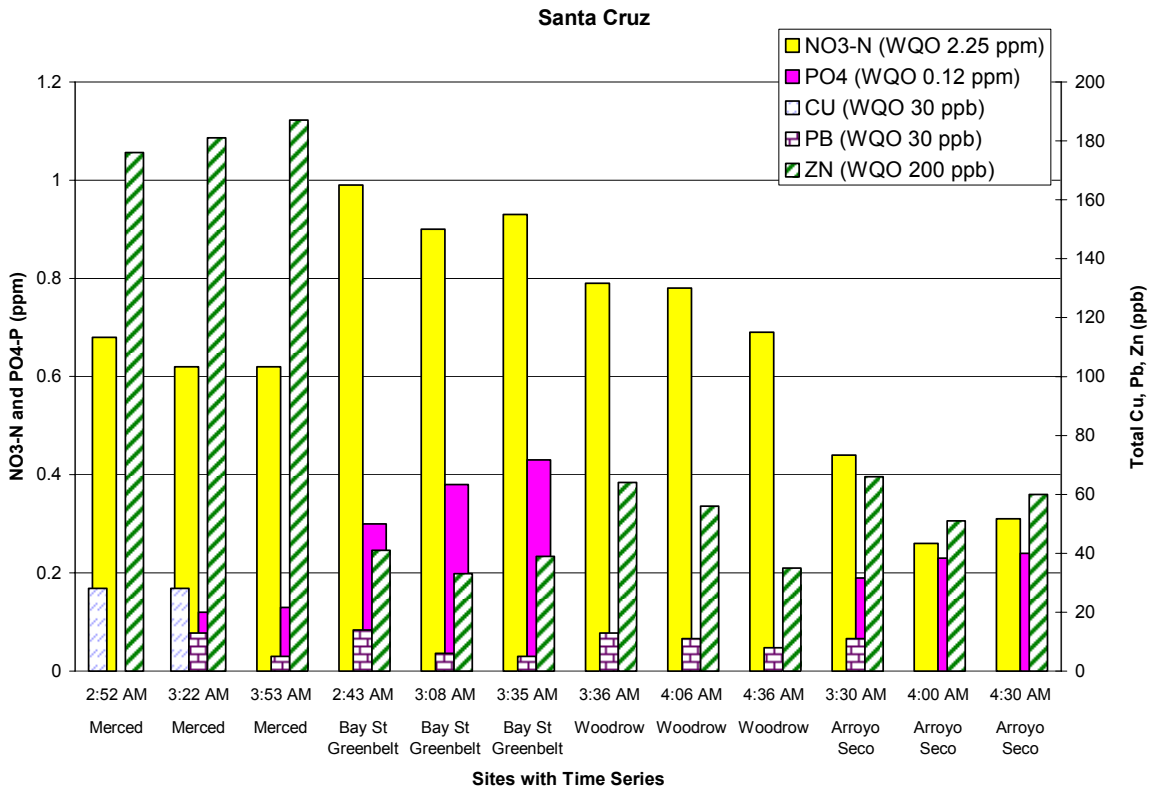


Figure 10. First Flush results at Santa Cruz sites for each time series. Nitrate-N and orthophosphate-P results on the primary y-axis (left side) and Zn, Cu and Pb concentrations on the secondary y-axis (right side).

⁷ NOAA National Climate Data Center

Live Oak

Four sites were monitored in Live Oak for both the Dry Run event on September 24th and for the First Flush event on November 8th. During the Dry Run, there was only flow at the 30th Avenue site, the other three sites were dry. All of the parameter concentrations were either non-detect or very low during the Dry Run except for *E. coli* which was 2,627 MPN/100ml.

During the First Flush, nitrate concentrations were all below the WQO. Orthophosphate concentrations fluctuated slightly between time series at each site, but in general were high at three of the four sites. Blackpoint's first time series orthophosphate sample was 1.07 mg-P/l. This site was one of the top three of all the FF sites for orthophosphate. The zinc WQO was exceeded in the second time series sample at 30th Avenue. The copper WQO was also exceeded in that sample as well as the third time series sample. Lead concentrations were low throughout all of the Live Oak sites (see Figure 11). The highest *E. coli* concentrations in Live Oak were found at 30th Avenue, ranging from 48,844 to 86,644 MPN/100ml during all three time series. Oil and grease was not detected in Live Oak.

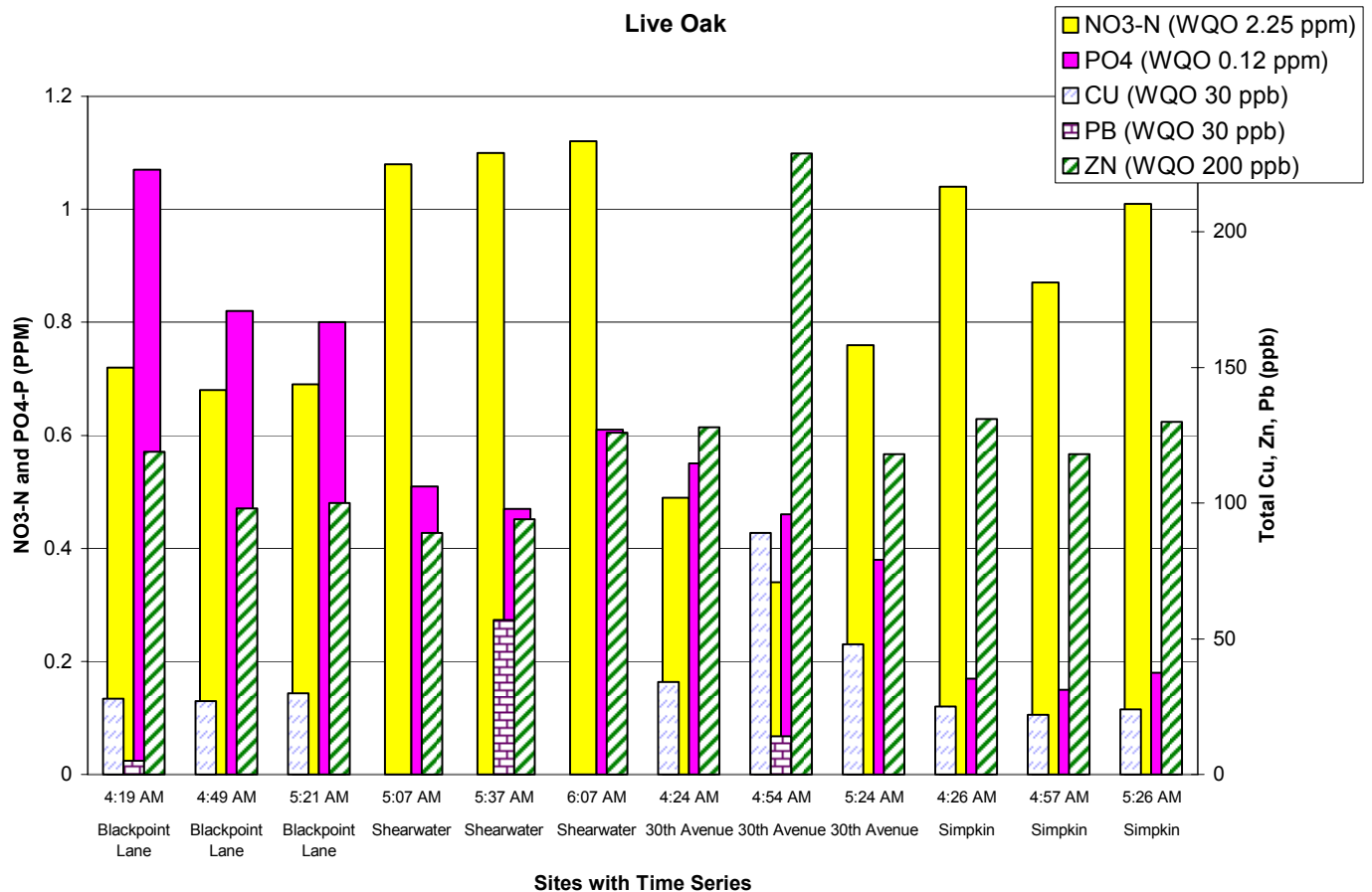


Figure 11. First Flush results at Live Oak sites for each time series. Nitrate-N and orthophosphate-P results on the primary y-axis (left side) and Zn, Cu and Pb concentrations on the secondary y-axis (right side).

Capitola

Four sites were monitored in Capitola for both the Dry Run event on September 24th and for the First Flush event on November 8th. During the Dry Run, there was flow at Creekside and Capitola Pier, but not at Auto Plaza and Capitola Village Bridge. Concentrations for *E. coli*, orthophosphate, zinc, copper, and lead were all below the WQO during the Dry Run. There was however, high nitrate detected at Creekside at a concentration of 6.16 mg-N/l. This was the highest nitrate concentration detected during the Dry Run.

First Flush results show low concentrations of nitrate at all of the sites except Capitola Village Bridge where the third time series reported a concentration of 2.31 mg-N/l. Orthophosphate was also below the WQO in many of the samples except for the second and third time series at Creekside where concentrations of 1.24 and 0.64 mg-P/l were detected. The highest *E. coli* concentrations were detected during the first and second time series at Capitola Village Bridge with concentrations of 17,233 and 12,356 MPN/100ml. Lead concentrations were non-detect at most locations. Copper was detected at Creekside and Capitola Pier but was just over the WQO. However, the WQO for zinc was exceeded at the Capitola Village Bridge with concentrations of 316 ppb during the first time series dropping to 263 ppb during the third time series (see Figure 12). Oil and grease was not detected in Capitola.

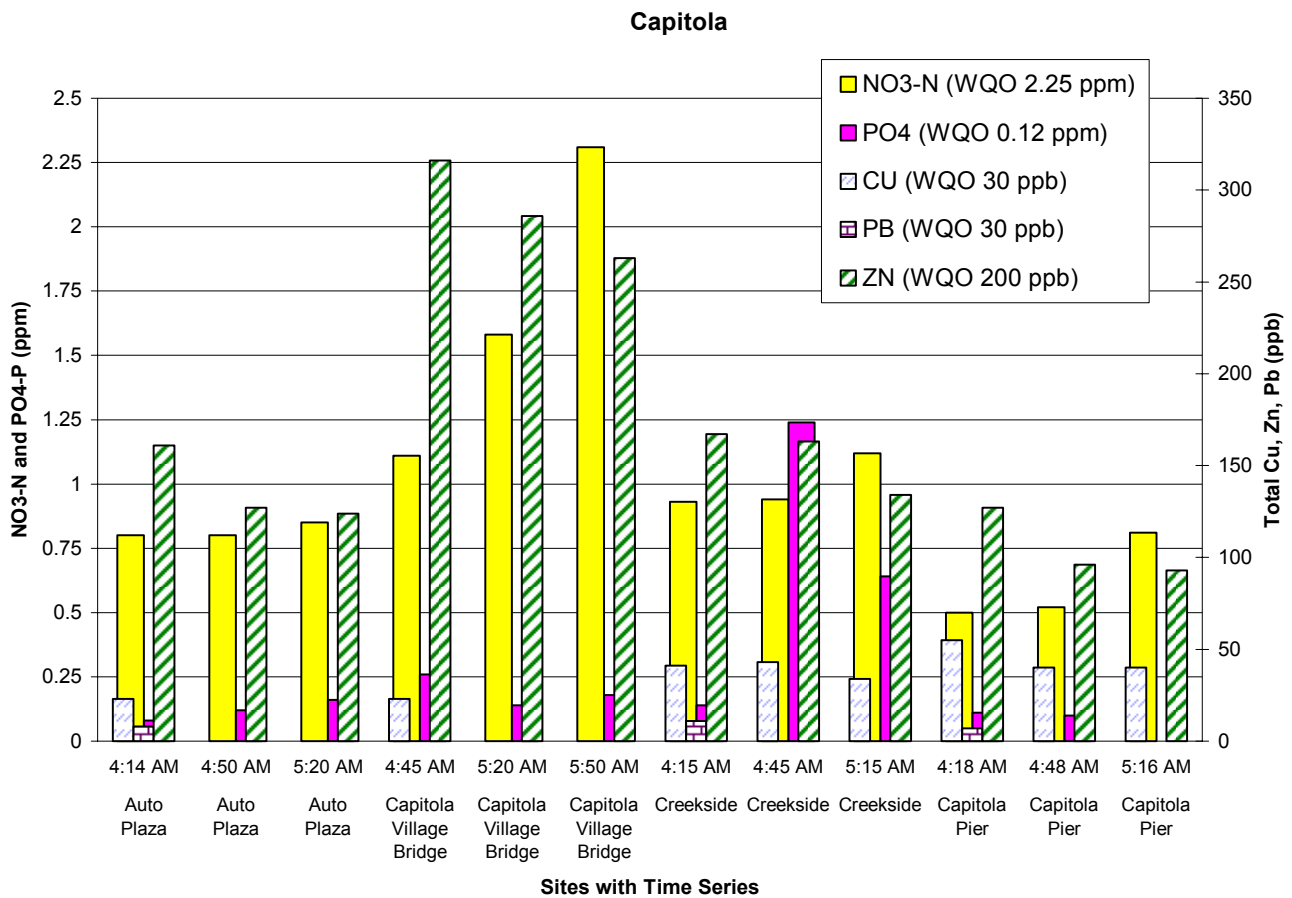


Figure 12. First Flush results at Capitola sites for each time series. Nitrate-N and orthophosphate-P results on the primary y-axis (left side) and Zn, Cu and Pb concentrations on the secondary y-axis (right side).

Seaside

Two sites were monitored in Seaside, both for the Dry Run event on September 24th and for the First Flush event on November 9th. During the Dry Run, the Bay Street culvert had sea water flowing up into the channel and Hilby was dry, so no samples were collected.

The First Flush occurred on November 9th at approximately 7:00 AM. There had been a few showers the day before when Monterey and Pacific Grove mobilized for the First Flush, but there was not enough runoff to sample in Seaside on November 8th. The rain was more intense on November 9th with approximately 0.30 inches of rain accumulating in 12 hours. The volunteers were on site when approximately 0.10 inch of rain had fallen. Nitrate concentrations were all well below the WQO. The orthophosphate concentrations exceeded the WQO for every time series sample at both sites except for the first one at Bay Street. All three of the lead time series samples and two of the zinc samples at Bay Street were in the top 10% for those parameters of all of the FF sites. The WQO for all three metals was exceeded at both sites during each time series except for lead at Hilby (see Figure 13). Oil and grease was detected at both sites at concentrations of 1.8 ppm at Bay St. and 2.0 ppm at Hilby. Both sites reported very similar *E. coli* concentrations ranging from 20,000 to 50,000 MPN/100 ml.

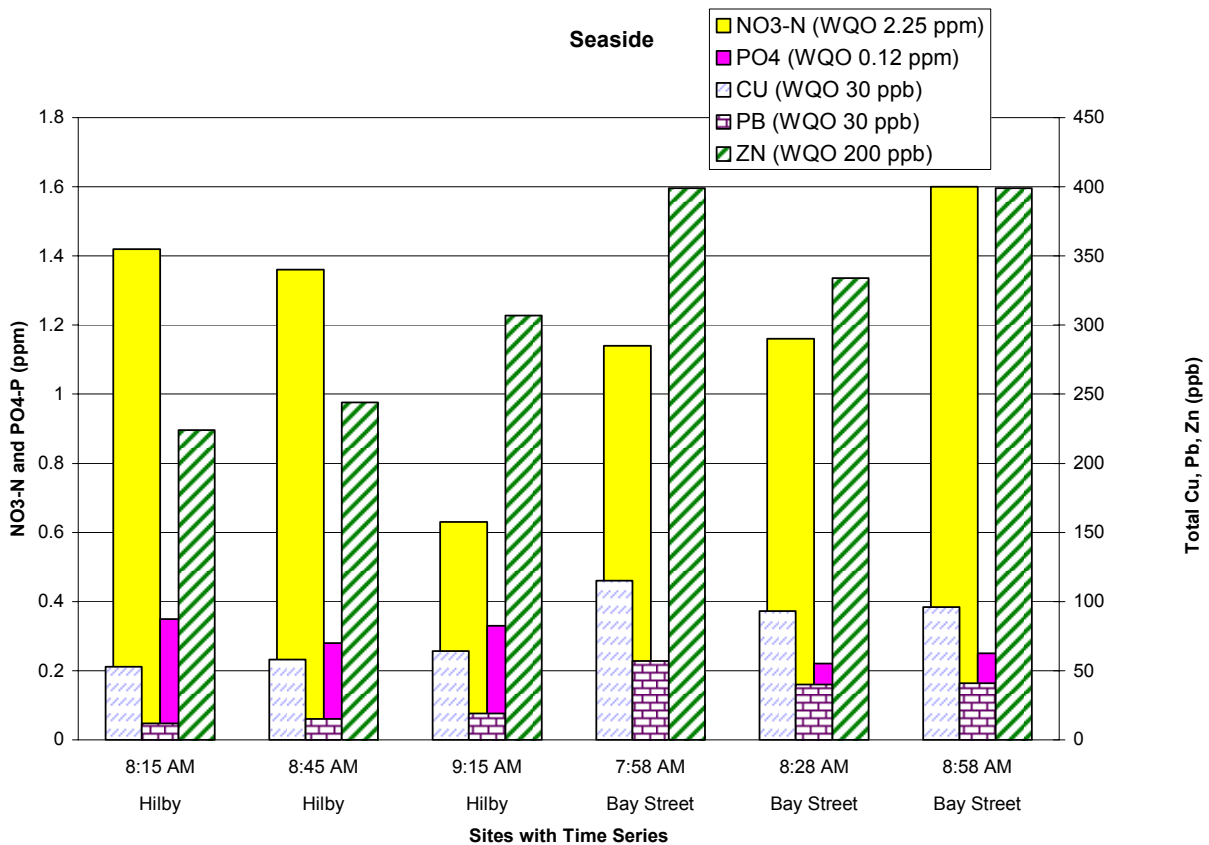


Figure 13. First Flush results at Seaside sites for each time series. Nitrate-N and orthophosphate-P results on the primary y-axis (left side) and Zn, Cu and Pb concentrations on the secondary y-axis (right side).

Monterey

The Dry Run and First Flush were conducted at five sites in Monterey. All of the sites were flowing in September during the Dry Run. *E. coli* concentrations were very high at three of the sites; Twin 51s (13,733 MPN/100 ml), Library (19,608 MPN/100 ml) and Steinbeck Plaza (48,391 MPN/100 ml). Nitrate concentrations were very low. Three sites exceeded the WQO for orthophosphate with Twin 51s (0.35 mg-P/l) and Steinbeck Plaza (0.86 mg-P/l) being the highest. All of the samples were non-detect for lead. Twin 51s and Steinbeck Plaza both exceeded the copper WQO and had detectable concentrations of zinc but did not exceed the WQO. Of all of the sites monitored for the Dry Run, Steinbeck Plaza and the Library reported the lowest transparency readings of 31 cm and 34.6 respectively.

The First Flush occurred on November 8th with volunteers mobilizing at approximately 4:30 AM. As reported for the other cities, the rain event occurred after several smaller storms during the month of October and early November. Even with this storm, the watersheds draining to the Twin 51s and west, received quite a bit more intense rain during the FF than the Library and Eldorado site, which probably explains some of the results. During the FF, zinc and copper concentrations were very high at several Monterey sites. The third time series at the Twin 51s had the highest copper and zinc concentrations of all of the sites sampled during the First Flush. Nitrate concentrations were very low, yet orthophosphate concentrations were high at 3 of the 5 sites. Steinbeck Plaza reported the highest orthophosphate concentrations in all of the nine cities (see Figure 14). Oil and grease was only detected at Steinbeck Plaza at a concentration of 1.1 ppm. *E. coli* ranged from 844 MPN/100 ml at Eldorado to 86,664 MPN/100 ml in the first time series at Steinbeck Plaza.

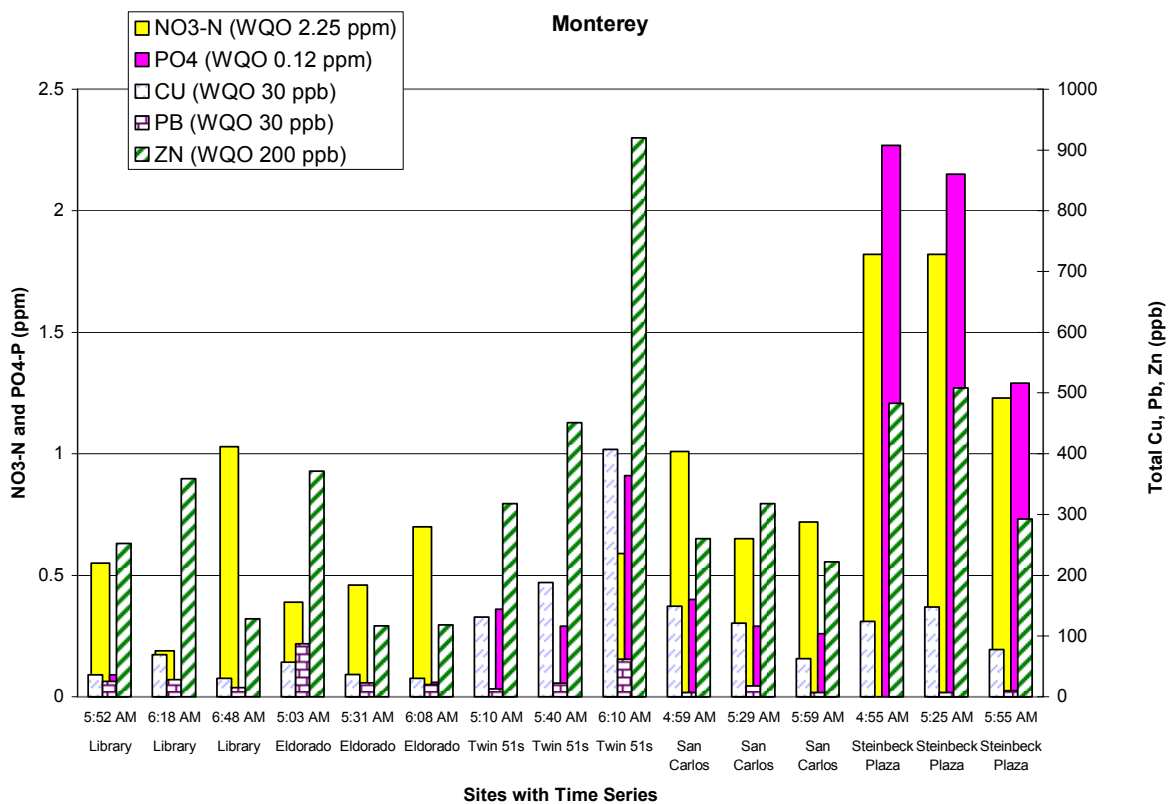


Figure 14. First Flush results at Monterey sites for each time series. Nitrate-N and orthophosphate-P results on the primary y-axis (left side) and Zn, Cu and Pb concentrations on the secondary y-axis (right side).

Pacific Grove

Five of the seven sites were monitored during the Dry Run and all were flowing. Lover's Point and Hopkins were only monitored during the First Flush because Lover's Point was no longer being diverted to Monterey Regional Water Pollution Control Agency and Hopkins was added due to the interest of the Monterey Bay Aquarium staff. *E. coli* concentrations were high (>1500 MPN/100 ml) at three of the five sites. Copper and zinc was only detected in the second sample at 8th Street and the concentrations were quite high (127 and 382 µS respectively). Nitrate concentrations were all below the action level but orthophosphate exceeded the action level at the same three sites as the *E. coli* exceedences; Greenwood Park, 8th Street and Asilomar.

The First Flush occurred on November 8th with the volunteers mobilizing at approximately 4:30 AM. Pacific Grove received approximately 0.3 inches of rain. As reported for the other cities, the rain event occurred after several smaller storms during the month of October and early November. Copper and zinc concentrations were the highest at Asilomar and Congress. Asilomar also had consistently higher lead concentrations than the other sites. Nitrate concentrations were all below the action level while orthophosphate concentrations were quite high at the four sites on the north side of the peninsula (first four sites from left to right in Figure 15). Lover's Point, Pico and Congress all had *E. coli* concentrations greater than 110,000 MPN/100 ml. Oil and grease was only detected at Congress with a concentration of 1.1 ppm.

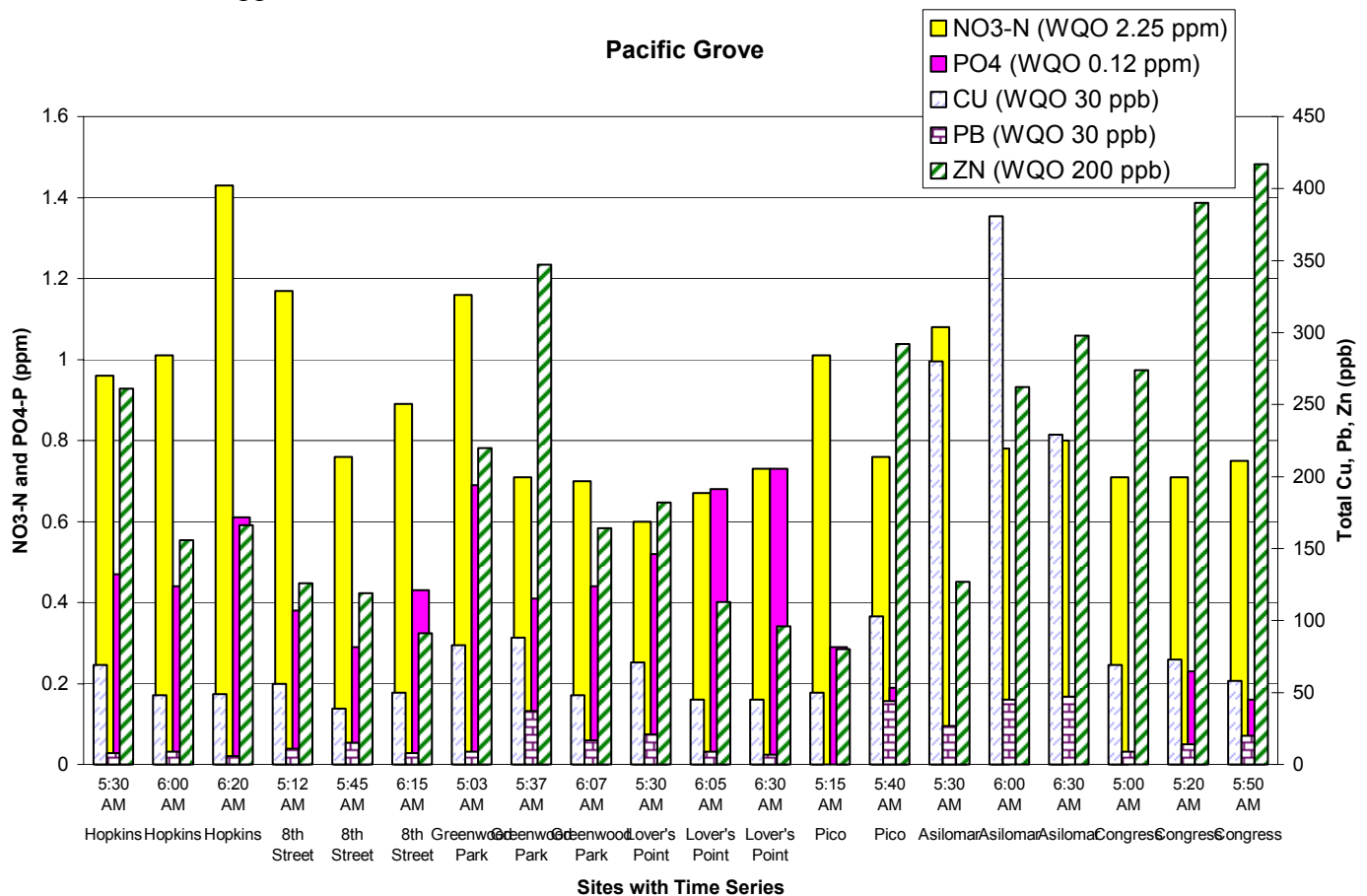


Figure 15. First Flush results at Monterey sites for each time series. Nitrate-N and orthophosphate-P results on the primary y-axis (left side) and Zn, Cu and Pb concentrations on the secondary y-axis (right side).

Conclusions

Results from the Dry Run were very good. Either sites did not have flowing water (a good sign in and of itself) or when they did, at most locations the concentrations did not exceed the water quality objectives. There were a few exceptions; Steinbeck Plaza in Monterey was high in *E. coli*, Creekside in Capitola had a high nitrate concentration, Scotts Valley had high orthophosphate values, and 8th Street in Pacific Grove had high copper and zinc values. 8th Street is a good example of how dynamic the storm drain system is and how conditions can change instantly. During the Dry Run, while the volunteers were on site, a very apparent change occurred when the flow of water and the turbidity increased dramatically. Observing this, the volunteers collected a second set of samples with results showing that the metal concentrations and total suspended solids increased five-fold.

2005 was a challenging year for the FF program. First, more cities than ever participated in the program. While a sure indication of the program's value, these new sample sites strained tight resources. Second, the weather leading up to the FF events was challenging. Ideally, the FF event is triggered by one large storm that comes after the long dry summer. However this year, there were several rain events that did not warrant mobilization but may have begun to wash away the accumulated pollutants normally captured during the FF sampling. This thought is substantiated by a comparison of results from the FF event in HMB versus the rest of the sites. HMB truly monitored the First Flush on September 20th, when the area received approximately 0.25 inches of rain. It was the first rain of the season and the results show higher concentrations than previous years. The oil and grease results were the highest of all the cities as well as *E. coli*, copper and zinc. In previous years, these concentrations were lower than the other cities.

Each of the cities has hotspot outfalls that warrant additional follow up to identify sources of pollutants. Because the dry-run was missed in HMB, dry weather monitoring is warranted to determine the concentrations in the runoff prior to the rains. In Scotts Valley, Carbonero had high orthophosphate during the Dry Run and high copper and oil and grease during the First Flush. In Santa Cruz, Merced had the second highest *E. coli* and nitrate concentrations of all the sites during the Dry Run. The hot spot in Live Oak was 30th Ave. which had high *E. coli*, copper and zinc concentrations. In Capitola, Creekside had high nutrient concentrations while Capitola Village Bridge had high *E. coli* and zinc. The two sites in Seaside had very similar results for all of the parameters with high metal results at both sites during the FF. In Monterey, Steinbeck Plaza currently is undergoing an upstream copper and zinc study but Twin 51s warrant additional monitoring for metals and orthophosphate. Finally, in Pacific Grove, the Urban Watch program will watch 8th Street more carefully during the dry weather and Asilomar warrants more upstream monitoring for the high metal concentrations.

In general, after six years of collecting water quality data, metal concentrations continue to be much lower in Santa Cruz County than in Monterey County. High *E. coli* and orthophosphate concentrations are more wide spread during both the dry and wet weather flows. This pattern is also apparent in results from the Snapshot Day event as well. Results from the annual citizen monitoring water quality events are producing valuable data that should now be used by local jurisdictions to try to track the sources of the pollutants and reduce the concentrations at the source.

Attachment 1

<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>
El Granada	EG 1			Surface drainage	Open ditch upstream of a major outfall at Surfers Beach along Highway 1 in El Granada	Ocean
Half Moon Bay	HMB1			Concrete pipe	Storm drain in Half Moon Bay at Main Street and Pilarcitos Creek	Creek
Glen Canyon (Scotts Valley)	SVSD-01			Metal Culvert	Metal culvert discharging to Evers Creek Creek; Off Glen Canyon Rd.; End of culvert; mid-system.	Creek
Disk Drive (Scotts Valley)	SVSD-02			Concrete pipe	Concrete culvert discharging to Carbonera Creek; Off Disc Dr.; End of culvert; mid-system.	Creek
Carbonero (Scotts Valley)	SVSD-03			Metal Culvert	Metal culvert discharging to Carbonera Creek; Off Carbonero Way; End of culvert; mid-system.	Creek
Seagate (Scotts Valley)	SVSD-05			Metal Culvert	Metal culvert discharging to Carbonera Creek; Along El Pueblo Dr.; End of culvert; mid-system.	Creek
Delaware (Santa Cruz)	SCSD1	352	90% residential 5% commercial 5% open space	Concrete pipe	On S side of W. Cliff Dr. at Monterey St.	Creek
Arroyo Seco (Santa Cruz)	SCSD6					
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
Bay Street Greenbelt	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
Blackpoint (Live Oak)	LOSD-03	37	70% residential 30% commercial	Surface drainage	Surface drainage, passing thru concrete culvert; end of culvert, <1000' from end of system.	Ocean
Shearwater (Live Oak)	LOSD-04	69	100% residential	Corrugated metal and concrete pipe	Corrugated metal pipe/concrete pipe join together; collect 'joint' flows below join, <500' from end of system.	Lagoon
30 th Avenue (Live Oak)	LOSD-05	390	40% residential 60% commercial	Surface drainage	Surface drainage, passing thru concrete culvert; end of culvert, <500' from end of system.	Lake
Simpkin's (Live Oak)	LOSD-07	110	50% residential 50% commercial	Surface drainage	Surface drainage, passing thru concrete culvert; end of culvert mid- system.	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
Creekside (Capitola)	CSD-06		95% residential 5% open space	Corrugated metal pipe		Creek
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	Lake

					Lane and Eldorado Street	
Twin's (Monterey)	MSD3	365	90% residential 10% commercial	Two 51" diameter concrete pipes	Below walking path at Heritage Harbor-adjacent to Wharf I, west ~500ft.	Ocean
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
8th Street (Pacific Grove)	PGSD1	35	100% residential	Concrete pipe	West of Ocean View Blvd. between 7th and 8th.	Ocean
Central & 13 th (aka Greenwood) (Pacific Grove)	PGSD2	250	90% residential 10% commercial	Concrete pipe	Greenwood Park at the corner of 13th 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 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 2a – 1st page of Field Data Sheet

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

Attachment 2b – 2nd page of Field Data Sheet

Changes Over Time			Station ID							
			(answer yes or no to the observations below)					FLOW (cm)		
Time	Conductivity (μ S)	Murkiness	Rain	Trash	Sewage	Oil Sheen	Bubbles/Scum	Velocity (gpm)	Depth (cm)	Width (cm)
Sample collection for one time series:										
Sample ID	Time	Collected by:	Container Type							
			clear 100 ml - bacteria							
			sq. white plastic 250 ml - metals							
			sq. white plastic 1 L - nutrients/TDS,TSS							
Duplicates or Blanks collected: Yes or No										
Sample Custody:										
Relinquished By:			Date /Time			Received By:			Date/Time	

Attachment 3

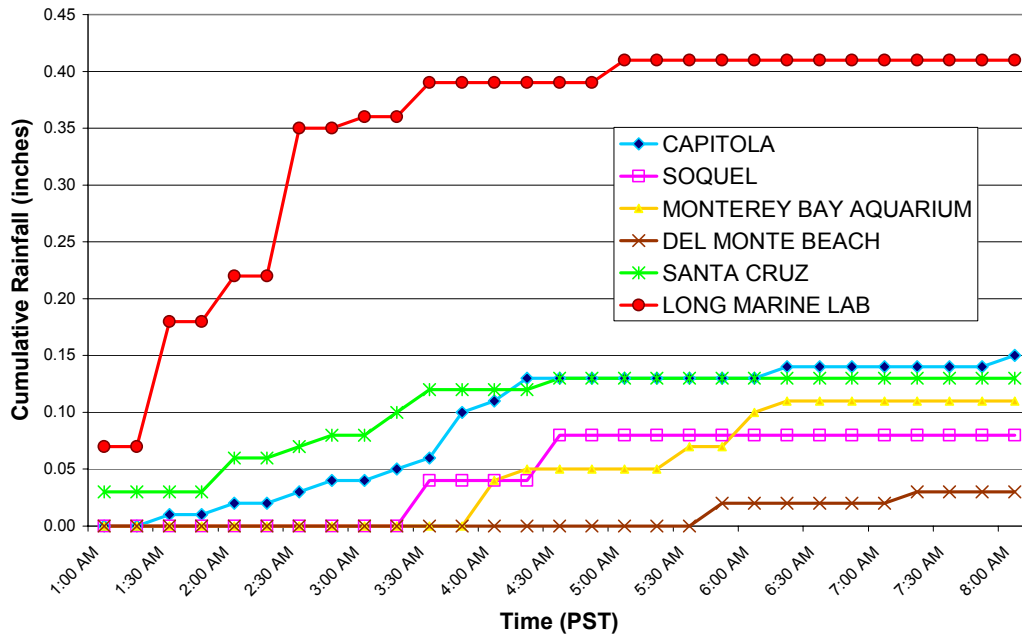
METHODS USED IN THE FIRST FLUSH 2003 SAMPLING EVENT

	Constituent	Detection Limits	Units	Laboratory	Method #	Method Principles
Field Measurements						
	Conductivity	10	µS	Field		Electrodes
	Water Temp.	- 5	°C	Field		Spirit bulb
	pH	4.5		Field		Non-bleeding test strips
	Transparency	2	Cm	Field		Transparency tube
Nutrients						
	Nitrate as N	0.05	mg/l	Monterey Bay Analytical	EPA 300.0	
	Orthophosphate as P	0.05	mg/l	Monterey Bay Analytical	EPA 300.0	
Bacteria						
	Total coliform	1	MPN/100 ml	Monterey Bay Analytical	Colilert	Chromogenic Substrate
	E. coli	1	MPN/100 ml	Monterey Bay Analytical	Colilert	Chromogenic Substrate
Total Metals						
	Zinc	20	µg/l	Monterey Bay Analytical	SM3111B ⁸	acid digestion, AA flame
	Copper	20	µg/l	Monterey Bay Analytical	SM3111B	acid digestion, AA flame
	Lead	5	µg/l	Monterey Bay Analytical	SM3113B	acid digestion, graphite furnace
Other WQ parameters						
	total suspended solids (TSS)	10	mg/l	Monterey Bay Analytical	SM2540D	Gravimetric: filtration thru 1.1µm, glass fiber drying and weighing of particulates
	total dissolved solids (TDS)	10	mg/l	Monterey Bay Analytical	SM2540C	Gravimetric: drying and weighing of 1.1µm filtrate
	Polynuclear Aromatic Hydrocarbons	5.0	µg/l	BSK Analytical	EPA 8270	
	Oil and Grease	1	mg/l	Monterey Bay Analytical	EPA 1664	

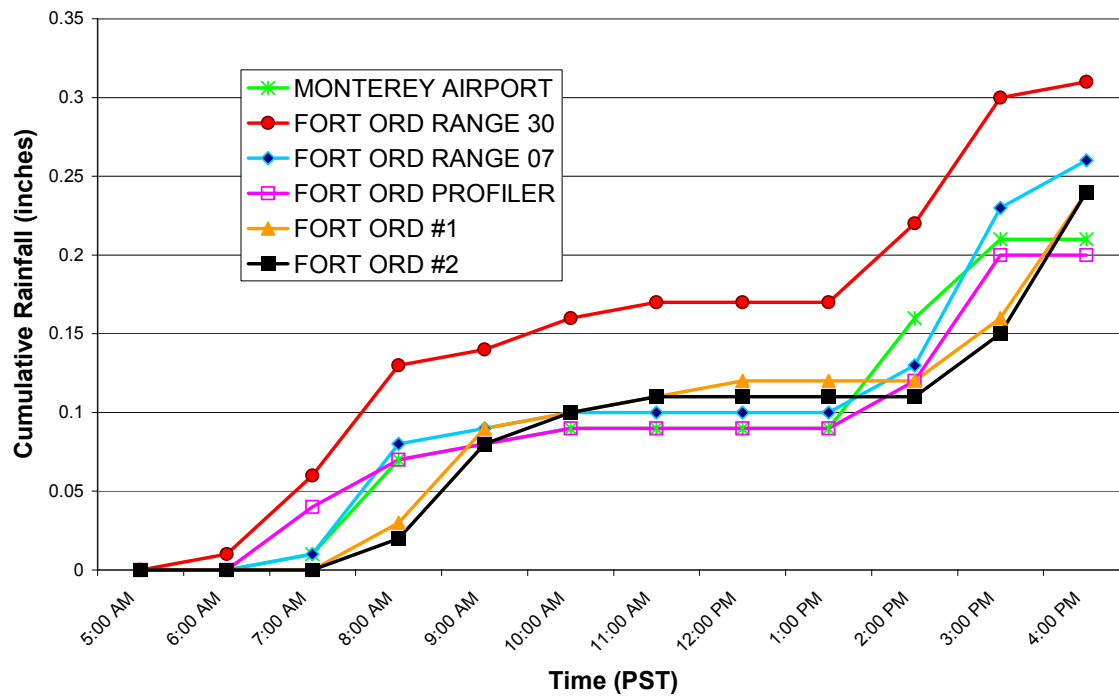
⁸ Standard Methods for the Examination of Water and Wastewater 20th Edition

Attachment 4 – Rainfall Graphs⁹

First Flush 2005 Rainfall (November 8)



First Flush 2005 Rainfall (November 9)



⁹ Graphs produced by Jeff Lerner, Meteorologist, Fleet Numerical, Monterey