Monterey Bay Sanctuary Citizen Watershed Monitoring Network

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First Flush Report

October 10, 2000

In the Cities of
Monterey, Pacific Grove and Capitola, CA

Made Possible by the:
Monterey Bay National Marine Sanctuary
Cities of Pacific Grove, Monterey and Capitola
Central Coast Regional Water Quality Control Board
CA State Water Resources Control Board
United States Environmental Protection Agency Region 9
California Coastal Commission
Coastal Watershed Council

Executive Summary

In the early morning hours of Tuesday, October 10, 2000 the Monterey Bay Sanctuary Citizen Watershed Monitoring Network conducted a First Flush sampling event in the cities of Pacific Grove, Monterey and Capitola, CA. The term, "First Flush", is used to describe the first significant rain of the season in which months of accumulated contaminants are washed into coastal waters. These contaminants include oils, bacteria, nutrients, metals, sediment, and numerous other chemicals that are discarded onto parking lots, streets and yards.

The First Flush was a pilot program initiated by the Monterey Bay Sanctuary Citizen Watershed Monitoring Network (Network), with funding provided by the Monterey Bay National Marine Sanctuary (Sanctuary), the Cities of Pacific Grove and Monterey, the US EPA and the Central Coast Regional Water Quality Control Board (RWQCB). The Network was assisted by the Coastal Watershed Council in organizing and training over 40 volunteers to collect water samples at 12 different stations in three cities. These cities were chosen because they have an existing Urban Watch program in which volunteers collect samples of urban runoff throughout the dry weather season each year.

Twenty-five volunteers were mobilized at 5:00 AM on Tuesday morning with equipment pre-staged at the team leaders' homes. The teams met at their designated stations and began collecting data. On station, they measured water temperature, conductivity, pH, and transparency. They recorded weather conditions, estimated flow rates and other physical observations. Water samples were collected for laboratory analysis of Nitrate (NO_3-NO_3), Orthophosphate (PO_4-P), Total coliform, Escherichia coli. (E. coli), total dissolved solids (TDS), total suspended solids (TSS), oil and grease, zinc, copper, iron, and lead.

The results indicate that nutrient and metal concentrations in the storm water flowing into the Sanctuary was cleaner than First Flush events in other California cities. Copper levels exceeded the Basin Plan standard at 6 of 10 stations ranging from 20 μg/l to 60 μg/l. Concentrations of zinc and lead exceeded the Basin Plan standard at just one station for each of the metals. Oil and grease was detected at concentrations less than 5 ppm at two outfalls in Pacific Grove. Nitrate levels were all below 10 ppm, which is the Action Level established by the Central Coast Ambient Monitoring Program (CCAMP) for nitrate (NO_3 -NO_3). Orthophosphate levels exceeded the CCAMP Action Level at 10 of 12 stations. Concentrations of orthophosphate ranged from 0.15 ppm to 2.72 ppm. All of the stations had levels greater than 24,000 MPN/100 ml for Total coliform. E. coli. levels exceeded 24,000 MPN/100 ml at all of the stations except for the two in Capitola and one in Monterey.

This First Flush event was a very successful pilot program organized by the Monterey Bay Sanctuary Citizen Watershed Monitoring Network. The goals of this effort were to collect information about the constituents of storm water runoff being discharged into the Sanctuary during a first flush, as well as to create a public awareness of human impacts

on the environment. The information collected during this event will be disseminated to local resource agencies and city governments. It may aid in tracking pollution sources as well as targeting educational outreach efforts. The dedicated volunteers provided a valuable set of information that might never be known without their participation. They also set an example for others through their actions and concern for the environment. Because of them, we have a better understanding of what is flowing into the Sanctuary. Our goal is to make this an annual event which will provide more data for decision makers to enhance outreach programs and mitigate pollution sources, ultimately reducing the pollutant load flowing into the Monterey Bay National Marine Sanctuary.

Background

In the past decade it has become apparent to environmentalists and government officials that urban runoff is one of the leading sources of water pollution in this nation. This pollution may contain toxic metals, hydrocarbons, nutrients, suspended solids and many other constituents that are detrimental to the marine environment. Urbanization and increases in population directly affect the type of pollution that enters storm drains. Impermeable surfaces such as roads, prevent storm water from soaking into the ground. These surfaces become conduits for toxics, some examples are oil and grease that wash off roads, fertilizers and pesticides from lawns, and detergents from restaurants. Non-point source pollution is now the nation's leading threat to water quality.

It is important to learn what is in urban runoff flowing into the Sanctuary. A dry weather monitoring activity, called Urban Watch, has been conducted by citizen monitors for the past four years in Monterey, two years in Pacific Grove, and one year in Capitola. The pollution detection kit that is used for Urban Watch was developed according to the National Pollutant Discharge Elimination System (NPDES) Phase 1 dry weather monitoring requirements and is designed to detect illegal storm drain connections and discharges. Because of this program, it is generally known which outfalls commonly discharge urban runoff that contains contaminants and education efforts are under way to reduce the pollutants. The First Flush event is the first time an organized wet weather monitoring was conducted. This is significant information because the heavy rains flush the impermeable surfaces and the pollutants are washed into the storm drains. The samples collected are a good indication of what is flowing into the Sanctuary when it rains.

Methods

The same storm water outfalls that are regularly monitored by the Urban Watch volunteers were chosen for this event. Three sets of water samples were taken at four stations to determine any differences in constituents over time. They are described below as "time series". In Monterey, the stations included the Twin 51's, El Dorado St., St. Timothy's, Steinbeck Plaza (time series) and San Carlos Beach. In Pacific Grove, the stations were Asilomar, Pico, Greenwood (time series), Lover's Pt., and 8th Street. Capitola stations included Nob Hill (time series) and Upper Nob Hill (time series) (See Attachment 1 for information about the stations).

A total of eight teams were assigned to the Cities of Monterey, Pacific Grove and Capitola. Each team had a team leader responsible for the monitoring equipment and sample bottles. The criteria used for mobilization included sheeting water on the roadways, heavy flow through the storm drain system and conductivity levels below 500 μS (background conductivity levels exceed 2000 μS at the outfalls in Pacific Grove and Monterey).

Two teams in Monterey and Pacific Grove were each responsible for two stations. The third team in those cities and the Capitola teams were responsible for just one station (listed above as "time series") to document the change in the discharge over time. At the "time series" stations, three samples were gathered at 15 or 30 minute intervals, observations made continuously, and changes recorded.

The conductivity measurements determined if it was indeed storm water runoff flowing out of the outfall. The field data sheet was used by all of the monitoring teams to follow a standard protocol (See Attachment 2-Field Data Sheet). Based on past "First Flush" events conducted by Region 2 and 3 of the Regional Water Quality Control Board, a list of monitoring parameters was developed. On station, the volunteers measured water temperature using a Comark DT300 digital thermometer. Conductivity was measured using an Oakton TDSTester 3 or 4. The pH was measured using Macherey-Nagel pH test strips with a range of 4.5-10. Transparency was measured using a one-meter transparency tube as described in the GLOBE program. Physical observations such as trash, odor, bubbles, scum, and oil sheen were also recorded on the field data sheet. As the on-station measurements were being collected, sample bottles were filled for later analysis in a certified laboratory. The lab analysis included total suspended solids (TSS), total dissolved solids (TDS), oil and grease, copper, lead, zinc, and iron, Total coliform, E coli., orthophosphate, and nitrate (See Attachment 2 for analytical methods).

Quality Assurance/Quality Control

Each team had a leader with experience in water quality monitoring. All volunteers were trained on the use of the monitoring instruments and protocols for collecting water samples. The conductivity meters were calibrated before being assigned to a team. Field data sheets were provided with written instructions on how to complete them so that each team followed the same protocols. Field duplicates and blanks were provided to each lab for analysis. All lab data was reviewed for QA/QC and validated by the Network Coordinator.

Data Management: An Excel workbook with multiple spreadsheets, otherwise known as a "Project File", was used for documentation of the following information: results of field measurements and lab analysis, exact location of sampling stations, instrument information and calibration records.

Results and Discussion

At approximately 4:00 AM on the morning of October 10, 2000, the mobilization criteria were met. Sheeting water flowed across roads and water flowed in the gutters. When conductivity was measured at San Carlos Beach outfall, it measured below 100 μS. This confirmed that it was storm water flowing out of the pipe, so the team leaders were notified and told to mobilize their team members.

The first flush of the season in the Monterey area amounted to approximately 0.84 inches of rain in a 24 hour period. The rain was not steady, but rather, significant down pours that lasted for ten or fifteen minutes each. This occurred throughout Monday afternoon and evening. By early Tuesday morning, it was evident that there was not going to be a longer duration of rainfall and that sufficient water had been flowing to free any accumulation of contaminants and carry them into the storm drain system. It is most likely that the samples collected were actually not the first half hour of the "First Flush" but the end of the "First Flush". This assumption was made because at all of the stations, the conductivity measurements increased rather than decreased. It should also be noted that the Capitola area had already experienced several significant rainfalls the month prior to this event.

The full suite of analysis was performed for all of the stations in Monterey and Pacific Grove. Because of funding shortages, the samples collected in Capitola were not analyzed for metals, oil and grease or total dissolved solids.

Currently, there are no regulatory discharge limits for storm water runoff. In order to evaluate the results of the data that were collected during this event, Total coliform, nitrate, orthophosphate, TSS and TDS results were compared with the Central Coast Ambient Monitoring Program's (CCAMP) Action Levels and metal results were compared to the Central Coast Basin Plan standards. CCAMP's Action Levels are set at levels which may potentially impact beneficial uses, and are typically either levels representing existing regulatory standards, levels derived from the literature or other agency references, or levels which are elevated relative to the data distribution for that parameter on the Central Coast.

Both Basin Plan standards and CCAMP Action Levels are established for receiving waters and NOT for discharge waters. It is logical to assume that storm water may have higher concentrations of pollutants than its receiving water.

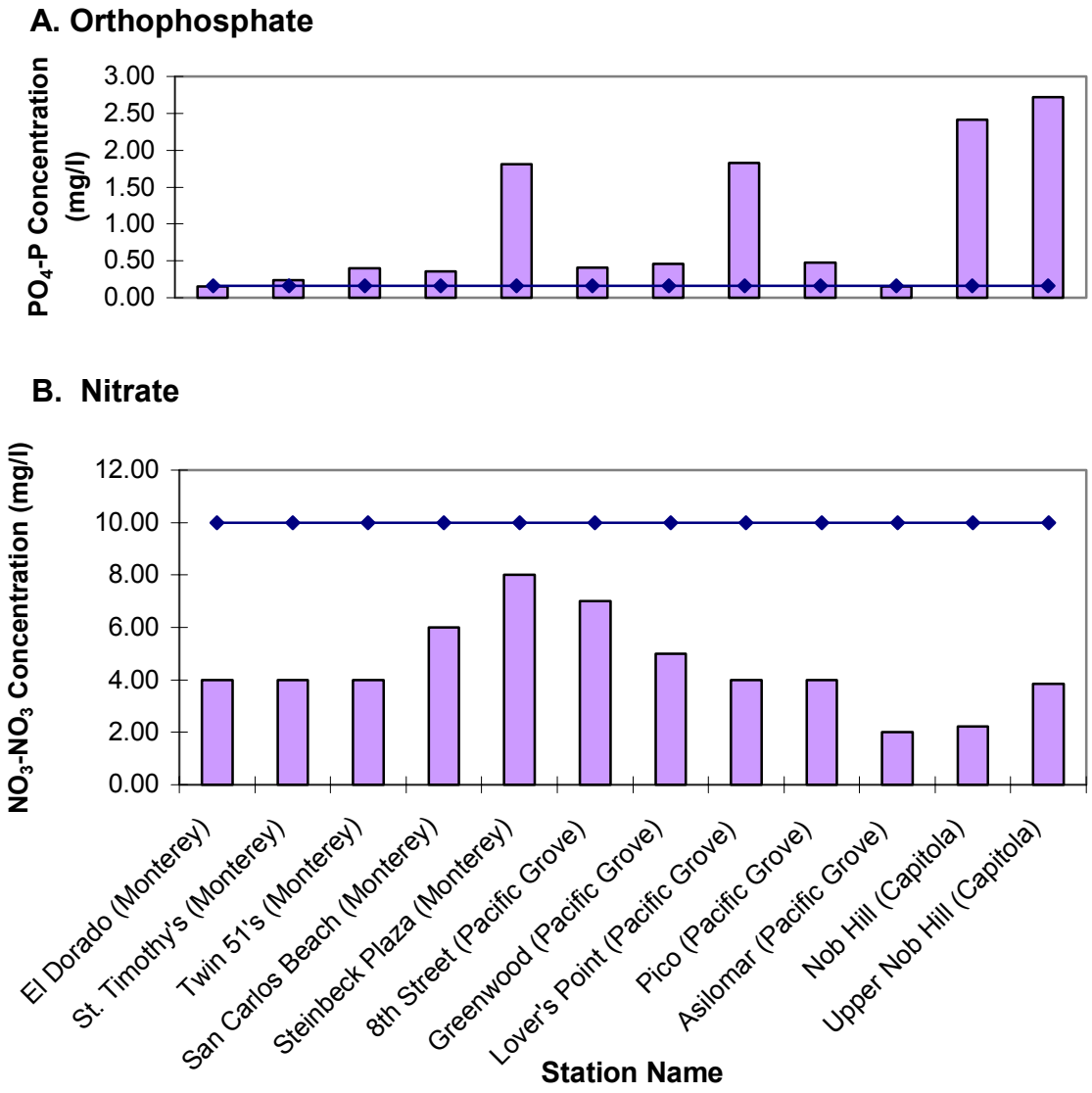
Nutrients

Phosphorus is a critical element for growth in plants. It is usually the growth-limiting factor for plants because it is present in very low concentrations in the environment. Orthophosphate is a form of phosphorus commonly found bound to soil particles, in sewage, fertilizers and in detergents that contain phosphates. Orthophosphate is rapidly taken up by algae and other larger marine plants. With excessive amounts present, large algal blooms occur. The CCAMP Action Level for orthophosphate (PO_4^{3-} -P) is 0.16 mg/l. All of the stations except for Asilomar and El Dorado were above the CCAMP

Action Level for orthophosphate. Two stations, Lover's Point and Steinbeck Plaza, were significantly higher than the others (See Figure 1A).

Nitrogen is also an element that is needed for plant growth. It is much more readily available in the environment than phosphorus. Nitrogen is more readily available than phosphorus because nitrate is much more soluble than phosphate. Plant growth is generally limited by phosphate, and not nitrate concentrations. Some sources of nitrate include runoff from fertilized lawns, agricultural and pasture lands, construction stations and septic leachate. The Action Level established by CCAMP for nitrate (NO_3 -NO_3) is 10.0 mg/l. All of the stations were below this action level (See Figure 1B).

Figure 1. Orthophosphate and Nitrate concentrations (mg/l) at storm drain outfalls during First Flush Event. The stations are listed in order traveled from east to west by city. The straight line depicts the CCAMP Action Level.



Bacteria

Total coliform and E. coli. are types of bacteria. They are pollutants of concern mostly because of their human health impacts. The State of California has determined that Total coliform over 1000 MPN/100 ml (most probable number/100 ml) poses health threats when physical contact is made. It should be noted that this is a value established for a receiving water and not the water flowing out of an outfall. The storm water is diluted considerably when it enters the receiving waters**.** Bacteria can also cause cloudy water, unpleasant odors and increased oxygen demand. Because of its aquatic effects, the CCAMP Action Level for Total Coliform is 10,000 MPN/100 ml.

Samples were collected and analyzed for Total Coliform and E. coli. at the EPA Region 9 lab in Richmond, CA. Every station in all three cities exceeded 24,000 MPN/100 ml for Total coliform. All of the Monterey and Pacific Grove stations exceeded 24,000 MPN/100 ml for E. coli. except for one. At St. Timothy's, the E. coli. concentration was 2400 MPN/100 ml. The two Capitola stations averaged 6785 MPN/100 ml for E. coli. (See Table 2).

Table 2. Depicts bacteria values for all stations listed in order traveling from east to west by city. The concentrations are in MPN/100 ml (Most Probable Number). Those stations with multiple listings are time series locations.

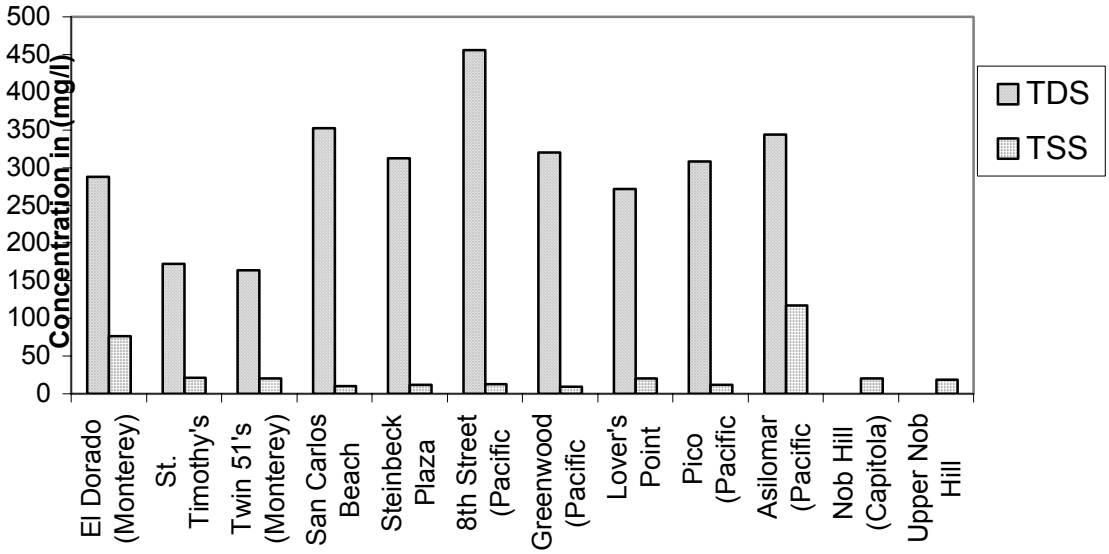
Station:	E. coli. (MPN/100ml)	Total Coliform (MPN/100 ml)
El Dorado	>24000	>24000
St. Timothy's	2400	>24000
Twin 51's	>24000	>24000
San Carlos Beach	>24000	>24000
Steinbeck Plaza T1	>24000	>24000
Steinbeck Plaza T2	>24000	>24000
Steinbeck Plaza T3	>24000	>24000
8th Street	>24000	>24000
Greenwood T1	>24000	>24000
Greenwood T2	>24000	>24000
Greenwood T3	>24000	>24000
Pico	>24000	>24000
Asilomar	>24000	>24000
Nob Hill T1	3100	>24000
Nob Hill T2	7700	>24000
Nob Hill T3	8200	>24000
Upper Nob Hill T1	6100	>24000
Upper Nob Hill T2	7700	>24000
Upper Nob Hill T3	7300	>24000

Total Dissolved Solids / Total Suspended Solids

TDS and TSS are important because they are sometimes indicative of the presence of pollutants. They provide a media or polar charges to attract contaminants. They also indicate high amounts of sediment which is harmful to fish populations because it destroys habit, it can suffocate eggs and/or limit the food supply.

TDS and TSS both were in very low concentration at all stations. The CCAMP Action Levels are 1000 ppm for TDS and 500 ppm for TSS. No stations exceeded these standards. Eighth Street had the highest TDS concentration of 456 ppm. Asilomar had the highest TSS concentration of 117 ppm (See Figure 2).

Figure 2. Total dissolved solids and total suspended solids in concentrations (mg/l) by station. The stations are listed by city traveling from east to west. Samples for TDS were not collected at the two Capitola stations.



Field Observations

While on site, volunteers recorded observations of bubbles and scum, trash, sewage, and oil sheen. Bubbles were observed at five of the ten stations indicating the possible presence of detergents. One station recorded a sewage odor and two stations observed trash. Temperature and pH measurements were well within the acceptable range at all of the stations. At each of the "time series" stations, the conductivity measurements increased, signifying that the storm water was subsiding. This was also reflected in the increased transparency of the water as well as the reduction in flow.

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 total metals. The effects

include reduced reproduction, developmental deformities, and mortality. In this monitoring event, samples were analyzed for copper (Cu), zinc (Zn), lead (Pb) and iron (Fe). The California Basin Plan has established water quality criteria for Cu, Zn, and Pb but not for Fe.

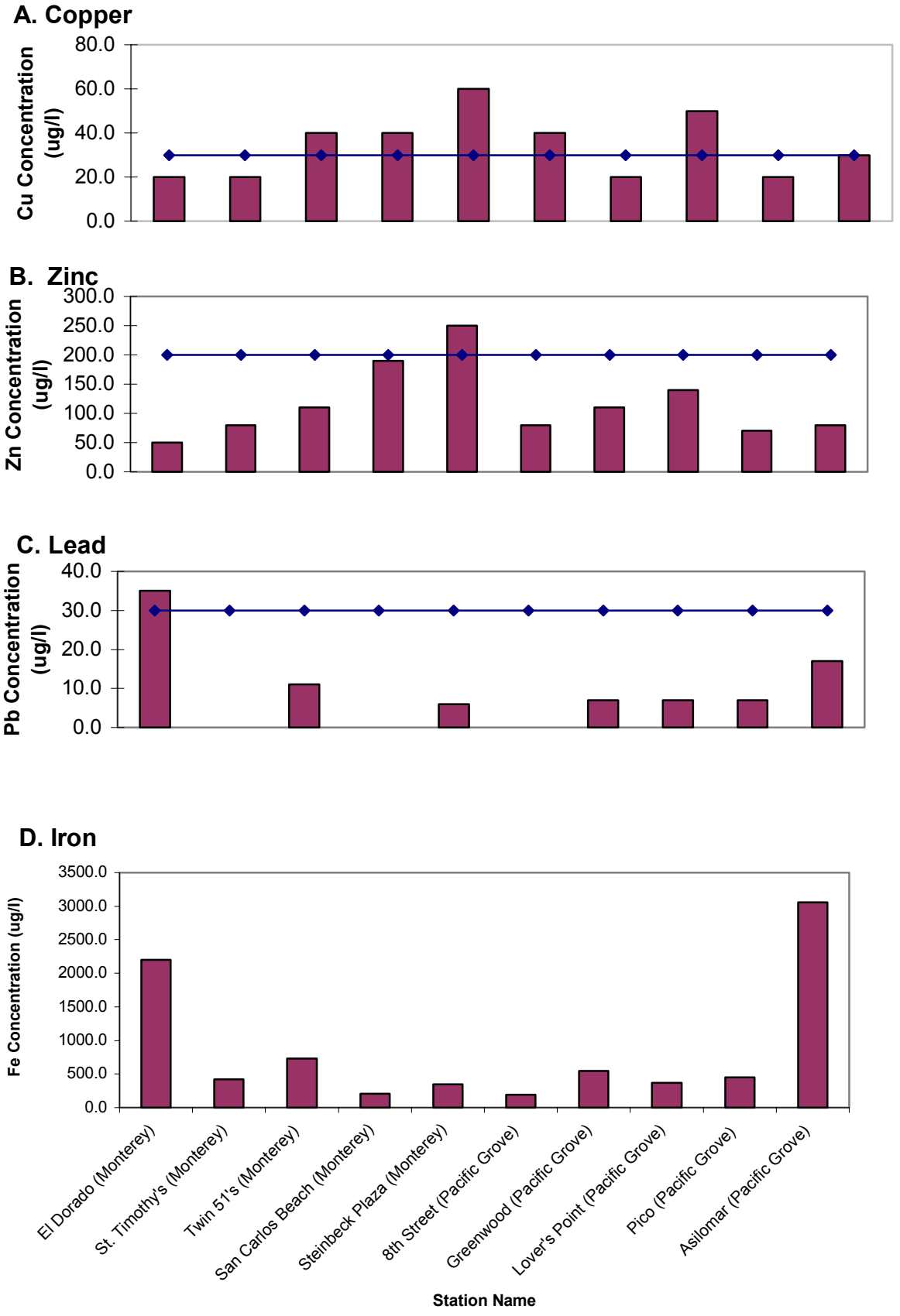
The background concentration for Cu in sea water is 2 parts per billion (ppb). The Basin Plan standard established for Cu is 30 µg/l (ppb). This was met or exceeded at 6 of the 10 stations monitored. The highest concentration was 70 ppb found at Steinbeck Plaza in Monterey. Steinbeck Plaza was one of the stations chosen to be a "time series" station. Each of the samples taken at 30 minute intervals contained measurable amounts of copper. The results were; sample #1 – 60 ppb, sample #2 – 70 ppb, sample #3 – 70 ppb (See Figure 3A).

The background concentration for Zn in sea water is 8 ppb. The Basin Plan standard for Zn is 200 µg/l (ppb). This value was exceeded at just one station, Steinbeck Plaza in Monterey. This was a "time series" station. The first sample collected had a Zn concentration of 250 ppb. The next two samples collected thirty minutes apart had concentrations of 260 ppb each (See Figure 3B).

The Basin Plan standard for Pb is 30 ppb. Asilomar was the only station to exceed this value with a concentration of 35 ppb (See Figure 3C).

Water quality criteria for iron (Fe) has not been established. Fe is a naturally occurring element and known to contribute to algal blooms in the marine environment. When evaluating the data, two stations stood out above all the rest. Asilomar, in Pacific Grove, and El Dorado in Monterey, were significantly different than the other stations. The concentration of Fe at Asilomar was 3060 ppb and at El Dorado it was 2200 ppb. The Fe concentrations at the other stations were near or below 500 ppb (See Figure 3D).

Figure 3. Depicts metal concentrations (µg/l) at stations located in Monterey and Pacific Grove. They are listed in order traveling from east to west. The blue line in graphs A, B and C is the standard for that metal listed in the Basin Plan.



Conclusion

There was much discussion on how to define a first flush. The goal was to mobilize the monitoring teams as soon as it started raining, so as to collect a sample within the first 30 minutes of the storm. This was not practical, however, because it was important to wait and see if a storm developed and also to provide scouring time for pollutants to be washed free from impermeable surfaces. It was necessary to have sheeting water on the roadways, runoff flowing down the storm drains and conductivity levels below 500μS.

When the volunteers arrived at their station, the first activity was to measure the conductivity. Initial measurements were below 500 μS indicating that storm water was already flowing from the outfalls. Samples were collected immediately as well as the field tests and visual observations. At each of the "time series" stations, the conductivity measurements increased over the course of 1½ hours, signifying that the storm water was subsiding. This was also reflected in the increased transparency of the water as well as the reduction in flow. This is important to consider when evaluating the data. The samples taken for this report were taken toward the end of a downpour and not within the first 30 minutes of the rain event. It is also important to consider that one sample taken at an outfall is not representative of the total amount of water flowing from that outfall. It provides only a glimpse of what is actually being discharged into the receiving water. The more data that is collected, the better understanding we have on what is actually occurring in our environment. Therefore, more sampling is needed to provide information on what is representative of storm water flowing into the Monterey Bay National Marine Sanctuary.

The results of the laboratory analysis indicated pollutants were present in the runoff. However, First Flush events in other California cities reported levels considerably higher for metals and nutrients. Total suspended solids and total dissolved solids, which sometimes indicate pollution, were well below the CCAMP Action Levels at all of the stations. Total coliform and E. coli were high at all of the stations and exceeded CCAMP Action Levels, but because of the analysis, we do not know exactly how high. When the bacteria samples were analyzed, they were run as 1:10 dilutions. More dilutions were necessary to determine exact counts. It is interesting to note however, that E. coli. levels were much lower in Capitola than in Monterey and Pacific Grove. Oil and grease were present at just two stations and in very low concentrations. Finally, metal concentrations were generally low except for copper, which was present at all of the stations and exceeded the CCAMP Action Level at 6 of 10 stations.

Based on the laboratory results, the outfall at Steinbeck Plaza had higher concentrations of contaminants than all of the other stations. It exceeded CCAMP's Action Levels or Basin Plan standards four times. Copper, zinc, orthophosphate, and bacteria were all well above the water quality criteria set for those parameters. The land use surrounding this outfall is primarily commercial. It is a well traveled location being situated in the middle of Cannery Row, a major tourist attraction in Monterey. There is substantial vehicle traffic as well as hotels, restaurants and parking lots in the vicinity of this outfall.

This First Flush event was a very successful pilot program organized by the Monterey Bay Sanctuary Citizen Watershed Monitoring Network. The goals of this effort were to collect information about the constituents of storm water runoff being discharged into the Sanctuary during a first flush, as well as to create public awareness of human impacts on the environment. The goals were met; the sampling went as planned, every station was monitored and good data was collected. Public awareness and education was achieved by twenty-one dedicated volunteers responding on a moments notice to collect storm water samples. They set an example for others, through their actions and concern for the environment.

Attachment 1

Station Name	Station ID	Drainage Area (acres)	Primary Land Use	Location	Description
Nob Hill (Capitola)	CSD1				
Upper Nob Hill (Capitola)	CSD2				
El Dorado (Monterey)	MSD1		80% residential 20% commercial	Major Sherman Lane south of HWY 1 and Don Dahvee Park	Surface drainage
St. Timothy's (Monterey)	MSD2		95% residential 5% commercial	On the corner of Soledad Drive and Via Esperanza	Surface drainage
Twin's (Monterey)	MSD3	365	90% residential 10% commercial	Below walking path at Heritage Harbor	Two 51' diameter concrete pipes
San Carlos (Monterey)	MSD4	70	40% commercial 35% residential 25% public land	On the beach adjacent to the west side of Coast Guard pier.	36' diameter concrete pipe
Steinbeck (Monterey)	MSD5	37	90% commercial 10% residential	At Steinbeck Plaza on Cannery Row	36' diameter concrete pipe
8th Street (Pacific Grove)	PGSD1	35	100% residential	West of Ocean View Blvd. between 7th and 8th.	concrete pipe
Greenwood (Pacific Grove)	PGSD2	250	90% residential 10% commercial	At the corner of 13th and Central Ave.	concrete pipe
Lover's Pt (Pacific Grove)	PGSD3	222	90% residential 10% commercial	At the top of the bank on the SE side of main beach at Lover's Pt	concrete pipe
Pico (Pacific Grove)	PGSD4	131	100% residential	On the W side of Ocean View Blvd. 100 ft. N of Pico St.	concrete pipe
Asilomar (Pacific Grove)	PGSD5	94	90% residential 10% commercial	On the W side of Ocean View Blvd. due W of the Asilomar Convention Ctr.	Natural riparian drainage area

Monterey Bay National Marine Sanctuary
First Flush 2000
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:

Sample Collection:

Instrument ID:	Time

Parameter		Taken by:
H20 Temp	F or C	
pH		
Conductivity	µS	
Transparency	cm	

Sample ID	Time	Collected by:	Comments

Duplicates or blanks collected: Yes or No

Notes (include any observations from back side, ie. types of trash, biological observations, etc.

Attachment 3

ANALYTICAL METHODS USED IN THE FIRST FLUSH 2000 SAMPLING EVENT

Constituent		Detection Limits	Units	Laboratory	Method #	Method Principles
Total Metals						
	Copper	25	µg/l	Monterey County	SM3111	acid digestion, AA flame
	Lead	5	µg/l	Monterey County	SM3113	acid digestion, graphite furnace
	Zinc	50	µg/l	Monterey County	SM3111	acid digestion, AA flame
	Iron	100	µg/l	Monterey County	SM3111	acid digestion, AA flame
WQ parameters						
	total suspended solids (TSS)	10	mg/l	Monterey County BC Lab	SM2540D	Gravimetric: filtration thru 1.1um, glass fiber drying and weighing of particulates
	total dissolved solids (TDS)	10	mg/l	Monterey County	SM2540C	Gravimetric: drying and weighing of 1.1um filtrate
	Oil&Grease as HEM	5	mg/l	BSK	EPA 1664	Gravimetric: liquid-liquid extraction with Hexane, volatilization of solvent, weighing of residue
Nutrients						
	Orthophosphate as PO4	0.3	mg/l	Monterey County BC Lab	SM4500-P-E	Colorimetric: ascorbic acid
	Nitrate as N	0.2	mg/l	Monterey County BC Lab	EPA 300	Ion Chromatography
Bacteria						
	Total coliform	1	MPN/100 ml	EPA Richmond	Colilert	Chromogenic Substrate
	E. coli	1	MPN/100 ml	EPA Richmond	Colilert	Chromogenic Substrate