City of Monterey
Urban Watch Monitoring Program

PROGRAM OVERVIEW

The City of Monterey Urban Watch storm drain monitoring program was initiated in June 1997 as a collaborative effort between the Coastal Watershed Council (CWC), the City of Monterey and the Water Quality Protection Program of the Monterey Bay National Marine National Marine Sanctuary. The purpose of this project is twofold. First is to serve as a tool for education and outreach to the general community regarding the impacts that the citizens have on local water quality. And secondly, to collect useful data to support local environmental management decisions. This is accomplished through the use of trained volunteers to monitor dry-season storm drain discharges at selected outflow areas from June through October of each monitoring year.

Working with staff from the City of Monterey Public Works Department, five sampling sites were selected based on drainage basin and safe access for volunteers. Figure 1 shows the locations of these sites. The five sampling sites were referred to as: (1) *Steinbeck Plaza* located at the end of Prescott Street on Cannery Row; (2) *Twin 51* located near the recreation trail at Heritage Harbor, west of Fisherman's Warf; (3) *San Carlos* at San Carlos Beach near the Breakwater; (4) *Del Monte* on Major Sherman Lane at El Dorado Street, North of Highway 1, Del Monte Shopping Center and Don Dahvee Park; and (5) *Monte Vista* on the corner of Soledad Dr. and Via Esperanza. This outfall drains a small strip mall and residential areas. During the monitoring year 2001, the Monte Vista site was replaced with the (6) *Library* site, corner of Pacific Street and Madison Street, due to the inaccessibility to the site due to overgrowth and a lack of flow from the storm drain outfall.

PROGRAM DESIGN

The program used the storm drain monitoring kit manufactured by the LaMotte Company (SSDK 7446) and designed in association with the City of Ft. Worth, Texas. The Urban Watch monitoring kit is designed to provide a method for volunteers to monitor dry-season storm drain discharges to identify common urban pollutants and contaminants within the study area. The kit was developed according to National Pollutant Discharge Elimination System (NPDES) Phase I dry weather monitoring requirements and is designed to detect illegal stormdrain connections and discharges. To this pre-assembled kit we added an Oakton 'ECTestr' conductivity meter and replaced the Oakton 'pHTestr' meter with pH strips for ease of use by volunteers.

Following a one-day training, volunteers were instructed to conduct sampling on a bimonthly schedule. Volunteers were divided into two teams with 3-5 members each. Volunteers conducted sampling twice within a 24-hour period with at least 4 hours between each sampling event. Parameters monitored included detergent surfactants, phenols, ammonia nitrogen, chlorine, turbidity, pH, conductivity, water and air temperature, odor, and color. Volunteers also noted if there was oil sheen, sewage, trash, and surface scum present. They also determined turbidity visually using a "Low-Medium-High" designation, as well as any other observations of note. Table 1 includes information on each of the parameters monitored and methods used for monitoring.

Samples were randomized through a flexible bimonthly schedule with the volunteers. Scheduling of field time was left up to the monitoring teams.

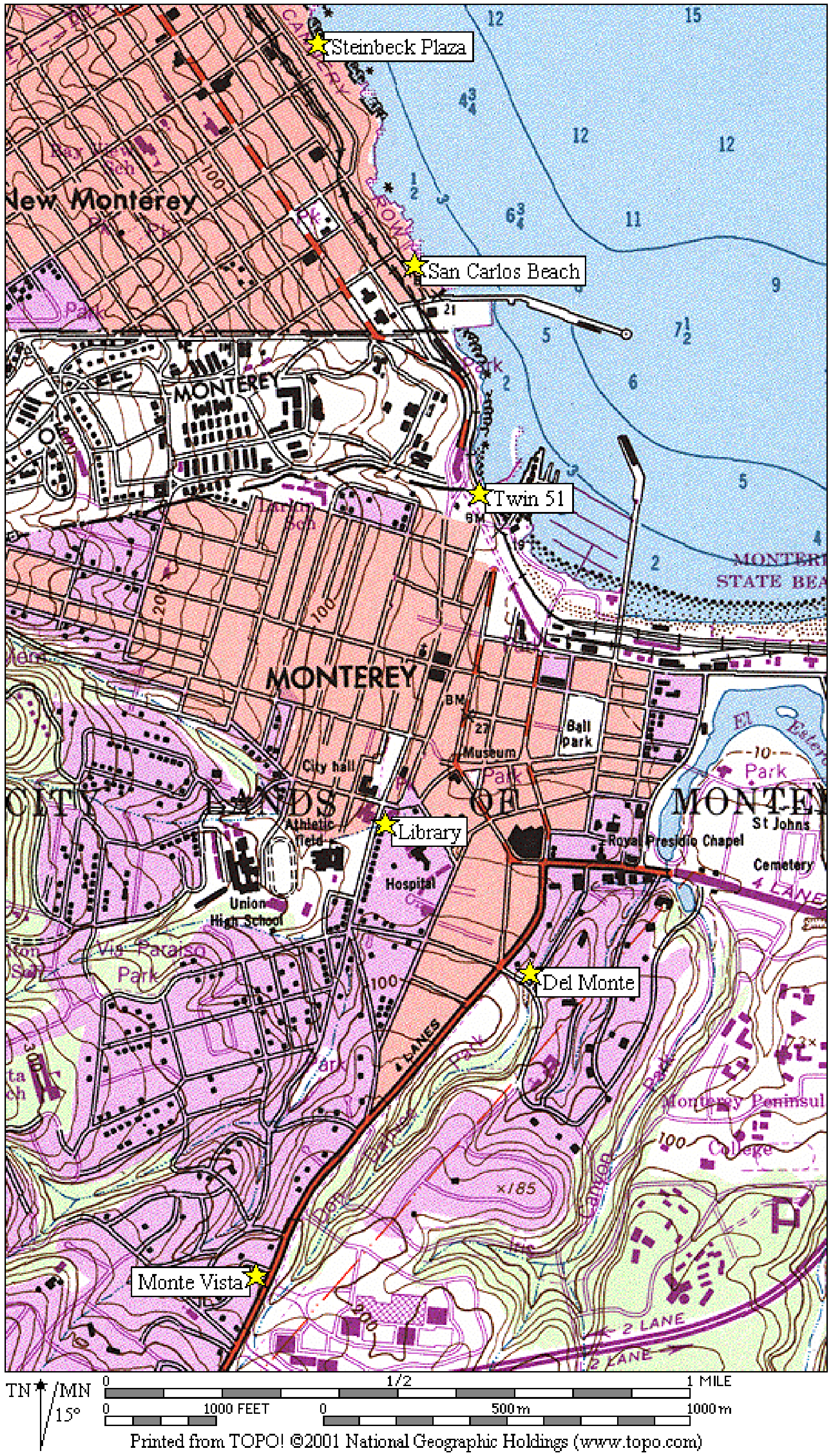

Figure 1. Locations of monitoring sites in the Monterey Urban Watch Program.

The Urban Watch Program culminates with the First Flush monitoring wherein the volunteers capture water samples from the storm drains monitored for the Urban Watch program during the first significant rain of the wet season. This rain washes the streets and cleans the gutters and storm drains of collected materials and pollutants that accumulate throughout the dry-season. Infield measurements of water temperature, conductivity, pH, and an assessment of transparency are taken by volunteers at the site, and samples are collected and sent to a professional lab where analysis for nitrate, orthophosphate, zinc, copper, lead, total coliform, *E. coli*., total dissolved solids, and total suspended solids are performed. The results are compared to the Central Coast Ambient Monitoring Program's (CCAMP) Action Levels. These action levels are not for regulatory purposes. Rather, they provide guidance on potential impacts to the health of the marine ecosystem.

VOLUNTEER TRAINING

CWC staff Susanna Danner, and Tamara Clinard, along with Bridget Hoover of the Monterey Bay Sanctuary Citizen Monitoring Network, and Maris Sidenstecker, Water Quality Education Consultant for the city of Monterey, provided a six-hour hands-on training for volunteers on May 19, 2001. Topics included monitoring concepts, sampling procedures, the meaning of each parameter monitored, use of kits in the field, and safety procedures.

Volunteers were placed in teams according to general skill level, interest and time availability. An experienced monitor, Ms. Sidenstecker, went out with each team until staff felt that the groups had a good understanding of the sampling and analytical skills outlined in the training packet given to them. An experienced monitor was chosen as a program coordinator to lead the team, help coordinate volunteer scheduling, and provide feedback to Ms. Sidenstecker.

QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

The Quality Assurance/Quality Control (QA/QC) program included the following components:

- Training on monitoring concepts, safety, sampling methods, and hands-on use of equipment.
- Training in use of data sheets and data entry for volunteers.
- Periodic calibration of test equipment, calibration records are available.
- Use of Instrument ID numbers to track equipment used by teams
- Monitoring of reagent stores and expiration dates, waste management.
- Periodic review of data sheets to determine inconsistency in data entry.
- Continued supervision until the trainer was confident in the volunteers' sampling and analysis skills.
- CWC prepared a Standard Operation Procedure for volunteers to use in the field while monitoring.
- Processing and analysis of data for report.

Table 1: Water Quality Parameters
Urban Watch Monitoring Program

Parameter	Possible Sources	Associated Problems	Method/Accuracy
Temperature	Illegal discharges	affects rates of chemical and biochemical reactions in water.	Method - Digital thermometer Accuracy - 1% full scale
Turbidity	Microorganisms, Sediment, erosion	interferes with fish and other aquatic life	Method - Visual Octa-Slide Viewer against turbidity standard slide bar
pH	Aerosols and dust in air, Mineral substances, sewer overflows, animal wastes, pesticides & fertilizers, photosynthesis	Interferes with fish and other aquatic life	Method – MacHerey-Nagel pH-Fix 4.5-10.0 color-fixed indicator strips Accuracy ± 0.25 units Min detection: 4.5
Detergent surfactants	illegal or unintended discharges, car washing, cleaning of screens and grills, leaking sanitary sewers	can be toxic to many aquatic insects, plants, and fish; can lower dissolved oxygen available to aquatic life	Method - solvent extraction/ bromphenal blue indicator Accuracy ± 0.1 ppm Min detection: >0.1 ppm
Copper	illegal discharge into the storm drain system; also can occur naturally in surface waters	concentrations over 0.025 parts per million are toxic to most freshwater fish	Method-Diethyldithiocarbamate Octa-Slide Comparator against color standard. Accuracy± 10%. Min detection: >0.0ppm
Phenols	disinfectants, toothpaste, mouthwashes from domestic wastewater	interferes with fish and other aquatic life	Method - Aminoantipyrine Octa-Slide Comparator against color standard. Accuracy ± 10%. Min detection: 0.5ppm
Chlorine	illegal or unintended connection to a stormdrain or draining of a swimming pool	toxic to aquatic life, can create a "sterile" environ-ment	Method – DPD Octa-Slide Comparator against color standard. Accuracy ± 10% Min detection: >0.2ppm
Ammonia Nitrogen	illegal connections to stormdrain systems, poorly functioning septic systems, wildlife	at certain concentrations can be toxic to aquatic organisms	LaMotte Code 5864 Colo-Ruler against a color standard Min detection: >0.1ppm
Conductivity	Discharges high in salts and minerals or metals, water moving through local geology	Possible agricultural, industrial or municipal wastewater runoff	Method –Electrode probe module. Accuracy ± 1% Min detection: 10 µS
Color	dyes or chemicals	Interferes with aquatic Insects	Method - Visual Borger Color System
Odor	illegal discharge or product of decomposition; "clean" drainage water should have no distinctive odor	can indicate presence of contaminants	Method - Scent
Oil sheen	hydrocarbons such as oil, gasoline, and grease; leaking underground petroleum storage tanks	toxic to aquatic organisms	Method - Visual
Trash, sewage, scum	illegal discharge or illegal dumping	Interferes with fish and other aquatic life	Method - Visual

RESULTS

I. Quantitative Parameters

The parameters listed below were analyzed in the field using the LaMotte kit described above. Over the period of June through October 2001, monitoring took place at the various sites for eleven rotations and a total of 109 individual monitoring events occurred. Volunteer availability and other influencing factors were taken into consideration throughout the program and not every parameter was tested on every site visit. Please see Appendix 1 for Summary Tables 1-4, which provide averages, minimum-maximum values, and frequency of parameters encountered. Appendix 2 presents all raw data collected in the field.

Detergent Surfactants
There were 90 samples tested for detergent from the six sampling sites. Of those, 43 tested positive for detergent, or 48% of all samples tested. The highest frequency and concentration of detergents was detected at the Steinbeck Plaza outfall where 19 of 22 samples detected detergent greater than 0.1 ppm. Samples ranged from 0.3 ppm to 4.6 ppm. The highest concentration found throughout the program was at the Steinbeck outfall where the measurement on 08/27/2001 was 4.6 ppm. Detergents were also detected 13 of 22 times at the Twin-51 site, ranging from 0.1ppm to 0.7 ppm. 6 of 20 samples from the San Carlos site also tested positive for detergents, ranging from 0.1 ppm to 2.0 ppm. 3 of 14 samples tested for detergent at the Library site, ranging from 0.1 ppm to 3.0ppm. Detergents were not detected at the Monte Vista (of 1 samples) or Del Monte (of 10 samples) sites.

Phenols
Phenols were not detected at any site during the monitoring period.

Ammonia Nitrogen
Ammonia nitrogen was detected on 25 of 90 total visits to all sites (28%). Ammonia nitrogen was detected in about one third of the visits to the Library (29%), San Carlos (27%), Steinbeck (32%) and Twin-51 (33%) sites. The most frequently detected value across all sites was 0.25ppm, 13 detections (52%) among all sites. There were two measurements of 1.0 ppm, at Twin-51 and the highest concentration reported was from the Steinbeck site on 09/25/01, which measured 4.0 ppm. No Ammonia Nitrogen was detected in the single sample taken from the Monte Vista site.

Copper
Copper was not detected at any site during the monitoring period.

Chlorine
Chlorine was detected twice in 89 tests during the monitoring period, once on 07/02/01at San Carlos (0.6 ppm) and once on 08/01/01at Del Monte (0.6ppm).

II. Measured Values

The following parameters were measured in the field during the 109 individual monitoring events. Please see Appendix 1 for Summary Tables 1-4, which provide averages, minimum-maximum values, and frequency of parameters encountered. Appendix 2 presents all data collected in the field.

Flow Presence

Flow was detected in 46 of 55 of the first site visits and 45 of 54 second visits, 91 of 109 observations (83%). Although the site values cannot be compared to one another, depth and width values varied a great deal between visits to a particular site. Average, min-max and frequency can be found in Appendix 1, Summary Table 1. The greatest variance in flow depth was found at the Del Monte site where depth ranged from 0.5 to 6.4 cm (5.9 cm), and the greatest difference in flow width was found at Twin 51 where flow width ranged between 17.0 cm and 45.7 cm (28.7 cm).

Air Temperature

Air temperature averaged between 17.9°C (Library) and 21.4°C (Del Monte) for all sites throughout the program. The lowest recorded temperature was 15.0°C at the San Carlos site at 5:25 pm on 10/23/01, and the highest recorded temperature was 26.5°C at the San Carlos site at 4:45 pm on 9/10/01.

Water Temperature

Water temperature averaged between 16.0.°C (Library) and 19.1°C (San Carlos) for all sites throughout the program. The lowest recorded temperature was 14.1°C at the Del Monte site at 7:16 pm on 6/6/01, and the highest recorded temperature was 21.4°C at the San Carlos site at 5:20 pm on 7/2/01.

Conductivity

Conductivity averaged between 1248 µS (Del Monte) and 1758 µS (Twin 51) for all sites throughout the program, however this was calculated without the 25 measurements that exceeded the range of the Oakton ECTestr meter used, 0-1990 µS. The lowest recorded Conductivity was 680 µS at the Del Monte site at 6:55 pm on 6/6/01, and the highest measurable conductivity value was 1970 µS at the San Carlos site at 6:24 pm on 8/27/01. For the entire program, 25 of 64 (39%) conductivity measurements taken were over the detectible range of the meter used. All 14 of 14 measurements taken at the Library site exceeded 1990 µS (100%), and 11 of 22 measurements taken at the Twin 51 site exceeded 1990 µS (50%). The remaining seven measurements at the Twin 51 site averaged 1662 µS for all measurable values, and ranged from 740 µS (9/25/01 5:12 pm) and 1940 µS (8/28/01 5:12 pm, and 8/16/01 4:50 pm).

pH

pH values throughout the entire program averaged from 7.3 (Del Monte and Library) to 7.8 (San Carlos). The lowest and most common pH measurement was 7.0, which was recorded 63 of 90 times (70%), and the highest was 8.0, which was recorded 13 of 90 times (14%).

III Qualitative Parameters

Volunteers were asked to make 'presence or absence' observations of the following parameters. More detailed descriptions were noted on the data sheet, and can be provide upon request. Site observations may have been recorded when a water sample was not collected. "Frequency" therefore is the relationship of the number of times the parameter was recorded as other than normal, out of the number of times an observation for that parameter was recorded throughout the program. Over the period of June through October 2001, monitoring took place at the six sites for eleven rotations and a total of 109 individual monitoring events occurred. Please see Appendix 1 for Summary Tables 3 and 4, which provide frequency of parameters encountered. Appendix 2 presents all data collected in the field.

Odors

Odors were noted on 7 of 78 total visits. On all occasions a 'putrid or sewer' smell, or a 'decay or decomposition' smell was noted: twice at Monte Vista on 07/02/01 and 07/03/01; three times at Steinbeck 06/18/01, 08/27/01 and on 09/10/01; and twice at Twin-51 on 07/03/01 and on 09/25/01.

Color

Volunteers matched water samples to a Borger Color System (BCS) booklet used to identify colors in nature. All samples from Del Monte, Monte Vista, and San Carlos were colorless. In 1 sample of 14 at the Library (7%), 7 of 17 samples at Steinbeck (41%), and 2 of 20 samples at the Twin-51 (10%) sites detected some color. The colors noted varied from a light tan (BCS-48), to a light green (BCS-13) and a drab tan (BCS-91).

Oil sheen
Oil Sheen was not detected at any site during the monitoring period.

Sewage
'Sewage sighted' or 'sewage smell' was noted on 10 of 93 monitoring events (11%). 'Sewage sighted' or 'sewage smell' was noted in 1 of 4 sampling events at the Monte Vista site; in 6 of 22 sampling events at the Steinbeck Plaza site; and in 3 of 22 sampling events at the Twin-51 site. 'Sewage' or 'sewage smell' was not noted at the Del Monte, Library, or San Carlos sites. Five of the ten noted observations recorded under *odor* as 'putrid or sewer' smell, or a 'decay or decomposition' smell, and in none of the notes from the site visits did volunteers mention sewage sighted.

Surface scum
Surface scum was reported 5 times of 93 total monitored events at all sites (5%). In many cases, algae were reported to be a component of the surface scum. Surface scum was noted once at Del Monte, twice at the Library, and twice at Monte Vista. Surface scum was not noticed at Steinbeck Plaza, which varies from last year where it was noticed most frequently.

Trash
Trash was reported on 84 of 98 site visits (86%), an increase from 59 of 80 total visits (74%) in 2000. Trash was noticed at all sites with great frequency: Del Monte had trash sited in 100% of its 15 site visits; the Library had trash on 7 of 14 sites (50%); Monte Vista had trash sited in 100% of its 3 site visits; San Carlos had trash sited in 19 of its 22 site visits (86%); Steinbeck had trash sited in 21 of 22 of its site visits (95%); and Twin-51 had 19 of 22 trash observations (86%).

Turbidity
Turbidity was consistently low for all sites, with the exception of one medium turbidity measurement on 09/10/01at the Library site.

IV. Additional Data

Day of Week/Time of Day
Volunteer monitoring occurred between Monday and Friday. No weekend data was collected for the 2001 program. Most events occurred earlier in the week with the most common monitoring day being Tuesday: 20 on Monday (18%), 39 on Tuesday (36%), 30 on Wednesday (28%), 15 on Thursday (14%), and 5 on Friday (5%). The monitoring times varied, however, they were consistently in the afternoon hours for the 107 times recorded. The earliest monitoring time was 1:45pm (Del Monte 7/31/01), and the latest was 7:16pm (Del Monte 6/6/01). Most of the monitoring events, 75 of 107 recorded times, occurred between 5:00pm and 5:59pm (70%). 20 occurred between 1:30 and 4:49pm (19%), and 12 occurred between 6:00 and 7:29pm (11%).

V. First Flush Event

The First Flush monitoring event occurred on Tuesday, October 30th 2000, at approximately 4:30am, and was held in the cities of Monterey, Pacific Grove, and Santa Cruz. Storm drain outfalls were monitored for conductivity, water temperature, pH, transparency, nitrate, orthophosphate, zinc, copper, lead, total coliform, *E. coli*., total dissolved solids, and total suspended solids. The results were compared to the Central Coast Ambient Monitoring Program's (CCAMP) Action Levels. These action levels are not for regulatory purposes; rather they provide guidance on potential impacts to the health of the marine ecosystem.

In Monterey, the results were mixed. Steinbeck exceeded CCAMP Action Levels for orthophosphate, E. coli, zinc, copper, and transparency. The concentrations of orthophosphate, zinc and copper were much higher there than all of the other sites in all three cities. Del Monte had the lowest E. coli concentration of all of the sites. The Library site was very turbid. The Twin 51 and San Carlos sites each exceeded CCAMP action levels for orthophosphate, E. coli., zinc and copper. Nitrate concentrations, total dissolved solids and total suspended solids were all very low in Monterey. There were no sites that exceeded CCAMP action levels for oil and grease.

A separate report will be written for the 2001 First Flush monitoring event and sent to local area governments and agencies. The data will be made available to interested organizations, and will be used to assess the pollutant load in the waters flowing into the Monterey Bay National Marine Sanctuary. The results of First Flush are available by contacting Bridget Hoover, Coordinator of the Monterey Bay Sanctuary Citizen Watershed Monitoring Network at (831) 883-9303.

DISCUSSION

Results from the 2001 Urban Watch Program data showed that detergent surfactants and ammonia nitrogen were the most common pollutants detected. Conductivity proved to be consistently higher than the equipment used in this program. Chlorine was detected once, and turbidity was found to be above 'low' once during the 2001 program. Phenols and Copper were not detected.

Detergent surfactants have consistently been detected in the storm drains monitored in this program for all monitoring years. Detergents were again found frequently throughout this year's program, and in high concentrations at the Steinbeck and Twin 51 sites. Among the different sites, detergents were found in 48% of all samples collected. However, detergents were found in 86% of samples taken from the Steinbeck site, with values from 1.3 ppm to 4.6 ppm (the highest value for the program). The Twin 51 site detergent values ranged from 0.1 ppm to 0.7 ppm with 59% of samples testing positive for detergents. Detergents are a significant inhibitor to fish health in concentrations as low as 2.0 ppm they can

Ammonia nitrogen was detected in 28% of the samples tested and concentrations varied from 0.25 ppm to 4.0ppm. Although the most common detection was a low value for the method used, 0.25 ppm, it was detected in enough instances to warrant further investigation. Ammonia nitrogen was detected in moderately high percentages at two sites, Steinbeck (32%) and Twin 51 (33%). Both sites showed high values in their tests. All of the test values of 1.0 ppm and over were taken from these two sites, twice at Twin 51, and seven times at Steinbeck with values from 0.1 ppm to 4.0 ppm. According to the Santa Cruz County Department of Environmental Health Services as much as 0.5 ppm of ammonium nitrogen can be expected in the native system as background levels, and detections above 0.50 should be looked at more carefully (Peters 2001).

Conductivity is a measure of the free ions in the water and reflects the ability of the water to conduct electrical current. Measuring conductivity gives an indication of the amount of total dissolved solids (TDS) in the water, such as salts, sugars, mineral, and acids.[1] Conductivity is measured for the Urban Watch program in microsiemens (µS), with a temperature compensated meter. Collection of conductivity measurements in the Urban Watch program serves to characterize the baseline value for each specific channel, and allows detection of significant changes (Katznelson pers. comm. 1/17/02). The average value of conductivity from each site was used in the First Flush event to establish the presence of increased quantities of rainwater in the flow (a significant change from baseline) and triggered sample collection at each site.

[1] State Water Resources Control Board (SWRCB), 2000. Measurements of conductivity/salinity, IP-3.3(EC). In: Watershed monitoring guidance: A Compendium of Information Papers and Standard Operating Procedures. Division of Water Quality, SWRCB, Sacramento, Ca. Sect 3.3: 10-2000

In the 2001 Urban Watch monitoring for the City of Monterey conductivity values ranged from 680 µS to 1970 µS for valid measurements. Measurements frequently exceeded the detection limit for the equipment used, 1990 µS (39% of all measurements), therefore 'valid' measurements, or measurable values, are those that could be determined with the equipment used. Every measurement taken at the Library (14) and half the measurements from the Twin 51 (11) sites were over the detectable range of the meter used. Although the Twin 51 site had one low reading of 740 µS, the remaining 10 measurements averaged 1754 µS, higher than all the other site averages. As all the conductivity measurements taken at this site were taken within a six-hour period (1:45 pm-7:16 pm), and 70 % were taken within an hour of one another (5:00 pm-5:59 pm) it would not be expected that time-of-day would be a contributing factor to the values of these conductivity measurements.

Although the Twin 51, San Carlos, and Steinbeck outfalls drain to the ocean, none are inundated with seawater during the dry-season monitoring period. The affect of ocean 'spray' may be a contributing factor at these locations, upstream measurements are recommended to clarify this factor. The Del Monte, Library and Monte Vista sites are inland a mile or more and would therefore not have any sea influence, however the Library site exceeded the conductivity meter's range consistently. Identifying the source(s) of water flowing through the storm drains in question and understanding the local geological and environmental influences would provide a more detailed insight to the conductivity of the water flowing at these sites to determine if this is a natural state or if some anthropogenic influence is artificially raising conductivity at these sample collection sites. In the future volunteers will be instructed in properly diluting the sample water or provided a higher range meter in order to collect more useful information.

CONCLUSION

It is important to stress the recurrent detection of detergents and ammonia nitrogen throughout the entire program and specifically at the Steinbeck and Twin 51 sites. There should be further investigation by the City of Monterey Public Works Department with the CWC Coordinator for Monterey to strategically locate some new sites "up the watershed" so as to determine where these pollutants enter the system. With five years of data collected, we recommend looking further into the drain system to identify more localized sources of flow. Furthermore, outreach should continue to be directed at businesses and increase in the neighborhoods that drain into this part of the storm drain system.

It is further recommended that project organizers develop a relationship with a certified lab to run QA/QC checks on the equipment. Additionally, when positive results are found for samples it is recommended that the volunteers collect an additional sample, which should be taken for processing by the certified lab. This could be done occasionally throughout the program to reduce costs for this quality assurance measure. Program coordinators could then inform the City of Monterey of findings as soon as they are recorded.

Modifying the current Urban Watch Program tests to include new parameters, expand the detection ranges, or to eliminate parameters that have never been detected over the five-year period, may be warranted. This could be done as the result of a five-year data review with the city of Monterey Public Works department and the Coastal Watershed Council as the first step of establishing the 2002 program.

The First Flush event proved a useful event for data collection and showed a great need to do further monitoring in the systems now looked at with the Urban Watch monitoring. This program also is a great tool for volunteers to see what the storm drain system is meant to do. Even though the event took place in the middle of the night feedback from participating volunteers was extremely favorable. Their experience will surely be shared with family and friends.

The data results continue to show the need for a targeted public outreach program for urban runoff control within the city limits as well as in the neighborhoods that feed these drains. The city of Monterey does an excellent job utilizing bus ads, posters, coloring books and other outreach materials as public education tools. The restaurant survey and outreach program conducted by the City of Monterey and the Sanctuary currently being repeated is another valuable outreach instrument. Other ideas include working with local newspapers to publish weekly monitoring results from the storm drain monitoring program, and collaborating with the Chamber of Commerce and other business associations to promote clean water practices.

In conclusion, it is recommended that the City of Monterey: 1) continue the Urban Watch monitoring program for a sixth season to augment the data presented here; 2) assess upstream sources of illicit discharges and pollutant sources; 3) investigate additional parameters for study; and 4) continue outreach programs targeting local businesses, schools and residents to further reduce detergent concentrations entering the Monterey Bay National Marine Sanctuary.

Sources

Katzneslon, R. PhD, State Water Resources Control Board, State of California. Personal communication. 1/10-17/2002.

Peters, Steve. Water Quality Specialist, Santa Cruz Department of Environmental Health Services, Santa Cruz County, CA. Personal communication. 12/18/2001. T. C. Doan.

State Water Resources Control Board (SWRCB), 2000. Measurements of conductivity/salinity, IP-3.3(EC). In: Watershed monitoring guidance: A Compendium of Information Papers and Standard Operating Procedures. Division of Water Quality, SWRCB, Sacramento, Ca. Sect 3.3: 10-2000