



2001 Urban Watch Storm Drain Monitoring Program City of Santa Cruz, California

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For:

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City of Santa Cruz

Urban Watch Monitoring Program

PROGRAM OVERVIEW

The City of Santa Cruz' storm drain monitoring program was initiated in June 2001 and is a collaborative effort between the Coastal Watershed Council (CWC), the City of Santa Cruz Public Works Department, and the Water Quality Protection Program of the Monterey Bay 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 Santa Cruz Public Works Department, CWC evaluated eight sampling sites based on drainage basin and safe access for volunteers. Five monitoring sites were established for this program and three were eliminated for various access or safety reasons (Figure 1). The five sampling sites are referred to as: **Bay** at the northwest corner of Bay St. and Escalona Dr., collections are taken from the open channel at the northwest corner; **Hollywood**, at the intersection of Dodero St., Hollywood Ave. and King St., collections are taken at the northeast corner, where water flows into the culvert. The remaining three sites are located in the West Cliff region: **Delaware**, between Swift St. and Swanton Blvd. where the open channel passes into the Delaware Ave. culvert, collections are taken from the channel downstream of two drainage pipes that empty into the channel; **Merced**, where Merced Ave. terminates at West Cliff Drive, collections are taken at the culvert outfall among the rip-rap southwest of the pedestrian path; **Woodrow**, where Woodrow Ave. Terminates at West Cliff Dr., collections are taken from the open channel, downstream of storm drainpipes, just inland of West Cliff Drive.

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 specifically designed and manufactured to meet the US EPA requirements according to National Pollutant Discharge Elimination System (NPDES) Phase I dry weather monitoring requirements to detect illegal storm drain connections. To this pre-assembled kit we added an Oakton 'ECTestr' conductivity meter and replaced the Oakton 'pHTestr' meter (0-1990 μ S) with MacHerey-Nagel pH strips (4.5-10.0) for ease of use by volunteers.

Following an evening orientation and in-field training, volunteers were instructed to sample on a weekly schedule. Eleven volunteers were divided into four teams with two to three members each. Volunteers visited between two and three sites each week and 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, total chlorine, total copper, turbidity, pH, conductivity, water and air temperature, odor, and color. Volunteers also noted if there was oil sheen, sewage, trash, and surface scum present, and 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 method used for monitoring.

A randomized sample was achieved through a flexible weekly schedule with volunteers. Volunteers sampled during daylight hours both on weekdays and weekends.

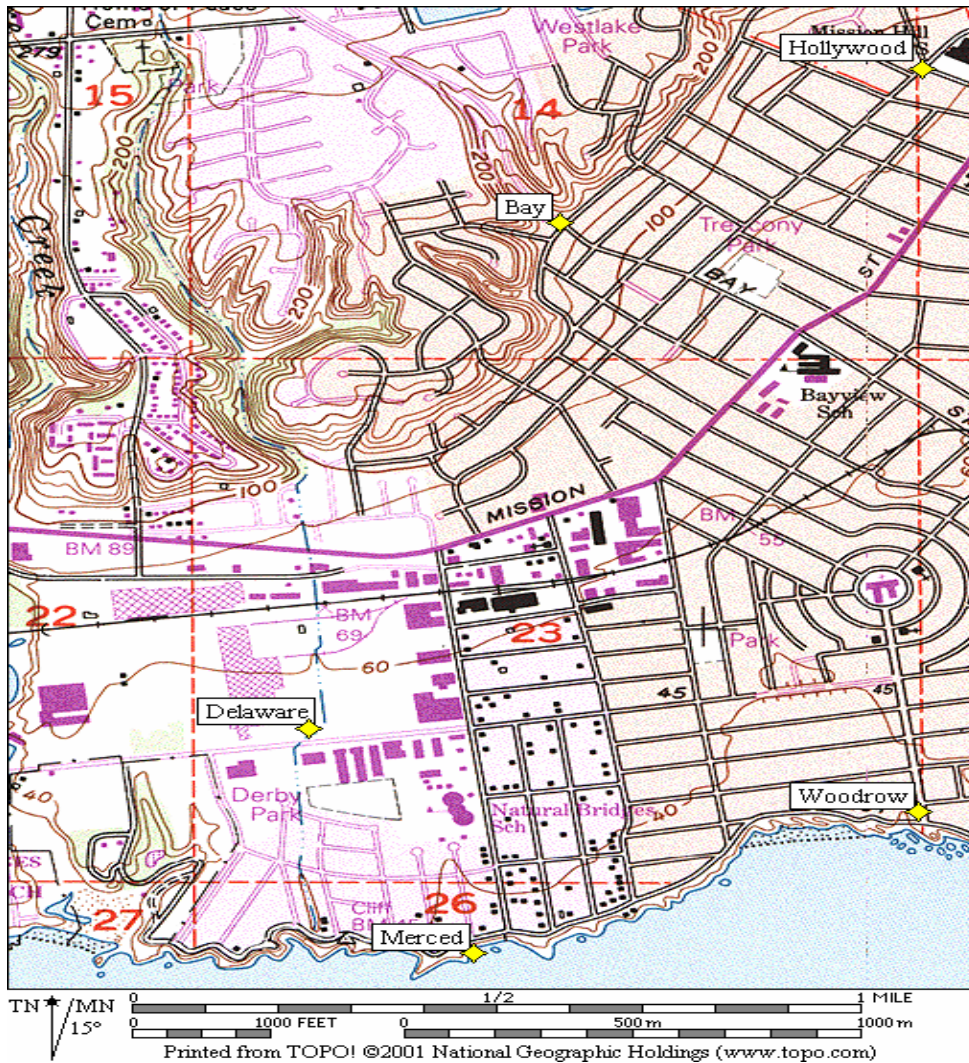


Figure 1. Locations of monitoring sites in the City of Santa Cruz Urban Watch Program for 2001.

The Urban Watch Program culminates with the First Flush monitoring wherein the volunteers capture water samples from the same storm drains as 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 a visual assessment of turbidity are taken by volunteers. Water 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

Volunteer training included six hours of classroom lecture, product training and infield "hands-on learning" facilitated by CWC staff Tamara Clinard, Urban Watch Coordinator, on July 20th and July 23rd 2001. Volunteers were presented with training materials detailing site locations, procedural instructions and test protocols, as well as ancillary information on the subject of urban pollutants. Topics included

**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 – MacHery-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" environment	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

monitoring concepts, sampling procedures, test protocols, 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 from CWC accompanied each team in the field until staff felt the groups had a full understanding of the sampling and analytical skills outlined in the training packet given to them. A team leader was chosen to lead each team and to facilitate scheduling and provide feedback to CWC.

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.
- 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.

RESULTS

I. Quantitative Parameters

The parameters listed below were analyzed in the field using the LaMotte kit described above. Over the period of July through October 2001, monitoring took place at the five sites for eleven rotations and a total of 88 individual monitoring events occurred. Volunteer availability and other influencing factors were taken into consideration throughout the program and not every parameter was tested for on every site visit. Please see Appendix 1 for Summary Tables 1-4, which providing averages, minimum-maximum values, and frequency of parameters encountered. Appendix 2 presents all raw data collected in the field.

Detergent Surfactants

Detergents were detected one time in 88 site visits. On 9/13/01 detergent was recorded at the Merced site as $>0.1 < 0.2$ ppm.

Phenols

Phenols were not detected at any of the five sites on the dates tested.

Ammonia nitrogen

Ammonia nitrogen was detected twice at the Merced site. On 8/15/01 and 9/13/01 detections of 3.0 ppm of Ammonia nitrogen were recorded.

Total Copper

Copper was detected once at the Delaware site. On 9/7/01 detection of 0.25ppm of Copper was recorded.

Total Chlorine

Chlorine was not detected at any of the five sites on the dates tested.

II. Measured Values

The following parameters were measured in the field during the 88 individual monitoring events. Volunteers used a tape measure, separate air and water thermometers, a hand-held conductivity meter and pH strips to collect this data. 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

In the five sites sampled, flow was detected during all of the 88 observations and samples were collected in 100% of the sampling events. Measurements were taken by volunteers in inches and converted to centimeters for consistency in the data reports of this program.

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 and min-max values can be found in Appendix 1, Summary Table 1. The greatest variance in flow depth was found at the Bay site where depth ranged from 3.15 to 19.69 cm (16.54 cm), and the greatest difference in flow width was found both at Bay where flow width ranged between 43.18 cm and 88.90 cm (45.72 cm), and Delaware where flow width ranged between 15.24 cm and 60.96 cm (45.72 cm).

Air Temperature

Air temperature averaged between 13.5°C and 29.5°C for all sites throughout the program. The lowest recorded temperature was at the Woodrow site at 8:40 am on 10/3/01, and the highest recorded temperature was at the Bay site at 2:45 pm on 10/2/01. The greatest difference in air temperature at a site

was recorded at Bay, showing 14°C between measurements of 15.5°C on 10/27/01 at 8:49 am, and the 29.5°C mentioned above.

Water Temperature

Water temperature averaged between 13.0°C and 20.5°C for all sites throughout the program. The lowest recorded temperature was at the Merced site at 8:13 am pm on 10/27/01, and the highest recorded temperature was at the Hollywood site at 3:15 pm on 8/10/01. The greatest difference in water temperature at a site was found both at Hollywood where water temperature ranged between 13.5°C on 10/27/01 at 8:33 am, and 20.5°C on 3:15 pm on 8/10/01 (7°C), and Merced where water temperature ranged between 13.0°C on 10/27/01 at 8:13 am, and 20 °C on 8/15/01 at 3:55 pm (7°C).

Conductivity

Conductivity averaged between 450 µS and 860 µS for all sites throughout the program. The lowest recorded Conductivity was 450 µS at the Hollywood site both at 2:30 pm on 7/26/01, and on 8/10/01 at 3:15pm. The highest Conductivity value was 860 µS at the Merced site, recorded three times on 8/16/01 at 8:52 am, on 9/29/01 at 10:45 am, and on 10/12/01 at 9:55 am. The greatest difference in conductivity at one site was recorded at Woodrow where conductivity ranged from 710µS on 8/10/01 at 2:45 pm and on 8/15/01 at 4:40pm, and 800µS on 9/20/01 at 9:35 am (90µS).

pH

pH values throughout the entire program averaged from 7.3 (Delaware and Woodrow) to 7.7 (Hollywood). The lowest pH measurement was 7.0, which was recorded 20 of 82 times (24%). The most common pH measurement was 7.5, which was recorded 53 times (65%), and the highest was 8.0, which was recorded 9 times (11%).

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 provided upon request. Site observations may or may not have been recorded whether or not a water sample was not collected. “Frequency” therefore is the relationship of the number of times the parameter was recorded as other than ‘none’, out of the number of times an observation for that parameter was recorded for a site throughout the program. 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

Volunteers made odor observations from the sample collected by wafting air across the sample toward their nose. Odors were not detected at any of the five sites on the 78 observations recorded.

Color

Volunteers matched water samples to a Borger Color System (BCS) booklet used to identify colors in nature. Water color was found to be transparent (BCS-93) for all 79 observations recorded.

Oil sheen

Oil sheen was noticed once on the surface of the water at the Delaware site on 9/8/01 at 9:30 am.

Sewage

Sewage ‘sighted or smell’ was noted once of 82 observations recorded (1%); “dried feces” was sited in the stream channel of the Delaware site on 10/15/01 at 11:35 am.

Surface scum

Surface scum was recorded for 10 of 82 observations (12%). It was recorded at Delaware five times (9/7, 9/13, 9/14, 10/2, and 10/15), at Merced three times (7/18, 7/19, and 7/27), and at Woodrow twice (9/7, and 9/13). No surface scum was recorded for the other sites.

Trash

Trash was found at all sites, in 41 of 82 observations (50%). The volunteers were provided trash bags and frequently removed the trash indicated in each observation. The highest frequency was recorded at Merced where 18 of 22 observations (82%) recorded the presence of trash. The presence of trash was detected at the remaining sites in the following frequencies: Delaware 10 of 19 (53%); Woodrow 9 of 21 (43%); Hollywood 2 of 9 (22%); and Bay 2 of 11 (18%).

Turbidity

Turbidity was consistently recorded as 'low' for all 78 observations made.

IV. Additional Data

Please see Appendix 2 for this data collected in the field.

Site Visits

Over the period of July 18, through October 27, 2001, three sites were visited at a time for each of the monitoring events and all five sites were monitored on a rotational basis. The two upland sites, Bay and Hollywood, were visited 5-6 times, and the three lowland sites, Delaware, Merced and Woodrow, were visited 10-11 times each. A total of 88 monitoring observations occurred. Notations for observations were recorded as "1V" for the first visit, and "2V" for the second visit within the 24-hour period. Please see Appendix I for tables of averages, maximum values, and frequency of parameters tested.

Day of Week/Time of Day

Volunteer monitoring occurred between Monday and Sunday for the 2001 program. Most events occurred later in the week with the most common monitoring day being Friday: 3 on Monday (3%), 10 on Tuesday (12%), 16 on Wednesday (19%), 19 on Thursday (22%), and 21 on Friday (24%). The monitoring times varied for the 86 times were recorded. The earliest monitoring time was 8:13 am (Merced 10/27/01), and the latest was 5:40pm (Woodrow 7/18/01).

Most monitoring events occurred between 8:00 am and 9:59 am (37%). 20 occurred between 4:00 pm and 5:59 pm (25%), 16 occurred between 2:00 and 3:29pm (20%), 13 occurred between 10:00 and 11:59 am (16%), and 3 occurred between 12:00 and 1:59 am (4%).

V. First Flush Event

The First Flush monitoring event was held on October 30th at approximately 4:30 am, in Monterey, Pacific Grove, and Santa Cruz. Storm drain outfalls were monitored for conductivity, water temperature, pH, turbidity, 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; the number of times of exceedence of the CCAMP action level, and that level are shown in parenthesis. These action levels are not for regulatory purposes; rather they provide guidance on potential impacts to the health of the marine ecosystem.

In Santa Cruz, the results at each of four sites tested were as follows: Bay exceeded CCAMP Action Levels for orthophosphate (1x 0.16ppm), E. coli (1x 400 MPN), copper (1x 0.03 ppm), and transparency (1x < 25cm). Delaware exceeded CCAMP Action Levels for orthophosphate (1x 0.16ppm), E. coli (2x 400 MPN), zinc (2x 0.20ppm), copper (1x 0.03 ppm), and transparency (1x < 25cm). Merced exceeded CCAMP Action Levels for Nitrate (1x 10ppm), orthophosphate (1x 0.16ppm), E. coli (2x 400 MPN), zinc (1x 0.20ppm), copper (1x 0.03 ppm), and transparency (1x < 25cm). Woodrow exceeded CCAMP Action Levels for Nitrate (2x 10ppm), orthophosphate (1x 0.16ppm), E. coli (1x 400 MPN), zinc (1x 0.20ppm), and copper (2x 0.03 ppm).

None of the four Santa Cruz sites tested for lead, oil & grease, total dissolved solids, or total suspended solids at a value exceeding the CCAMP action level (Lead 0.03ppm; TDS 1000 ppm; TSS 500ppm; no level is set for oil & 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:

Quantitative Parameters

Results from the 2001 Urban Watch Program in the City of Santa Cruz showed no major detections of the chemically analyzed quantitative parameters phenols, and total chlorine. Two detections of ammonia nitrogen and one each of detergent surfactants and of total copper were detected throughout the entire program.

The two ammonia nitrogen detections recorded were both 3.0 ppm, first on 8/16/01 at 8:52 am, and a second time on 9/14/01 at 12:45 pm. These detections were both on second visits in the '2 samples in 24-hour' cycles. Volunteers did not retest these detections. Throughout the program the Ammonia Nitrogen test reagents turned a number of colors "off" the LaMotte color chart provided. Representatives of the LaMotte Company assured CWC that this was not an indicator of concern. Volunteers kept track of the reaction color throughout the program using the Borger color chart. If this condition occurs in the next monitoring cycle it is recommended that the test and samples be validated at a professional lab.

Detergent surfactants were only detected one time in 80 samples throughout the program, a detection of 0.1 ppm. However, on two occasions "off-site" samples of water where 'suds' sat upon the surface of the water were collected in areas not designated as the sample collection site (once at Merced and once at Delaware), and these tested positive for detergents. It is suggested here that the detection of detergent surfactants is hampered by the amount of water flowing in the storm drains tested in this program and that this water dilutes the constituents beyond the detection limit of the method of analysis used in this program.

Measured Parameters

Flow was present at all sites at every monitoring event and was observed by CWC staff to be present at all times through out the dry season when this monitoring program operates. Each site was consistent in the amount of water with some variation at each site. However, it became apparent in the analysis for this report that the different volunteer groups did not always take the measurements at the same place.

Therefore, it is not valuable to compare these measurements other than to say that there was water present in a consistent pattern for each site.

Over the four month period air temperatures varied by 16°C, and water temperature varied by 7.5°C while the time of the measurements ranged within a ten hour period from 8:13 am to 5:40 pm, however, nothing in the air temperature data indicates concern for this program. The cooler air temperatures, of 13 °C to 16.0 °C, were all taken before 10:30 am (37%), and air temperatures of over 20 °C were taken between 11:05 am and 5:22 pm (32%), leaving the remaining measurements between 16.5-19.5°C (32%), to be taken anywhere between 8:50 am and 5:40 pm.

Water temperatures did not show the same direct correlation to time or date, however nothing in the water temperature data indicates concern for this program. Temperatures lower than 16°C were taken anywhere from 8:13 am and 5:40 pm, and between 7/18/01 and 10/27/01. As well higher temperatures, of 19.0°C and over, were taken between 8:52 am and 5:15 pm and fell between 7/18/01 and 10/27/01. Water temperatures did vary by site. Merced consistently fell above 19.0°C (95%) and only once measured below that, at 13.0 °C, while Woodrow consistently fell below 16.0°C, 62%, and never measured above 17.0 °C. All Bay measurements were below 17.5 °C, and 45% were below 16.0 °C. Delaware never measured below 17.0 °C, and 32% of measurements were 19.0 °C or above. Hollywood had the fewest measurements and the most diversity, with nine measurements ranging from, 13.5 °C and 20.5 °C (33% below 16 °C, and 22% above 19 °C.)

Conductivity measurements at all sites only varied 410 µS, and each site had very little deviation from it's average. The greatest variance from the average was less than 57 µS at Woodrow where values range from 710 to 800 µS (90 µS), while at Bay variance from the average was the least, less than 21 µS, and values ranged from 500 and 510 µS (50 µS). Nothing in the conductivity data indicates concern for this program.

Qualitative Parameters

Trash proved to be a consistent pollutant in this west side program, observed in 51% of all site visits, and was detected most commonly at the Merced site on 82% of visits. The West Cliff Dr. sites, Merced, Woodrow and Delaware, were consistently littered with beverage cans, plastic bags and high levels of paper wrappers and food containers. Of the remaining qualitative parameters, oil sheen and sewage 'sited or smelled' were detected once each throughout the entire program. Surface Scum was detected in 15% of site visits, most frequently at the Delaware site (26%), where the channel is opened and directly adjacent to undeveloped lands. In all cases surface scum was noted as being completely or in part algae. All site observations of odor, color and turbidity were negative.

Encouragement of community 'Stream/Coast Clean-Up' days, or targeted notices posted to point out the problem could be beneficial in trash abatement. As is true in most urban environments, the presence or absence of trash receptacles directly affects the amount of trash pollution in a given area. Locating and maintaining trashcans in the areas where the community use is obvious, as well as making sure they are emptied, is an important component in reducing trash as a pollutant in our waterways. Other ideas may include working with local newspapers to publish weekly monitoring results from the Urban Watch program, and working with the Chamber of Commerce or other neighborhood associations to promote clean living practices. Development of a Public Service Announcement for the local television channels detailing information about stormwater and urban runoff pollution is another possible avenue for outreach to a wider audience.

CONCLUSION

Storm drain monitoring during the Santa Cruz Urban Watch Program of 2001 resulted in very few detections of the parameters tested. This could be an indication that water samples from the test sites were free from these parameters, however, sampling was conducted primarily during weekdays and does not provide adequate data for weekend flows when increased incidents of car washing and neighborhood urban runoff would be expected. Of further concern is that the amount of water in the systems tested could have diluted the analytes beyond the detection levels of the monitoring kit used in this program.

Given the sensitivity limits of the testing equipment and the lack of pollutant detections from this year's sampling sites the Coastal Watershed Council recommends redesigning the Santa Cruz Urban Watch Program in the year 2002 to better meet the needs of the City's goal of outreach to the citizenry. A revised program could include selection of new sites for monitoring or other program retooling to increase public outreach capacity.

Possible methods for increasing the number of people reached through the program include neighborhood docents, urban watershed tours for neighborhood residents and associations, school outreach programming, community event presentations and outreach booths, or numerous other options. While the Santa Cruz Urban Watch Program 2001 was successful in raising awareness of urban runoff issues for a segment of Santa Cruz residents, the number of people reached could readily be expanded through some of the suggestions listed above.

The City of Santa Cruz is to be commended for joining the cities of Pacific Grove and Monterey in taking part in the Urban Watch Program. In addition to providing useful water quality data, the program serves as a valuable public education tool. The Coastal Watershed Council looks forward to the opportunity to discuss ways in which the Urban Watch Program can be tailored to more specifically meet Santa Cruz' public outreach needs.