# ASSESSMENT OF STORM DRAIN SOURCES OF CONTAMINANTS TO SANTA MONICA BAY

## VOLUME III
## SURFACE DRAINAGE WATER QUALITY MONITORING PROGRAM PLAN

by

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# PREFACE AND ACKNOWLEDGEMENTS

This report represents Volume III from a series of four volumes of reports which form the basis of a pollution assessment and monitoring plan for Santa Monica Bay. Volume I describes storm drainage system land use statistics, catchment areas, existing water quality monitoring data, rainfall data, NPDES permit information for existing permits to storm drains, and contaminant mass emission estimates, based upon land use modeling. Volume II reviews sampling techniques, including sampling equipment, and other aspects associated with sampling such as a quality assurance plan. Volume III presents the proposed monitoring plan. Volume IV addresses best management practices as they apply to the Santa Monica Bay area. The first draft of this volume was issued in October, 1992.

The contract was performed by UCLA and Woodward-Clyde Consultants (WCC). Professor Michael K. Stenstrom of the Civil and Environmental Engineering Department, UCLA and Eric Strecker from WCC's Portland office were the project managers. There were several key individuals from both UCLA and WCC who assisted with the project; they include Sim-Lin Lau and Kenneth Wong (UCLA) and Lou Armstrong, Gail Boyd, Carol Forrest, and Joan Kersnar (WCC).

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# ABSTRACT

The monitoring plan includes two primary goals: 1) assessing mass emissions of contaminants to Santa Monica Bay, and 2) developing more data in order to provide a better understanding of the relationship between land use and pollutant runoff. These two goals were developed in a workshop conducted in June, 1992 which was attended by representatives from the agencies responsible for implementing the monitoring plan, citizens groups and regulatory agencies. The plan addresses these goals by proposing 16 sampling stations

To determine the mass emissions 4 candidate sampling stations, located on Ballona Creek, Malibu Creek, Pico-Kenter and Topanga Creek, are proposed. These stations would sample runoff from about 75 percent of the Bay's watershed. To better understand the relationship between land-use and pollutant runoff characteristics, 12 additional candidate stations are proposed to monitor 6 different types of land uses, including single-family residential, multi-family residential, commercial, industrial, open, and highway.

Final sampling station locations are not proposed because the exact location will depend upon many site specific concerns, which are beyond the scope of this project. It is felt that the exact monitoring locations should be determined by the monitoring agency, who will be able to address such issues as proximity to electric power, freedom from vandalism, site hydraulics, and safety.

In addition to the candidate locations of the monitoring stations, additional information is provided on sampling techniques, analytical procedures, quality assurance procedures, data reporting, field crew training and methods for estimating pollutant loads. This information complements the sampling review presented in Volume II.

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# 1.0
# INTRODUCTION

This monitoring plan describes the objectives and approach for collecting data on the quality of storm drain discharges to Santa Monica Bay. The plan presents the methods used for selecting monitoring sites, specifies types of equipment required, discusses storm selection and runoff estimation procedures, and presents sampling event management and field sampling methods. Quality assurance and control, data reporting, monitoring schedule and training requirements are also presented. A more detailed review of sampling procedures and techniques is presented in Volume II of these reports (Stenstrom, et al., 1993) and should be consulted for more information on sampling. Included in the plan is a discussion of methods for pollutant load estimation.

## 1.1 MONITORING PLAN OBJECTIVES

The objective of this monitoring program is to provide accurate data for assessing the extent of pollutant loadings to Santa Monica Bay from storm drains and streams, from both dry and wet weather flows. The data should provide information that allows the determination of the need for and the prioritization of best management practices (BMPs). It should identify areas with potential water quality problems and provide for accurate and defensible detection of constituents. It should also provide information for assessing long-term trends in the quality of storm drain discharges to Santa Monica Bay. The monitoring program provides for an assessment of pollutant mass emissions to the Bay in an economical fashion. The plan includes installation of continuous flow monitoring stations, which will allow for collection of hydrologic data from all events, and in addition could be used to identify illicit dumping or illegal connections.

It is recommended that this program be integrated with other monitoring programs including those that are not part of the early NPDES permit, such as the comprehensive Bay monitoring Bay plan. If possible, collecting information on receiving waters (e.g., surf zone, coastal lagoons, and Malibu Estuary) during monitored storm events would also be appropriate, at least initially. Receiving water quality information can be used to determine the impact of storm water discharges on the health of the Bay, during and just after runoff events.

Finally, the proposed plan has been designed to assist the co-permittees in meeting the intent of both the Federal regulatory program for municipalities as well as Los Angeles County's "early permit" requirements specific to Santa Monica Bay.

## 1.2 MONITORING APPROACH

To meet the monitoring plan objectives noted above, a combination of two sampling approaches have been formulated. One approach is to collect samples at locations that monitor runoff from the largest possible areas of the watershed. Mass emissions can be estimated directly from these data. The second approach is to monitor runoff from locations having a single predominant land use. Data from these monitoring stations can be used with a pollutant loadings model to determine loadings to the Bay from unmonitored areas. These data can also be used to prioritize drains and to facilitate the process of selecting appropriate and effective BMPs.

The combination of these two approaches provides some redundancy in how loadings can be estimated as well as improve our information and understanding of pollutant/land use relationships for the Santa Monica Bay watershed. Having both types of stations allows the use of the data from the mass emission stations with the data from a variety of land use stations to calibrate and validate with existing and future land-use-based pollutant loadings models.

The mass emission stations will likely be permanent and used for quite sometime. Data from these stations will also establish a baseline for future comparisons. The permanence of these stations helps justify their costs, including the cost for data telemetry. The permanency of the land use stations will depend upon future efforts to model the Santa Monica Bay watershed. Data from these stations, and the ability to exactly repeat the sampling protocol, will be vitally important for future modeling efforts.

The plan includes a detailed Quality Assurance/Quality Control element to help assess the accuracy of the field and analytical program. Station equipment was recommended to provide accuracy of measured flows, and ease and accuracy in sample collection. The plan also includes a description of the storm selection process, sampling methods, and data reporting.

Water quality data should be obtained during dry weather as well as wet weather. Flow measurements should be made continuously at all stations, and samples will be collected for laboratory analyses in both wet and dry weather. Dry weather monitoring should provide information on the quantity and quality of base flows and may indicate the presence of illicit discharges or illegal dumpings. However, it is highly recommended that a separate illicit connection detection program be developed and implemented to find and eliminate these sources of pollutants. Monitoring of storm events would provide information on rainfall-runoff relationships and pollutant loadings from specific catchments and land uses.

## 1.3 MONITORING PLAN SUMMARY

In designing the monitoring plan, the climate and rainfall patterns of the Los Angeles area were considered. The number of storms that can be sampled during a given year may be quite limited; a total of eight storms will be targeted over the two-year monitoring period. Monitoring during dry weather is also proposed. The monitoring program proposed in this plan is summarized as follows:

- Monitoring of drainage areas with single land uses (i.e., residential, commercial, and light industrial), as well as drainage areas with mixed land uses (i.e., mass emissions stations).
- Continuous flow and rainfall measurement for all stations.
- Collection of grab samples and flow-composited samples for eight storm events over a period of 2 years.
- Collection of grab samples and 24-hour flow-composited samples during dry weather 4 to 6 times per year over a period of 2 years at the mass emissions stations; collection of grab samples during dry weather at the single land use sites if flow measurements indicate a possible problem (if a

permitted discharge to the selected stormdrain is found, it must be accounted for it the plan, or a different single land use site must be selected.

- Analysis of the samples for:
    - conventional pollutants
    - nutrients
    - bacteria
    - total and dissolved metals
    - volatile and semi-volatile organic compounds
    - pesticides/herbicides

In addition to the full suite of parameters listed above, a reduced suite of parameters has been recommended. Final locations of the monitoring stations have not been provided at this time, since this will require consideration of detailed site-specific information such as hydraulic conditions, general site access, and health and safety of the sampling crew.

# 2.0
# MONITORING SITES

This section of the monitoring plan describes the criteria that were used to select candidate sites for flow and water quality monitoring in Santa Monica Bay.

## 2.1 SITE SELECTION CRITERIA

To accurately determine storm water characteristics in a large, diverse study area, a strategic monitoring program can use some stations that sample runoff from relatively small and homogenous land use catchments (so called "single land use" or "upland" stations) and some stations that sample runoff from relatively large catchments representing a composite of land uses (so called "mass emissions" stations). The mass emissions stations are sometimes located in streams toward the lower ends of watersheds and are sometimes referred to as "stream" stations.

The study design requires a station mix that is representative of the land use distribution in the Santa Monica Bay Watershed. Table 2-1 shows the land use distribution within Santa Monica Bay Watershed. The table shows that the principal land uses within the watershed are single-family residential (26 percent) and undeveloped or open lands (57 percent). Other land uses include multiple-family residential (7 percent), commercial (3 percent), light industrial (2 percent), and public (2 percent) areas. Other urban areas constitute the remaining 3 percent of the total area.

Single-family residential areas and open spaces should be targeted in the monitoring program because these land use categories overwhelmingly form the largest types of land uses. Commercial and industrial areas are candidates for direct sampling, because previous studies have shown that these land use types contribute a significant percentage of pollutants to urban storm water runoff despite their relatively small contributing area (EPA, 1983). These previous studies also indicated that the quality of runoff from these types of land uses are widely variable from site to site, so that large parcels with various properties and uses are desirable to characterize the overall pollutant loadings from these types of land uses. Although not included in the land use breakdown, traffic corridors can also be significant contributors of runoff pollutants (Driscoll, et al., 1989). One traffic corridor site previously monitored by Cal Trans should be included with the single land use sites.

Other urban and public land uses not targeted by the single land use sites should be sampled at the designated mass emissions stations. The single land use stations should also monitor other land use types in those instances where the other land uses form a small percentage of the catchment to the monitoring station.

The following criteria were used as guidelines in selecting the single land use sites:

- The total catchment area is large enough (greater than about 50 acres) to generate significant runoff and not be affected by possible localized irregularities.
- The catchment consists primarily of one of the targeted land use types.

## TABLE 2-1

## LAND USE IN SANTA MONICA BAY WATERSHED

| LAND USE | ACREAGE | PERCENT OF TOTAL |
|---|---|---|
| Single-Family Residential | 70,200 | 26 |
| Multi-Family Residential | 18,500 | 7 |
| Commercial | 8,500 | 3 |
| Light Industrial | 4,000 | 2 |
| Public | 5,200 | 2 |
| Other Urban | 8,200 | 3 |
| Open | 150,200 | 57 |
| Unknown | 400 | <1 |
| TOTAL | 265,200 | 100 |

- A single outfall or discharge point for the catchment has been identified or is likely to exist.

In determining the single land use stations, the land use data generated by the WCC geographical information system (GIS) was heavily relied upon. The subbasins having more than 50 acres were ranked by the percentage of each land use type. Maps of the subbasin drainage systems were then reviewed to select potential candidates from the subbasins with the highest percentage of each land use type. Drainage system maps for subbasins in the Hollywood Quadrangle were not available for review. Further evaluation of the potential sites is required before final selection.

Monitoring sites on basins that discharge directly to the sea (via outfalls) would need to be located upstream to avoid tidal influences and/or backwater effects that could affect sampling results.

Preliminary storm water monitoring stations were selected from examination of County of Los Angeles Department of Public Works drainage maps, based on the above criteria and are presented in the next section. Additional information from field reconnaissance would be required for each site to confirm the preliminary monitoring site selections reported herein. The following technical and operational requirements should be used during the final site selection and verification process:

Catchment Area Characteristics

- The drainage system and boundaries are known
- Land uses are known
- Contamination from or interaction with the sanitary system is unlikely to occur (this may be challenging for some catchments, such as Ballona Creek, where spills from sanitary sewers are frequent)

Hydraulic Suitability

- Uniform flow conditions exist
    - upstream sections are straight and uniform for (at least approximately six channel widths or 12 pipe diameters)
    - backwater conditions do not exist (i.e., receiving waters do not back up to the monitoring site)
    - pressure flow or pipe surcharging does not occur within normal precipitation ranges for sampling and never occurs at levels that could endanger equipment
    - tidal flows do not affect the sampling location
- A rating curve can be reliably determined or other flow measuring technique developed (channel bottom must be stable and not subject to cutting and filling during periods of high and low flows).
- The channel or storm drain is soundly constructed and stable
- Well mixed conditions exist (i.e., the sampling site is located sufficiently downstream from any major upstream storm water inflows)
- The access point (e.g., manhole, bridge) is not excessively deep

- The sampling equipment should not impede flow and reduce flood protection

Crew Safety

- The site has good access during all weather conditions
- The crew should be easily visible
- Minimal traffic or other hazards exist
- The station is relatively secure from vandalism
- Confined space entry can be performed safely and in compliance with regulations during wet and dry weather conditions

Use of the above criteria would help ensure that the storm water samples are representative, as well as meeting safety requirements.

## 2.2 PRELIMINARY SINGLE LAND USE STATION SITES

Preliminary monitoring sites were selected to represent the following land use types: single-family residential, multi-family residential, commercial, light industrial, and traffic corridor. For each of these sites, the basin number, subbasin name, and component land use type areas, by acreage or percentage, is presented in Table 2-2a and 2-2b. Following the subbasin name, a paragraph is included which describes the catchment composition. The site identification codes, or subbasin names, are based upon the County of Los Angeles Public Works maps. Each code represents the name of a subbasin from the map and the name of the outfall draining the subbasin.

### 2.2.1 Single-Family Residential

The screening process identified six preliminary station sites (outfalls or manholes draining a particular subbasin) for single-family residential land use. Two of these sites would be selected for monitoring.

BI9815 is in basin #24 of the Venice Quadrangle located near Hermosa Beach in the City of Manhattan Beach. BI9815 is approximately 225 acres with land use breakdowns of 93 percent single-family residential, 4 percent multi-family residential, 2 percent commercial, and 1 percent open. BI9815 is a piped system draining to Santa Monica Bay. The outfall is located near Hermosa Beach in Manhattan Beach.

BI5238 is in basin #21 of the Inglewood Quadrangle located north of UCLA in Bel Air. The 248-acre basin drains a steep canyon with land uses of 95 percent single-family residential, 4 percent public, and 1 percent open space. BI5238 has only one pipe outlet.

SMB62 is in basin #8 of the Point Dume Quadrangle on Point Dume. SMB62 contains 181 acres of 95 percent single-family residential, 4 percent public, and 1 percent open land use. The open channel system drains into Santa Monica Bay possibly requiring the sampling station to be moved upstream from the outfall to avoid tidal influences.

# TABLE 2-2a
# PRELIMINARY LAND USE STATION SITES

| BASIN # | SUBBASIN NAME | LAND USE (Acres) Single-Family Residential | Multi-Family Residential | Commercial | Light Industrial | Public | Other Urban | Open | Unknown | Subbasin Total Acreage |
|---|---|---|---|---|---|---|---|---|---|---|
| **Single-Family Residential (2 stations to be selected)** | | | | | | | | | | |
| 8 | SMB62 | 171.3 | 0.0 | 0.0 | 0.0 | 7.5 | 0.0 | 2.0 | 0.0 | 180.8 |
| 21 | BI5238 | 230.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 17.8 | 0.0 | 248.2 |
| 24 | BI9815 | 210.6 | 8.3 | 5.0 | 0.0 | 0.0 | 0.0 | 1.5 | 0.0 | 225.3 |
| 21 | BI81 | 711.9 | 7.1 | 0.1 | 65.7 | 0.0 | 0.1 | 0.0 | 0.0 | 784.9 |
| 26 | BI9817 | 193.7 | 0.0 | 0.0 | 0.0 | 16.2 | 0.0 | 3.1 | 0.0 | 213.0 |
| 21 | BI4881 | 410.1 | 0.0 | 0.6 | 0.0 | 39.6 | 0.0 | 0.0 | 0.0 | 450.2 |
| **Multi-Family Residential (2 stations to be selected)** | | | | | | | | | | |
| 20 | BI249C | 10.9 | 296.9 | 24.0 | 0.0 | 61.6 | 14.7 | 97.6 | 0.0 | 505.5 |
| 21 | BI5212 | 108.5 | 401.5 | 67.3 | 6.6 | 44.9 | 0.0 | 5.6 | 0.0 | 634.3 |
| **Combined Residential** | | | | | | | | | | |
| 21 | BI504 | 340.5 | 94.1 | 21.6 | 2.7 | 3.8 | 0.1 | 0.0 | 0.0 | 462.8 |
| 21 | BI503 | 138.5 | 49.8 | 5.4 | 0.0 | 5.2 | 0.0 | 0.0 | 0.0 | 198.8 |
| 20 | BI736 | 38.9 | 142.0 | 5.7 | 0.6 | 0.1 | 0.0 | 8.5 | 0.0 | 195.8 |
| 21 | BI5213 | 623.1 | 125.9 | 4.6 | 13.3 | 6.7 | 4.0 | 31.8 | 0.0 | 809.4 |
| 21 | BI648A | 91.0 | 198.5 | 24.5 | 7.3 | 0.7 | 0.0 | 0.0 | 0.0 | 322.1 |
| 21 | BI11021 | 836.0 | 288.7 | 72.5 | 32.0 | 50.6 | 18.7 | 0.3 | 0.0 | 1298.8 |
| 21 | BI572 | 338.6 | 599.0 | 61.9 | 0.0 | 45.4 | 8.9 | 14.3 | 0.0 | 1068.1 |

## TABLE 2-2a (continued)
## PRELIMINARY LAND USE STATION SITES

| | | *LAND USE (Acres)* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **BASIN #** | **SUBBASIN NAME** | **Single-Family Residential** | **Multi-Family Residential** | **Commercial** | **Light Industrial** | **Public** | **Other Urban** | **Open** | **Unknown** | **Subbasin Total Acreage** |
| **Commercial (2 sites to be selected)** | | | | | | | | | | |
| 20 | BI249D | 0.0 | 0.0 | 68.8 | 0.0 | 0.3 | 0.0 | 6.5 | 0.0 | 75.6 |
| 21 | RXFRD1 | 458.4 | 77.8 | 185.3 | 36.1 | 15.7 | 0.0 | 0.0 | 0.0 | 773.2 |
| **Light Industrial (2 sites to be selected)** | | | | | | | | | | |
| 21 | BLLNA9 | 19.7 | 0.0 | 0.0 | 58.2 | 0.0 | 0.0 | 0.0 | 0.0 | 77.8 |
| 21 | BLLNA6 | 52.7 | 0.0 | 13.1 | 37.5 | 0.0 | 0.0 | 4.6 | 0.0 | 107.9 |
| 21 | CULVER1 | 189.8 | 49.0 | 6.2 | 116.5 | 23.6 | 10.4 | 0.0 | 0.0 | 395.6 |
| 21 | BI81 | 711.9 | 7.1 | 0.1 | 65.7 | 0.0 | 0.1 | 0.0 | 0.0 | 784.9 |
| **Commercial/Light Industrial** | | | | | | | | | | |
| 23 | BI3402 | 149.1 | 21.5 | 35.6 | 113.4 | 9.5 | 26.3 | 87.4 | 0.0 | 442.7 |
| 21 | BI5243 | 402.5 | 40.8 | 46.1 | 123.7 | 58.8 | 0.2 | 9.2 | 0.0 | 681.2 |
| 21 | BI52041 | 3.4 | 0.0 | 510.5 | 378.5 | 9.2 | 0.0 | 0.0 | 180.2 | 1081.7 |
| 21 | BI52042 | 0.0 | 0.2 | 30.0 | 309.5 | 102.2 | 0.5 | 0.0 | 0.0 | 442.3 |
| 21 | BI52043 | 697.3 | 975.3 | 603.7 | 213.9 | 295.6 | 98.4 | 50.4 | 0.0 | 2934.5 |

## TABLE 2-2a (continued)
## PRELIMINARY LAND USE STATION SITES

*LAND USE (Acres)*

| BASIN # | SUBBASIN NAME | Single-Family Residential | Multi-Family Residential | Commercial | Light Industrial | Public | Other Urban | Open | Unknown | Subbasin Total Acreage |
|---|---|---|---|---|---|---|---|---|---|---|
| **Open (2 sites to be selected)** | | | | | | | | | | |
| 1 | ARSEQ2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2912.7 | 0.0 | 2912.7 |
| 1 | ARSEQ1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2169.1 | 0.0 | 2169.1 |
| 1 | ARSEQ3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1906.3 | 0.1 | 1906.3 |
| 4 | LACHU1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 826.1 | 0.0 | 826.1 |
| 10 | LATIG1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 696.6 | 0.0 | 696.6 |
| 15 | PENA1 | 1.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 481.1 | 0.0 | 482.8 |
| 8 | RAMRZ1 | 11.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1664.0 | 0.0 | 1675.6 |
| 3 | LALIS1 | 11.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 932.7 | 0.0 | 943.9 |
| 6 | TRANC3 | 2.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 351.6 | 0.0 | 354.1 |
| 6 | TRANC1 | 40.8 | 0.0 | 0.0 | 0.0 | 43.3 | 0.0 | 4702.4 | 0.0 | 4786.5 |
| 2 | SNICH | 12.7 | 0.0 | 0.0 | 0.0 | 0.0 | 3.0 | 831.5 | 0.0 | 847.1 |
| 15 | TUNA1 | 24.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 909.9 | 0.0 | 934.5 |
| 6 | TRANC2 | 7.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 69.0 | 0.0 | 76.2 |
| **Transportation (2 sites to be selected)** | | | | | | | | | | |
| | I-405 | | | | | | | | | 3.2 |
| | Hollywood Freeway | | | | | | | | Approximately | 15.0 |

## TABLE 2-2b
## PRELIMINARY LAND USE STATION SITES

| BASIN # | SUBBASIN NAME | *LAND USE (Percent of Total)* Single-Family Residential | Multi-Family Residential | Commercial | Light Industrial | Public | Other Urban | Open | Unknown | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **Single-Family Residential (2 stations to be selected)** | | | | | | | | | | |
| 8 | SMB62 | 95% | 0% | 0% | 0% | 4% | 0% | 1% | 0% | 100% |
| 21 | BI5238 | 93% | 0% | 0% | 0% | 0% | 0% | 7% | 0% | 100% |
| 24 | BI9815 | 93% | 4% | 2% | 0% | 0% | 0% | 1% | 0% | 100% |
| 21 | BI81 | 91% | 1% | 0% | 8% | 0% | 0% | 0% | 0% | 100% |
| 26 | BI9817 | 91% | 0% | 0% | 0% | 8% | 0% | 1% | 0% | 100% |
| 21 | BI4881 | 91% | 0% | 0% | 0% | 9% | 0% | 0% | 0% | 100% |
| **Multi-Family Residential (2 stations to be selected)** | | | | | | | | | | |
| 20 | BI249C | 2% | 59% | 5% | 0% | 12% | 3% | 19% | 0% | 100% |
| 21 | BI5212 | 17% | 63% | 11% | 1% | 7% | 0% | 1% | 0% | 100% |
| **Combined Residential** | | | | | | | | | | |
| 21 | BI504 | 74% | 20% | 5% | 1% | 1% | 0% | 0% | 0% | 100% |
| 21 | BI503 | 70% | 25% | 3% | 0% | 3% | 0% | 0% | 0% | 100% |
| 20 | BI736 | 20% | 73% | 3% | 0% | 0% | 0% | 4% | 0% | 100% |
| 21 | BI5213 | 77% | 16% | 1% | 2% | 1% | 0% | 4% | 0% | 100% |
| 21 | BI648A | 28% | 62% | 8% | 2% | 0% | 0% | 0% | 0% | 100% |
| 21 | BI11021 | 64% | 22% | 6% | 2% | 4% | 1% | 0% | 0% | 100% |
| 21 | BI572 | 32% | 56% | 6% | 0% | 4% | 1% | 1% | 0% | 100% |

## TABLE 2-2b (continued)
## PRELIMINARY LAND USE STATION SITES

*LAND USE (Percent of Total)*

| BASIN # | SUBBASIN NAME | Single-Family Residential | Multi-Family Residential | Commercial | Light Industrial | Public | Other Urban | Open | Unknown | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **Commercial (2 sites to be selected)** | | | | | | | | | | |
| 20 | BI249D | 0% | 0% | 91% | 0% | 0% | 0% | 9% | 0% | 100% |
| 21 | RXFRD1 | 59% | 10% | 24% | 5% | 2% | 0% | 0% | 0% | 100% |
| **Light Industrial (2 sites to be selected)** | | | | | | | | | | |
| 21 | BLLNA9 | 25% | 0% | 0% | 75% | 0% | 0% | 0% | 0% | 100% |
| 21 | BLLNA6 | 49% | 0% | 12% | 35% | 0% | 0% | 4% | 0% | 100% |
| 21 | CULVER1 | 48% | 12% | 2% | 29% | 6% | 3% | 0% | 0% | 100% |
| 21 | BI81 | 91% | 1% | 0% | 8% | 0% | 0% | 0% | 0% | 100% |
| **Commercial/Light Industrial** | | | | | | | | | | |
| 23 | BI3402 | 34% | 5% | 8% | 26% | 2% | 6% | 20% | 0% | 100% |
| 21 | BI5243 | 59% | 6% | 7% | 18% | 9% | 0% | 1% | 0% | 100% |
| 21 | BI52041 | 0% | 0% | 47% | 35% | 1% | 0% | 0% | 17% | 100% |
| 21 | BI52042 | 0% | 0% | 7% | 70% | 23% | 0% | 0% | 0% | 100% |
| 21 | BI52043 | 24% | 33% | 21% | 7% | 10% | 3% | 2% | 0% | 100% |

## TABLE 2-2b (continued)
## PRELIMINARY LAND USE STATION SITES

*LAND USE (Percent of Total)*

| BASIN # | SUBBASIN NAME | Single-Family Residential | Multi-Family Residential | Commercial | Light Industrial | Public | Other Urban | Open | Unknown | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **Open (2 sites to be selected)** | | | | | | | | | | |
| 1 | ARSEQ2 | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 100% |
| 1 | ARSEQ1 | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 100% |
| 1 | ARSEQ3 | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 100% |
| 4 | LACHU1 | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 100% |
| 10 | LATIG1 | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 100% |
| 15 | PENA1 | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 100% |
| 8 | RAMRZ1 | 1% | 0% | 0% | 0% | 0% | 0% | 99% | 0% | 100% |
| 3 | LALIS1 | 1% | 0% | 0% | 0% | 0% | 0% | 99% | 0% | 100% |
| 6 | TRANC3 | 1% | 0% | 0% | 0% | 0% | 0% | 99% | 0% | 100% |
| 6 | TRANC1 | 1% | 0% | 0% | 0% | 1% | 0% | 98% | 0% | 100% |
| 2 | SNICH | 1% | 0% | 0% | 0% | 0% | 0% | 98% | 0% | 100% |
| 15 | TUNA1 | 3% | 0% | 0% | 0% | 0% | 0% | 97% | 0% | 100% |
| 6 | TRANC2 | 9% | 0% | 0% | 0% | 0% | 0% | 91% | 0% | 100% |
| **Transportation (2 sites to be selected)** | | | | | | | | | | |
| | I-405 | | | | | | 100% | Transportation | | 100% |
| | Hollywood Freeway | | | | | | 100% | Transportation | | 100% |

<u>BI9817</u> is in basin #26 of the Redondo Beach Quadrangle near Palos Verdes Point. The 231 acre subbasin is 91 percent single-family residential, 6 percent multi-family residential, and 3 percent commercial land use. The system is piped with a direct outfall into Lunada Bay.

<u>BI81</u> is in basin #21 of the Venice Beach/Inglewood Quadrangles east of Hughes Airport and north of Los Angeles Airport. The 785-acre piped system runs from Manchester Avenue to 83rd Avenue and is 91 percent single-family residential, 1 percent multi-family residential, and 8 percent light commercial land uses.

<u>BI4881</u> is in basin #21 of the northern Inglewood Quadrangle located near Pepperdine University. The 450-acre piped system drains an area from the 66th Street to Manchester Avenue into a larger subbasin, BI4883. The land uses include 91 percent single-family residential and 9 percent public. Because of BI4881's proximity to BI81, only one of these two stations should be selected.

### 2.2.2 Multi-Family Residential

The screening process identified one preliminary station site and 10 potential sites that require further review of drainage system maps for multi-family residential land use. <u>Two</u> sites are suggested for monitoring.

<u>BI249C</u> is in basin #20 of the southwest Beverly Hills Quadrangle. The basin contains 505 acres with 59 percent multi-family residential, 19 percent open, 12 percent public, 5 percent commercial, 3 percent other urban, and 2 percent single-family residential land use. The basin is located in Santa Monica along Pico Boulevard. The piped system drains into the Kenter Canyon Storm Drain System. A station could be put on the upper reach of the basin near 14th Street to increase the multi-family land use percentage.

<u>BI5212</u> is in basin #21 of the east Hollywood Quadrangle and is located in Los Angeles north of Wilshire Boulevard and south of Sunset Boulevard. The 634 acre channel and piped system contains 63 percent multi-family residential, 17 percent single-family residential, 11 percent commercial, 7 percent public, 1 percent light industrial, and 1 percent open land uses. BI5212 eventually forms a piped system which drains to the Grant Boundary Piped System.

### 2.2.3 Combined Residential

The screening process identified three preliminary station sites and nine potential sites that require further review of drainage system maps for combined residential land use. These sites could be substituted for one or more of the single or multi-family sites mentioned above.

<u>BI504</u> is in basin #21 of the central Beverly Hills/Venice Beach Quadrangles and is located in Ballona. The land uses are 74 percent single-family residential, 25 percent multi-family residential, 3 percent commercial, and 3 percent public. BI504 drains an area of 462 acres from Charnoch Road to Ballona Creek between Bentivela Avenue and Alla Road. BI504 is most likely a piped system.

<u>BI503</u> is in basin #21 of the central Beverly Hills/Venice Beach Quadrangle located east of BI504. The land uses are 70 percent single and 25 percent multi-family. It drains an 198 acre area from Venice Avenue and Sepulveda Channel into Ballona Creek. Sample station #12 is located at the outfall of the piped system to Ballona Creek.

BI736 is in basin #20 of the southwest Beverly Hills Quadrangle located in Santa Monica, south of Pico Boulevard and north of Rose Avenue. BI736 drains 195 acres of 73 percent multi-family residential, 20 percent single-family residential, 4 percent open, and 3 percent commercial land uses. BI736 drains directly into Santa Monica Bay through a piped system. Two sample stations are located at the outfall, #30 and #22.

BI5213 is basin #21 of the east Hollywood Quadrangle and is located in Los Angeles north of the Hollywood Freeway and south of Silver Lake Reservoir. The 809 acre piped system contains 77 percent single-family residential, 16 percent multi-family residential, 4 percent open, 2 percent light industrial, 1 percent commercial, and 1 percent public land uses. BI5213 drains into the Grant Boundary Piped System.

BI648A is in basin #21 of the central Hollywood Quadrangle and is located in Las Cienegas between Venice Boulevard and Washington Boulevard. The 322 acre piped system drains to the upper reach of Ballona Creek. the land uses include 62 percent multi-family residential, 28 percent single-family residential, 8 percent commercial, and 2 percent open. BI648A also is a possible multi-family residential land use site candidate.

BI11021 is in basin #21 of the northeast Hollywood Quadrangle. The basin contains 1,299 acres with 64 percent single-family residential, 22 percent multi-family residential, 6 percent commercial, 4 percent public, 2 percent light industrial, and 1 percent other urban land uses. The basin is located in east Hollywood between Olive Hill and the Silver Lake Reservoir, north of the Hollywood Freeway and south of Los Feliz Boulevard. The piped system drains to the Grant Boundary piped system. The BI11021 monitoring site would need to be moved upstream near the intersection of Hillhurst Avenue and Romaine Street to avoid possible dual outlets.

BI572 is in basin #21 of the east Hollywood Quadrangle and is located in Hollywood between 4th Street and the Santa Monica Mountains. The 1,068 acre piped system eventually drains to Ballona Creek. Land uses include 56 percent multi-family residential, 32 percent single-family residential, 6 percent commercial, 4 percent public, 1 percent open, and 1 percent other urban.

### 2.2.4 Commercial

The screening process identified two preliminary station sites and two potential sites that require further review of drainage system maps for commercial land use. Two commercial sites would be recommended.

BI249D is in basin #20 of the southwest Beverly Hills Quadrangle located between w Boulevard and Colorado Avenue in Santa Monica. The basin is 76 acres with 91 percent commercial and 9 percent open land use. The piped system discharges into Santa Monica Bay. It appears to have two possible outlets and actual drainage must be further investigated.

RXFRD1 is in basin #21 of the central Beverly Hills Quadrangle located between Santa Monica Boulevard and Wilshire Boulevard in Beverly Hills. The upper reach of storm drain #412 can be isolated for approximately 80 acres of commercial property. RXFRD1 is 59 percent single-family residential, 24 percent commercial, 10 percent multi-family residential, 5 percent light industrial, and 2 percent public land uses.

### 2.2.5 Light Industrial

The screening process identified four preliminary station sites and two potential sites that require further review of drainage system maps for light industrial land use. Two stations would be recommended for sampling.

BLLNA9 is in basin #21 of the Beverly Hills Quadrangle located northwest of Santa Monica High School on Wilshire Boulevard. The 78-acre piped system appears to drain to two possible outlets but remains a good candidate due to its high concentration of light industrial land use. The land uses are 75 percent light industrial and 25 percent single-family residential.

BLLNA6 is in basin #21 in the southeastern Beverly Hills Quadrangle located in Culver City near the Santa Monica Freeway. BLLNA6 is a 108-acre piped system draining to Ballona Creek with two pipe/channel storm drains, #424 and MTD 613. Storm drain #424 is predominantly light industrial and appears to be easily isolated, thus increasing the light industrial land use percentage.

CULVER1 is in basin #21 of the southeastern Beverly Hills Quadrangle located just northwest of DESILU Studios in Culver City. The piped section along Washington Boulevard could be isolated, as it appears to drain a light industrial area of approximately 60 acres. The land use percentages are 48 percent single-family residential, 29 percent light industrial, 12 percent multi-family residential, 6 percent public, 3 percent other urban, and 2 percent commercial.

### 2.2.6 Commercial and Light Industrial

The screening process identified two preliminary station sites and four potential sites that require further review of drainage system maps for combined commercial and light industrial land use. These sites could be substituted for one or more of the commercial and/or light industrial sites.

BI5242 is in basin #21 of the Venice Quadrangle located in Ballona north of Marina Del Ray. The 681-acre piped system drains 170 acres of commercial and light industrial land (25 percent of the total). Approximately 80 acres of light industrial and commercial land could be isolated on storm drain 3872 at the intersection of Thatcher and Oxford Avenues. The reach drains from Redwood Avenue to Thatcher Avenue. Additional confirmation of actual area drainage patterns will be needed.

BI3402 is in basin #23 of the Venice Quadrangle located in El Segundo just south of the Los Angeles International Airport (LAX). The 443-acre basin drains 149 acres of commercial and light industrial land (34 percent of the total). BI3402 drains from Mariposa Avenue to El Segundo Boulevard. Reach 3401 on the eastern portion could be isolated at Penn Street and El Segundo Boulevard, providing approximately 100 acres of light industrial and commercial land use.

BI52041 is in basin #21 of the southeast Hollywood Quadrangle and is located in Los Angeles between 12th Street and Jefferson Boulevard. The 1,082 acre piped system drains into storm line #5204. The land use percentages include 47 percent commercial, 35 percent light industrial, 17 percent unknown, and 1 percent public.

BI52042 is in basin #21 of the southeast Hollywood Quadrangle adjacent to BI52041. BI52042 is located in Los Angeles between 12th Street and the University of Southern California. The 442 acre piped system drains to storm line #5204. The land use percentages include 70 percent light industrial, 23 percent public, and 7 percent commercial. Sample station #3 is located in BI52042.

BI52043 is in basin #21 of the southeast Hollywood Quadrangle and is located in Los Angeles adjacent to BI52041 and BI52042. The 2,934 acre system drains to storm line #5402. The land use percentages include 33 percent multi-family residential, 24 percent single-family residential, 21 percent commercial, 10 percent public, 7 percent light industrial, 3 percent other urban, and 2 percent open. BI52043 should be isolated on the upper reach to produce a much higher commercial and light residential land use percentage.

### 2.2.7 Open Space

The screening process identified ten preliminary station sites for open space land use. Two stations would be recommended.

ARSEQ1, ARSEQ2 and ARSEQ3 are in basin #1 of the Trifuno Pass Quadrangle. The 8000 acres of combined area drain portions of the Santa Monica Mountains into the Arroyo Sequint and discharges into the Pacific Ocean near Sequint Point and Leo Carrillow State Beach, east of Solromar. The Roosevelt Highway appears to provide good access to the channel. The drainage system is well defined with approximately 99 percent open land use.

LATIG1 is in basin #10 of the Point Dume Quadrangle located east of Malibu Riviera and Point Dume. LATIG1 drains 697 acres of 100 percent open space in Latigo Canyon to Santa Monica Bay.

LACHU1 is in basin #4 of the Trifuno Pass Quadrangle located east of Sequint Point and north of the Roosevelt Highway, allowing good access. The basin drains 826 acres of open space in Lachusa Canyon to the Pacific Ocean. Rain gage #4867 is located in the northern end of LACHU1 allowing access to local rainfall information.

PENA1 is in basin #15 of the Topanga Quadrangle located west of Topanga Beach in Pena Canyon. The 483 acres of 100 percent open space drains directly to Santa Monica Bay via a channel system.

TUNA1 is in basin #15 of the Topanga Quadrangle located in Tuna Canyon west of Topanga Beach and Pacific Palisades and directly east of PENA1. The 935 acres drains the 97 percent open and 3 percent single-family residential land uses through a channelized system.

RAMRZ1 is located in basin #8 of the Point Dume Quadrangle east of Malibu. The 1675-acre basin contains 99 percent open space and 1 percent single-family residential land uses. The basin drains most of the steep terrain of Ramiriz Canyon.

LALIS1 is in basin #3 of the Trifuno Pass Quadrangle located east of Sequint Point and north of the Roosevelt Highway, allowing good access. The basin drains 943 acres of open space in Los Alisos Canyon to the Pacific Ocean. LALIS1 is located west of LACHU1.

TEMES1 is in basin #18 of the central Topanga Quadrangle located north of Pacific Palisades. The 1548-acre area drains Temescal Canyon which is 87 percent open space and 13 percent single-family residential land use. The 1300 acres of the upper basin could be isolated, providing a possible monitoring site.

TRANC1, TRANC2, and TRANC3 are adjacent to one another in basin #6 of the Point Dume Quadrangle located in Trancas Canyon west of Point Dume. The three basins drain 5217 acres in the Santa Monica Mountains National Recreation Area and discharge to the Pacific Ocean through an open channel near Trancas. The land uses are 98 percent open, 1 percent single-family residential, and 1 percent public land uses. Sampling Station #34 is also located just south in TRANC4 providing additional monitoring information.

SNICH is in basin #6 of the Trifuno Pass Quadrangle located east of Sequint Point and north of the Roosevelt Highway, allowing good access. The basin drains 847 acres of open space to the Pacific Ocean. SNICH is located directly west of LACHU1 and LALIS1.

### 2.2.8 Transportation

The land use breakdowns that were obtained from Southern California Association of Governments (SCAG) and incorporated into the Project GIS system did not include a category for highways or other major transportation corridors. However, one site in the watershed was previously monitored by Cal Trans (Racin et al., 1982) and is proposed as a transportation land use station site for this monitoring program. The station site is located in Los Angeles on Interstate 405 at a 36-inch reinforced concrete pipe culvert. The station receives runoff from 3.2 acres of paved highway. At this location, Interstate 405 has 4 lanes in each direction and had an average daily traffic load of 200,000 vehicles in 1980.

The second candidate transportation site is in basin #21 of the east Hollywood Quadrangle and is located in Los Angeles. Over 6,500 linear feet of the Hollywood Freeway Corridor drain to the BI5213 system including 4,000 feet from basin BI5212. This represents a preliminary site selection and will require further review of specific highway drainage maps, which is beyond the scope of this plan.

## 2.3 PRELIMINARY MASS EMISSIONS STATION SITES

Stations were selected for mass emissions station sites which comprise large percentages of Santa Monica Bay Watershed land use mix or have been estimated to contribute significant portions of storm water runoff pollutants. The land use composition of the catchments of each of the mass emission monitoring sites is summarized in Table 2-3. Descriptions of the mass emissions station sites are presented below. The stations listed below are preliminary. The actual location of the station would depend on field reconnaissance of the storm drainage system. Together, these stations would measure runoff from a 4-basin total of 169,376 acres or approximately 75 percent of the 225,474 acre Santa Monica Bay Watershed.

### 2.3.1 Ballona Channel

Ballona Channel drains 82,287 acres of basin #21 and a total of 36.5 percent of the Santa Monica Bay Watershed. Land use in the basin includes 46 percent single-family residential, 18 percent multi-family residential, 8 percent commercial, 4 percent light industrial, 4 percent public, 3 percent other urban, 17 percent open space, and less than 1 percent unknown.

## TABLE 2-3a
## PRELIMINARY MASS EMISSIONS SAMPLING STATION SITES

*LAND USE (Acres)*

| SUBBASIN NAME | BASIN # | Single-Family Residential | Multi-Family Residential | Commercial | Light Industrial | Public | Other Urban | Open | Unknown | Subbasin Total Acreage |
|---|---|---|---|---|---|---|---|---|---|---|
| Ballona Channel | 21 | 38,049 | 14,996 | 6,664 | 3,371 | 3,048 | 2,929 | 13,874 | 356 | 83,287 |
| Malibu Creek | 12 | 5,694 | 353 | 430 | 414 | 346 | 1,184 | 61,874 | 0 | 70,292 |
| Pico-Kenter Storm Drain | 20 | 1,554 | 398 | 72 | 0 | 100 | 25 | 1,043 | 0 | 3,191 |
| Topanga Creek | 16 | 1,457 | 0 | 0 | 0 | 0 | 0 | 11,149 | 0 | 12,606 |
|  | TOTALS | 46,754 | 15,747 | 7,166 | 3,785 | 3,494 | 4,138 | 87,940 | 356 | 169,376 |

## TABLE 2-3b
## PRELIMINARY MASS EMISSIONS SAMPLING STATION SITES

*LAND USE (Percent of Total)*

| SUBBASIN NAME | BASIN # | Single-Family Residential | Multi-Family Residential | Commercial | Light Industrial | Public | Other Urban | Open | Unknown | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Ballona Channel | 21 | 46% | 18% | 8% | 4% | 4% | 3% | 17% | <1% | 100% |
| Malibu Creek | 12 | 8% | 1% | 1% | 1% | <1% | 2% | 87% | 0% | 100% |
| Pico-Kenter Storm Drain | 20 | 49% | 12% | 2% | 0% | 3% | 1% | 33% | 0% | 100% |
| Topanga Creek | 16 | 12% | 0% | 0% | 0% | 0% | 0% | 88% | 0% | 100% |
|  | TOTALS | 28% | 9% | 4% | 2% | 2% | 2% | 52% | <1% | 100% |

### 2.3.2 Malibu Creek

Malibu Creek drains 70,292 acres of basin #12 and a total of 31.2 percent of the Santa Monica Bay Watershed. Land use in the basin includes 8 percent single-family residential, 1 percent multi-family residential, 1 percent commercial, 1 percent light industrial, less than 1 percent public, 2 percent other urban, and 87 percent open space.

### 2.3.3 Pico-Kenter Storm Drain

Pico-Kenter Storm Drain drains 3,191 acres in basin #20 and a total of 1.4% of the Santa Monica Bay Watershed. Land use in the basin includes 49 percent single-family residential, 12 percent multi-family residential, 2 percent commercial, 3 percent public, 1 percent other urban, and 33 percent open space.

### 2.3.4 Topanga Creek

Topanga Creek drains 12,606 acres of basin #16 and a total of 5.6 percent of the Santa Monica Bay Watershed. Land use in the basin includes 12 percent single-family residential, 18 percent multi-family residential and 88 percent open space. Topanga Creek was selected because flows were previously measured at this creek, and records of stream flow are available from USGS and the Los Angeles County Department of Public Works. Since selecting this site we have learned that the flow monitoring station was removed; restoration of this station will be necessary for this creek to be used.

# 3.0
# MONITORING STATION EQUIPMENT

This section describes the types of equipment needed to implement the monitoring plan. Overviews of equipment installation, calibration, verification, and operation are also presented.

## 3.1 EQUIPMENT SELECTION

Equipment should be selected to perform flow monitoring and water quality sampling to meet the monitoring plan objectives. Various types and models of rain gages, water quality samplers, and flow monitoring systems are available. Minimum technical specifications should be developed for requesting bids from vendors. In general, the specifications should include that the stations be: automated with various programming and sampling options; capable of being linked by telemetry for remote operation and data transfer (recommended for long-term monitoring because it will reduce staff maintenance time and allows for continuous monitoring of the stations); installed as permanent but easily moveable stations; and supported by a sophisticated station and flow data management program.

### 3.1.1 Rain Gages

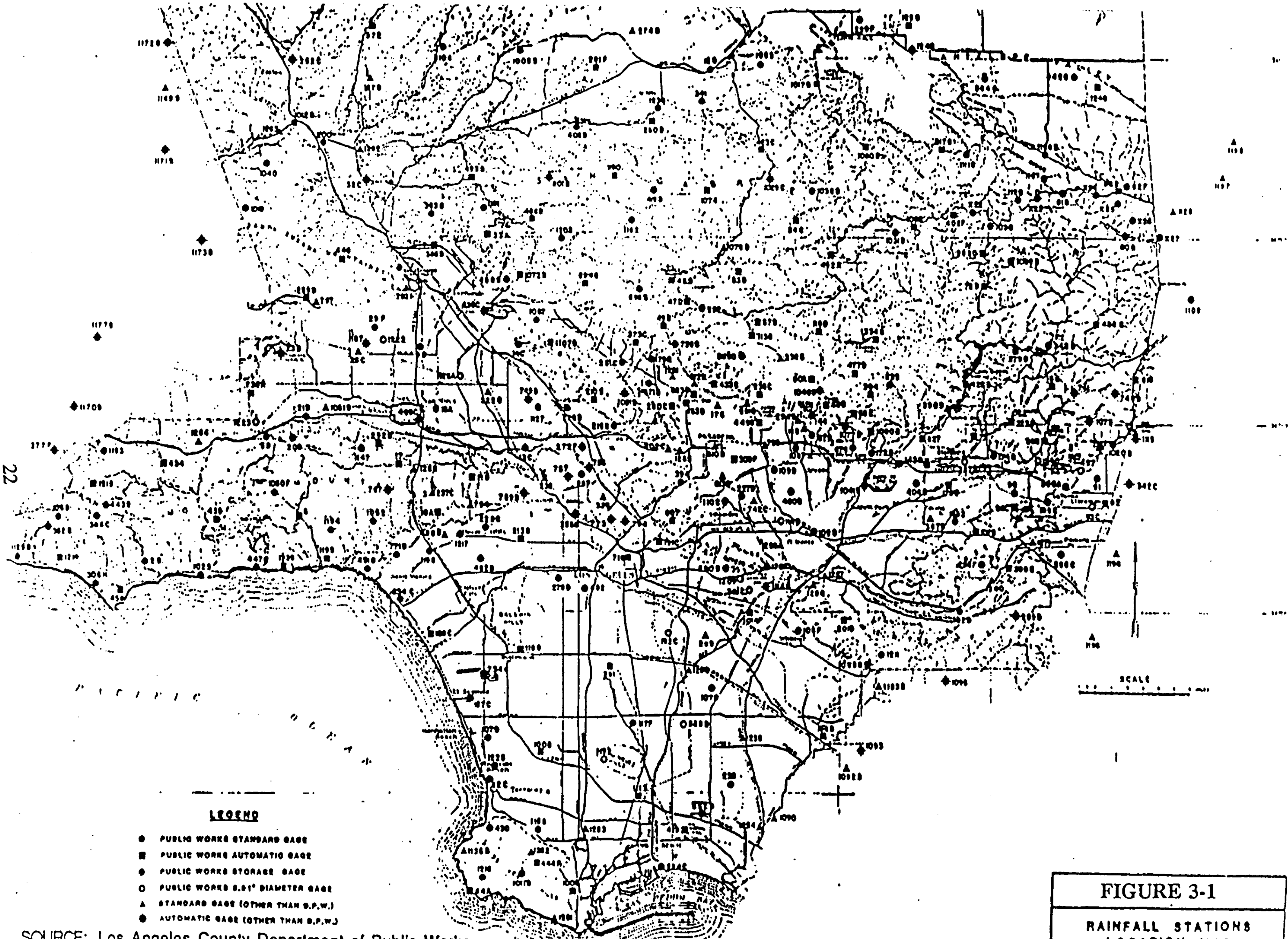
Rain gages are located throughout the watershed as shown in Figure 3-1. These gages are operated by the Los Angeles County Department of Public Works who should consider making them available for use in the monitoring program. The system should be set up so that at least some of the data (based upon final monitoring station selection) collected by these gages can be immediately available for inspection via a telemetry system and can be downloaded to a computer for graphical or tabular display.

### 3.1.2 Flow Monitoring Hardware/Software and Equipment Control

It is recommended that when possible monitoring stations (closed conduit stations), both water depth and velocity, be independently monitored because a variety of parameters (slope, roughness...) are necessary to ensure the accuracy of Manning's equation. The cross-sectional area of water can be obtained from the measured water depth and the shape of the given pipe. The flow can then be computed as the cross-sectional area multiplied by the average velocity.

Flow estimates for open channel stations should be obtained using rating curves established for each station. Rating curves correlate flow with depth using a limited set of velocity and flow depth measurements. This would require measurement of velocities over a variety of flow depths during several storm events.

Alternative methods for estimating flow without velocity measurements exist and may be utilized prior to establishing a rating curve to estimate flow rates. Depth measurements can be used in conjunction with channel characteristics and empirical flow equations to calculate flows (Manning's equation).



SOURCE: Los Angeles County Department of Public Works, *Hydrologic Report*, 1988-89.

FIGURE 3-1

RAINFALL STATIONS
LOCATION MAP
1988-89

Other equipment that should be installed at the monitoring stations include a system microprocessor; water quality sampler control unit; equipment housing (open channel stations only); computer site-specific software for hardware control; telemetry equipment; and power source (batteries or other electrical power). Decisions regarding specific equipment types or makes should be made by the implementing agency.

A typical station configuration is presented in Figure 3-2, which shows the major components of a monitoring station located in a manhole. A monitoring station located in an open channel would have a separate enclosure for the flow monitor and sampler. Open channel stations would use an overhead structure (a bridge) to mount the non-intrusive ultrasonic depth sensors or stream bottom-mounted pressure transducer. A rain gage is not shown in the figure. Finally a separate structure can be located adjacent to the sampling location and the equipment can be located inside, with appropriate connection to the liquid surface.

The exact type of installation will depend upon site-specific conditions; in some cases several alternative installations can provide adequate sampling. In such cases the preference of the agency performing the sampling will determine the sampling station design.

Station operation is depicted in Figure 3-3. Software on a personal computer would enable communication with the rain gage and flow monitor over a phone line. The flow estimated from the depth and velocity data would be used to update the cumulative volume. When a pre-defined cumulative volume is exceeded, the flow monitor would send a signal to activate the water quality sampler. The sampler collects a sample through the intake line. Signals from the rain gage can also be used to activate the water quality sampler for individual samples, but this method is not recommended in this plan.

### 3.1.3 Water Quality Samplers

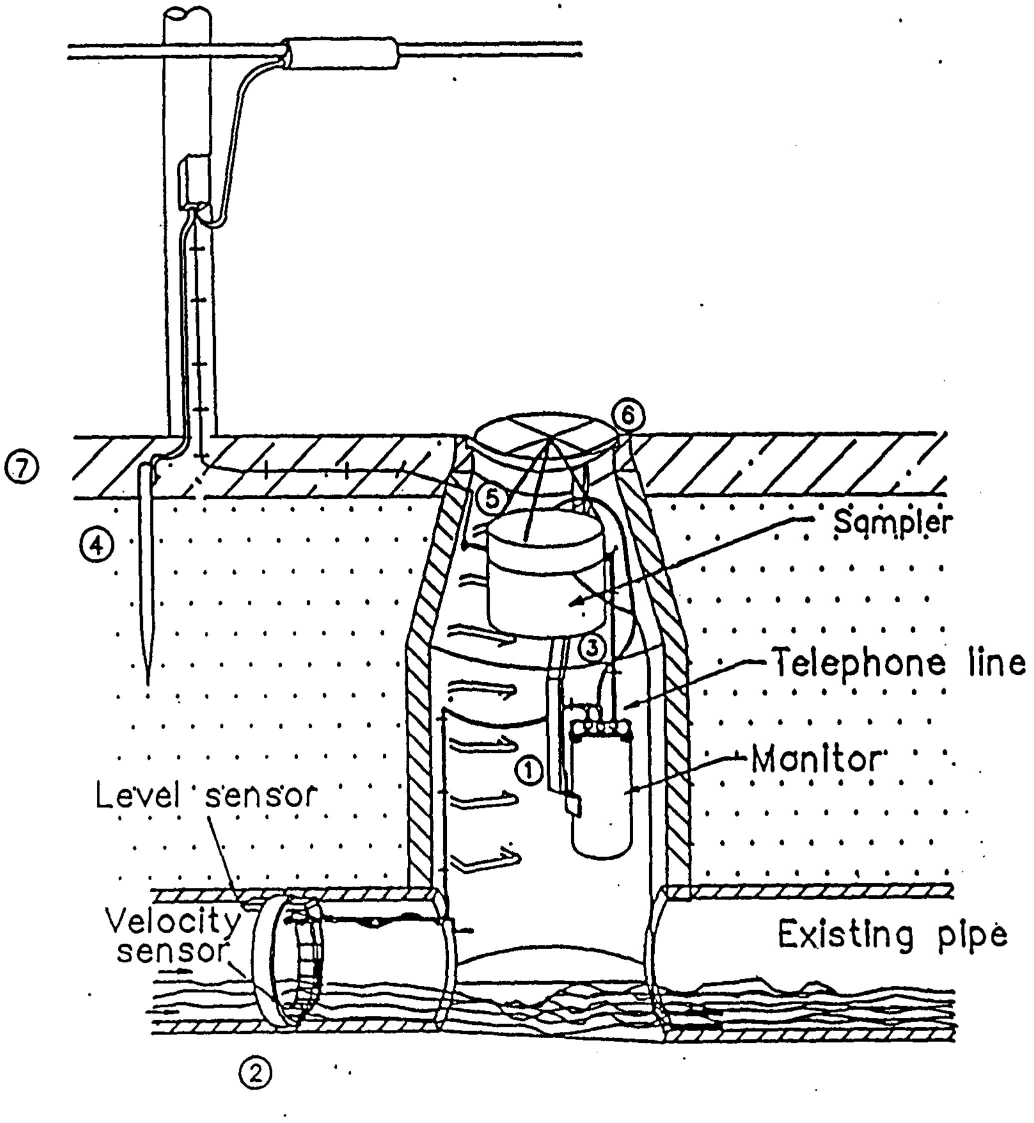
Each station should be equipped with an automatic water quality sampler that can be configured for either discrete or composite sampling. For storm water monitoring, the samplers can be configured to fill sample bottles for composite sampling by collecting samples per calculated flow volumes. For parameters that need to be tested on-site or in discrete samples, grab samples can be collected manually. For some parameters, such as oil and grease, in some cases it is necessary to use a hand sampler to collect a representative sample (see Volume II of these reports). Water quality samplers are available in refrigerated units which require a source of electrical power. If no power source is readily available, samples can be kept cool using ice, and the equipment can be powered using batteries. This decision should be made by the implementing agency.

## 3.2 EQUIPMENT INSTALLATION

The monitoring stations would be located in manholes, closed conduits, or in open channels. The following text provides a generalized overview of equipment installation procedures at these stations.

### 3.2.1 Closed Conduit and Manhole Stations

At manhole stations, sensor equipment should be installed in locations which provide the most stable hydraulic conditions. Typically these conditions occur just upstream from the location of the manhole, because construction of the manhole may have altered the original



## Mounting Details

1. Mounting flange consists of marine grade aluminum bar stock. Width is 3" — length is determinate upon the individual site condition.
2. Sensor mounting plates consist of marine grade aluminum bar stock that are attached with 1/4" anchor bolts (316SS). Embedment depth approx. 1".
3. Cables are anchored with 1/4" anchor bolts (316SS). Approximate embedment depth is 1".
4. Grounding rod is provided by phone company and is installed by them as per their specifications.
5. Cable penetration through corbell is made with rotary hammer drill and is then sealed with a urethane or epoxy compound.
6. Manhole rim is drilled and tapped. Aluminum mounting flange is attached with 3/8" threaded stud (316SS).
7. Roadcut depth varies between 6" and 12" depending on local regulations. Cut is then sealed with PRECO road sealant.

FIGURE 3-2 MONITOR AND SAMPLER INSTALLATION SPECIFICATIONS

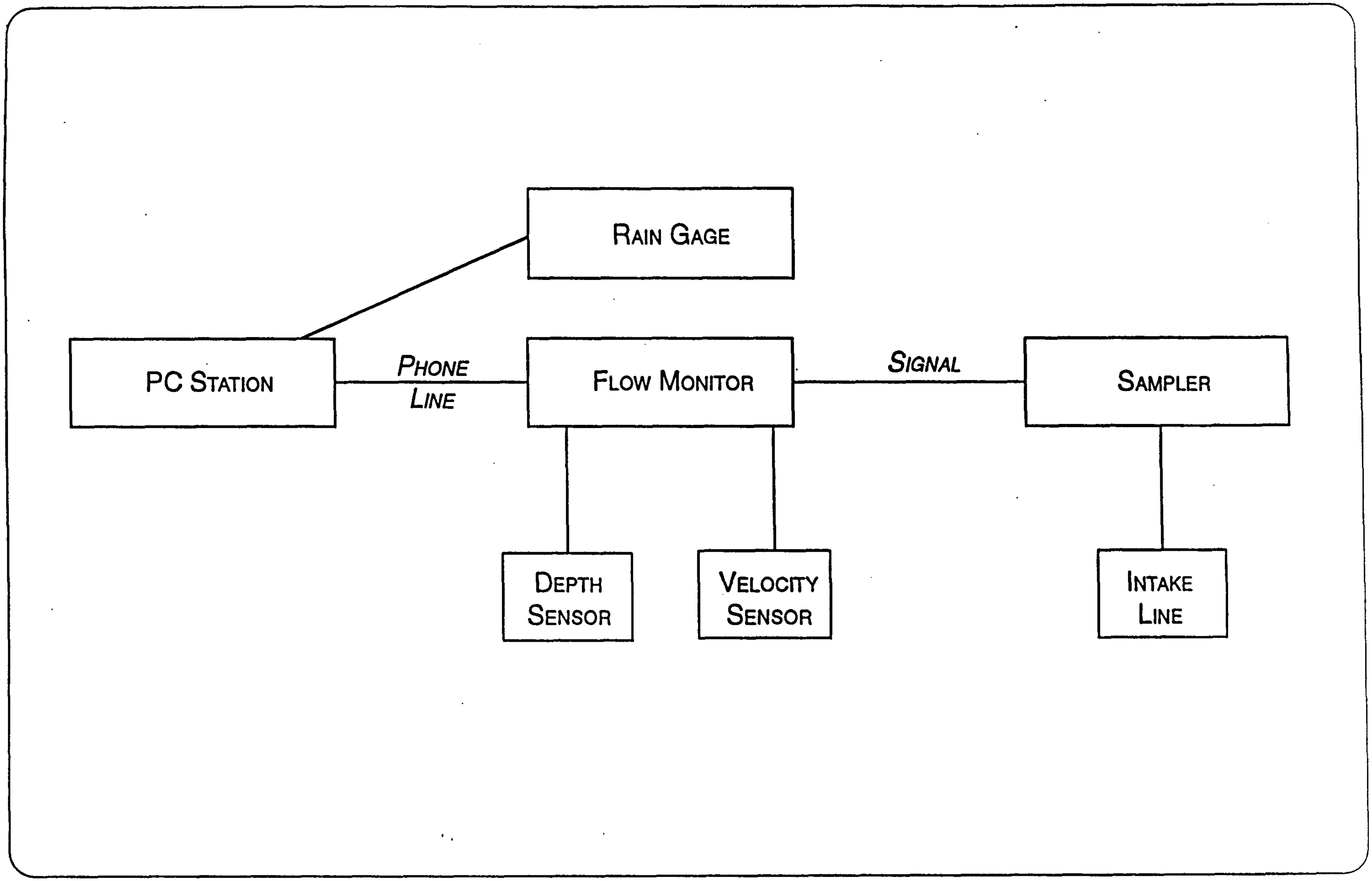


FIGURE 3-3 STATION COMMUNICATION

shape of the pipe at this point, thus changing the hydraulic characteristics of the channel. Actual sensor installation consists of mounting the depth and velocity sensors to expansion rings sized for an individual pipe and then expanding the ring for a tight fit. The expansion rings facilitate easy removal of the sensors for maintenance or replacement or movement to another site. The water sampler intake tubing and strainer are to be mounted at the invert of the pipe just downstream of the sensing equipment ring.

The sampling equipment can be mounted in the manhole so that it does not interfere with activities on the surface. Alternatively, it may be more desirable to mount the equipment in a protective enclosure at the surface. The choice will depend upon site-specific conditions.

### 3.2.2 Open Channel Stations

For an open channel station at a bridge or culvert, non-intrusive ultrasonic depth sensors can be mounted to the underside of these structures at or near mid-channel. Velocity sensors and pressure transducers should be mounted on the bottom at the center of these channels. The water quality sampler intake tubing and strainer are to be located just downstream at mid-channel. The intake is to be located so that water samples would be collected at the same width cross section location where depth measurements are made. The flow monitor microprocessor and water quality sampler units should be mounted in weather proof enclosures. For channels with low flow sections, the pressure transducer and intake screen will need to be located to sense the lowest point of the invert. If both wet and dry weather flows are to be measured, two sensors with different ranges may be required.

## 3.3 EQUIPMENT CALIBRATION

Calculation of flow in the closed conduits can be based either on the depth of flow, or the depth and the velocity of flow. Both depth and velocity of flow should be measured upon installation by means independent of the flow sensor to verify sensor readings. Depth measurements can be verified with a scaled wading rod or similar device. In order to verify and adjust the velocity sensors, concurrent measurements should be taken with hand-held electromagnetic velocity meters.

In cases were pressure flows exists alternative procedures may be required.

## 3.4 VERIFICATION AND OPERATION OF STATION EQUIPMENT

Station equipment and telemetry should be verified prior to storm sampling events. Equipment diagnostics should be performed to check the equipment. In addition, operation of each of the water quality samplers should be verified through operation of the samplers. Station preparation, event initiation, event operation, event shut down, and data transfer procedures will be fully described in the Standard Operations Procedures (SOPs). These are outlined in Chapter 7.

# 4.0
# STORM SELECTION AND RUNOFF ESTIMATION PROCEDURES

This section describes procedures used to estimate and measure rainfall and storm water runoff volumes. Also included are the criteria used for the selection of storms to be sampled.

## 4.1 BACKGROUND

One objective of the storm water sampling program is to estimate the relationship between rainfall amounts and runoff volumes for use in pollutant load estimation models. The runoff coefficient is defined as the fraction of the total rainfall volume (i.e., the amount of rainfall over the watershed area) that becomes storm water runoff. Runoff volume estimates (calculated by multiplying the runoff coefficient and the predicted rainfall volume) are used to program the sampling equipment to collect representative flow-weighted composite samples. Runoff volumes are also used in conjunction with calculated site median concentrations (SMC) of pollutants as input to storm water runoff models that generate (basin wide) pollutant loads.

Eight storm events are to be sampled over the course of two years (an average of 4 sampling events per year). These events should be selected to represent the various typical seasonal storms for the Santa Monica Bay area with the realization that storms available for sampling may be few. Storm selection criteria are designed to determine which storms will be sampled. These criteria will be used to ensure that sampled storms represent the storm characteristics (e.g., volume, intensity, antecedent dry period) that are typical for Santa Monica Bay and meet Federal regulatory requirements.

## 4.2 STORM SELECTION CRITERIA

Storm characteristics were determined for selected rain gages operated by the Los Angeles County Department of Public Works (LACDPW) with records available through the National Weather Service. Details are presented in Stenstrom and Strecker (1993). The rain gage records were analyzed for storms that were defined as having more than 0.10 inches of precipitation with a six-hour inter-event time. Characteristics of storms occurring during the wet season (i.e., November through April) were computed separate from the dry season. The results of the analyses are compiled by station and for the entire watershed in Table 4-1. Santa Monica Bay has an average of approximately 16 storm events per wet season.

The NPDES permit application requires storm water data from three storm events occurring at least one month apart, with an "event" defined as a minimum of 0.1 inches of rain occurring at least 72 hours from the previously measurable (greater than 0.1 inch of rainfall) storm event. At least three storms should be sampled where the duration and total volume are within about 50 percent of the average storm to meet the NPDES permit application requirements. Based upon analysis of data from the LACDPW rain gages, these storms should be between 6 to 25 hours in duration and about 0.4 to 1.7 inches in volume. These criteria can be relaxed if needed to make sure that enough storms are available for sampling.

## TABLE 4-1
## WET SEASON STORM STATISTICS (a)

| STATION | PERIOD OF ANALYSIS (water years) | STORM VOLUME (inches/storm) | | STORM INTENSITY (inches/hour) | | STORM DURATION (hours/storm) | | $^{333}$TIME BETWEEN $^{333}$STORMS (hours) | |
|---|---|---|---|---|---|---|---|---|---|
| | | Average | Coef of Var | Average | Coef of Var | Average | Coef of Var | Average | Coef of Var |
| 0619 | 1948-1980 | 1.06 | 1.22 | 0.084 | 0.66 | 12.5 | 0.85 | 209 | 1.32 |
| 0818 | 1948-1976 | 0.98 | 1.22 | 0.068 | 0.74 | 14.2 | 0.92 | 258 | 1.25 |
| 1194 | 1948-1989 | 0.88 | 1.31 | 0.067 | 0.69 | 13.0 | 0.89 | 231 | 1.20 |
| 1682 | 1948-1989 | 0.88 | 1.27 | 0.063 | 0.69 | 14.0 | 0.91 | 230 | 1.22 |
| 4867 | 1948-1989 | 1.09 | 1.17 | 0.101 | 0.73 | 11.3 | 0.87 | 198 | 1.35 |
| 5085 | 1977-1989 | 0.67 | 1.05 | 0.061 | 0.79 | 11.3 | 0.71 | 221 | 1.10 |
| 5114 | 1948-1989 | 0.68 | 1.16 | 0.062 | 0.72 | 12.0 | 0.83 | 221 | 1.23 |
| 5115 | 1948-1989 | 0.81 | 1.18 | 0.067 | 0.69 | 12.8 | 0.87 | 221 | 1.21 |
| 8092 | 1948-1989 | 0.96 | 1.26 | 0.069 | 0.74 | 13.5 | 0.89 | 238 | 1.23 |
| 8230 | 1948-1989 | 0.69 | 1.07 | 0.074 | 0.73 | 10.5 | 0.88 | 219 | 1.36 |
| Minimum | | 0.67 | | 0.061 | | 10.5 | | 198 | |
| Maximum | | 1.09 | | 0.101 | | 14.2 | | 258 | |
| Average | | 0.87 | | 0.072 | | 12.5 | | 225 | |

(a) For storms having more than 0.10 inches of precipitation with a 6-hour inter-event time during November through April.

Storms can be sampled during both the wet and dry seasons. As defined in Table 4-1, the wet season is defined as lasting from the beginning of November through the end of April. This wet season is associated with more frequent storms and shorter dry weather intervals between storms. Conversely, the dry season is associated with less frequent storms of greater intensity and longer dry weather intervals between storms. It is likely that almost all of the representative storm events will occur during the wet season.

## 4.3 RUNOFF ESTIMATION PROCEDURES

The predicted rainfall amounts, watershed area, and runoff coefficients (the product of all three parameters) can used to estimate runoff volumes for each of the selected catchments. Runoff coefficients by land use were developed for the loadings model based upon information from Los Angeles County.

Water depth and resulting flow data should be continually collected from each sampling station at a uniform time interval (5 minutes is typical during a storm event). The data would be retrieved using a portable computer (directly or by modem through telemetry equipment) and would ultimately be downloaded to a database. Runoff coefficients specific to each sampled catchment should be based upon an estimate of the impervious area percent in previous estimates for each of the land uses in the catchment.

Each storm event monitored by the flow and rainfall monitors provides additional information for calculating runoff coefficients. These coefficients can be calculated by dividing the total measured runoff for the event by the total rainfall volume over the contributing catchment. As those data are developed, the expected result coefficient for each watershed can be refined. It will also be a function of total rainfall and as well as condition of the watershed (e.g., the presence of residual moisture from a previous rainfall). Finally, flows from permitted discharges (if any) must be subtracted from the measured flow rates.

Once the total runoff volume is estimated, the water quality samplers should be programmed to collect a sample each time after approximately five percent of the runoff volume has flowed past the sensors. Therefore, the water quality sampler is programmed to collect about 20 samples over the entire storm. Each time the sampler is triggered to collect a sample a pre-specified volume of storm water would be deposited into one of the bottles. The total volume of storm water collected should be greater than or equal to the volume of sample needed by the laboratory to conduct all of the specified analyses. If a storm happens to be larger than expected, the sampler's bottles may be filled prior to the end of the storm. In this case it will be necessary to replace the full bottles with empty bottles.

For dry weather sampling, the water quality samplers should be programmed to collect a sample once each hour for 24 hours. The samples collected would be flow-weighted for laboratory analysis. Grab samples can be collected at the beginning of the sampling period and/or at the end of the sampling period. Dry weather sampling at the mass emission stations is proposed for 4 to 6 times per year during the 2-year sampling period. Unlike the mass emission stations, the single land use sites may not have base flows. Any flows that do occur during dry weather at the single land use stations may be due to illicit connections. It is proposed that one grab sample would be collected at the single land use stations if the continuous flow measurements indicate a potential problem (i.e., unaccounted for flow).

# 5.0
# SAMPLING EVENT MANAGEMENT AND WATER QUALITY FIELD SAMPLING METHODS

The objective of this section is to describe the field sampling methods for obtaining water samples. Automatic flow-weighted composite samples and manual grab samples should be collected. Automatic samplers would be used to collect flow-weighted composite water samples throughout the duration of a storm event or the duration of the dry-weather monitoring period, whereas grab samples would represent instantaneous samples.

Storm sampling would primarily be performed by automatic samplers because of their ability to automatically trigger sampling when a storm starts and their ability to composite storm water samples, based on flow volumes. Automatic samplers would also be used to collect the 24-hour flow composited sample during dry weather at the mass emission stations (by reprogramming the samplers). Grab samples would be collected for instantaneous field measurements at each initial station visit during a storm event and at the beginning and/or end of the dry-weather monitoring period. At the time of grab sample collection, chemical/bacteriological constituents that have short holding times (such as fecal streptococci) and those that are highly volatile in nature (such as volatile organic compounds) would be collected.

Figure 5-1 provides an overview of the storm event decision/action tree. The main elements of the tree are discussed below. Dry-weather monitoring would occur as described in Section 4.3.

## 5.1 PRE-STORM PREPARATION STRATEGY

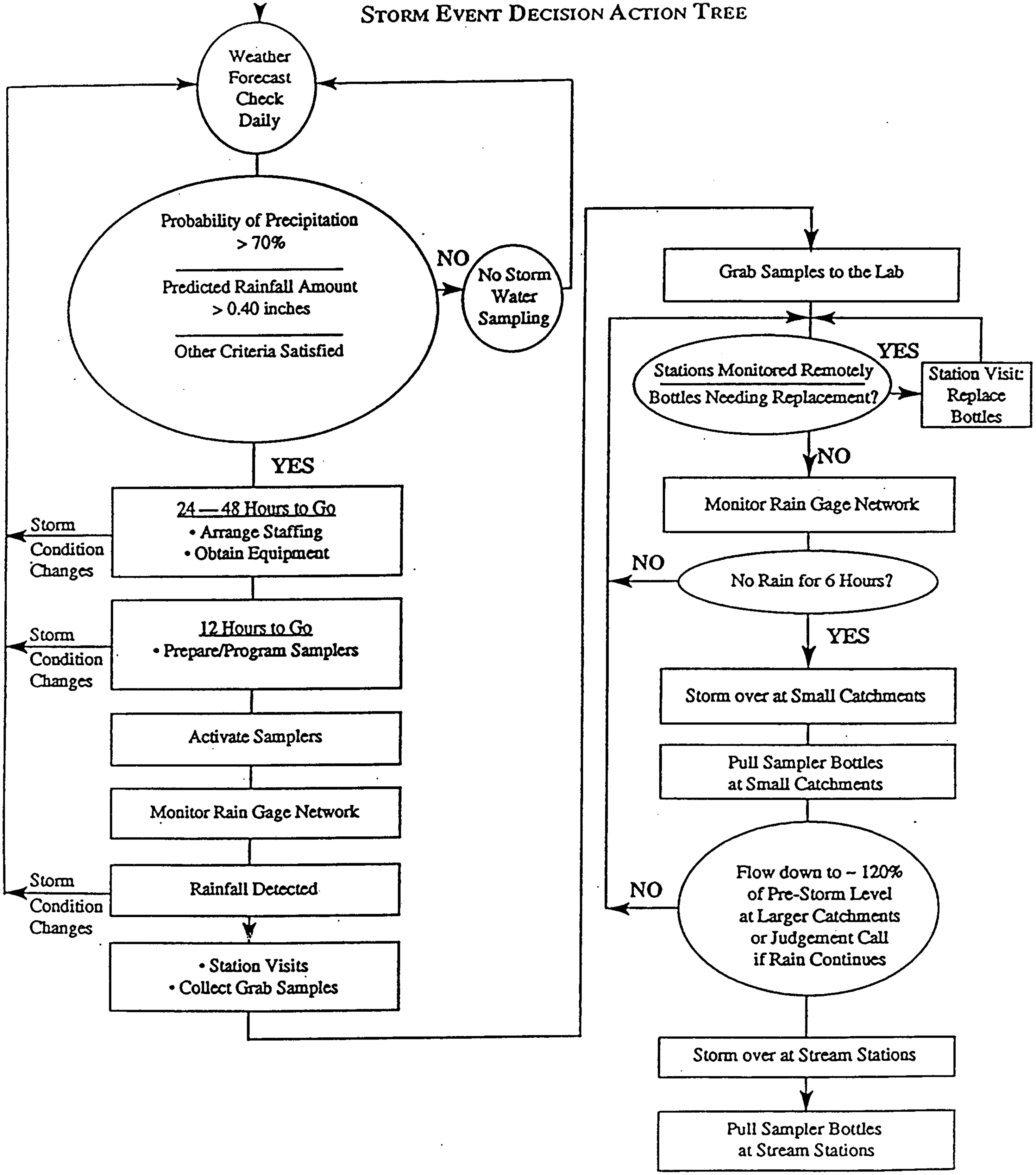
For wet-weather monitoring, preparation for storm water sampling would include weather forecasting, storm selection, mobilization strategies, and determination of appropriate automatic sampler settings. Proper coordination and management of these tasks would set the stage for effective storm sampling.

Weather forecasting will be an important aspect of storm water collection. It will be necessary to obtain the most reliable and up-to-date information on each storm's physical characteristics. The Sampling Event Coordinator (for discussion of sampling event staffing and roles, see Section 9), in consultation with the Program Manager would decide to mobilize and prepare for a given sampling event based on the probability of rainfall and, the expected rainfall amount, coverage, duration, and intensity.

The Sampling Event Coordinator would discuss upcoming storms with the Program Manager to ensure consistency with the storm selection criteria previously outlined. Preparation for a storm sampling event would be initiated when the probability of precipitation is about 70 percent or greater and the predicted rainfall amount is approximately 0.40 inches or greater, provided that the required conditions for the antecedent dry period are met (i.e., at least 72 hours with less than 0.1 inches of rain) and the target number of storms to be sampled in the season has not been reached. Additional criteria may be applied, including longer antecedent dry periods. Criteria could also be relaxed to make sure that enough storms are sampled.

## FIGURE 5-1

## STORM EVENT DECISION ACTION TREE



Weather forecasts are available each day from the National Weather Service and from private consultants. These forecasts include probability of precipitation, precipitation start and end times, and precipitation amount. If the forecast suggests that the storm satisfies the selection criteria, mobilization activities should begin 48 hours before the storm. Specific crew personnel would be identified, sampler batteries would be recharged, and sample bottles would be checked and made available. Within 12 hours of a given storm's arrival, if the updated forecast shows that the storm still satisfies the selection criteria, field crews would prepare the samplers (e.g., load and ice bottles, load the batteries, check the sampler program, and start the samplers).

## 5.2 SAMPLING EVENT MANAGEMENT

At least two to three field teams of two people each would be used during the initial stages of monitoring to visit each site, collect grab samples, and check the performance of the automatic samplers. As the sampling event progresses and grab sampling is completed only one to two field teams would be needed to check the samplers, change bottles, and deliver samples to the analytical laboratory.

All in-field water sampling activities would be coordinated from a centralized location. The Sampling Event Coordinator would coordinate all field crews during the sampling event. Communication is best maintained with each crew in the field via cellular phones or radios.

If any problems with the sampling equipment occur during the sampling event, it is the Sampling Event Coordinator who would decide the solution. For wet weather monitoring, the Coordinator would also decide when the storm is "over" based on previously-specified criteria. These criteria may be based on the number of hours since the last recorded rainfall or the number of hours since the start of the storm and/or a return to or near to pre-storm base flow conditions.

## 5.3 FLOW COMPOSITE SAMPLES

Once the decision is made to sample, estimates of the runoff volume expected at each station would be made, based on the predicted rainfall amount and the runoff coefficients corresponding to land use and soil type for the catchment of each sampling station. Monitoring stations are required that have flow measuring equipment as well as one or more automatic samplers that can communicate with the flow measuring equipment (some manufacturers make combine units). Once a runoff volume is projected, the data logger/controller for each station would be programmed to trigger the water quality sampler to collect a sample after each 1/20 of the total projected storm event volume has flowed past the flow monitor.

Borosilicate glass bottles would be placed in each automatic sampler. The bottles would be solvent-rinsed to remove trace organic contaminants and acid-cleaned to remove trace metal contaminants. If the water quality sampling units are not refrigerated, a sufficient amount of ice or "blue ice" would also be placed around the bottles in order to keep the storm water samples cool. Once activated, the automatic samplers would collect equal volumes of runoff water at flow-paced intervals for wet-weather monitoring and unequal volumes of runoff water at equal time intervals for dry-weather monitoring. All samples would be combined in the laboratory to create a single flow-weighted composite sample for analysis.

The goal is for the automatic sampler to collect the volume of sample that is adequate for the specified suite of chemical analyses. The required sample volumes are shown in Table 5-1. If insufficient volumes are collected, the runoff samples would be analyzed for fewer chemical constituents, as prioritized in Table 5-1. An excess amount of sample collected would require additional time and effort for sample bottle handling in the field, and compositing of samples in the laboratory, and could result in incomplete sampling event due to full bottles. When the forecasted runoff is different from the actual runoff volume, the sampling volume can be adjusted during the event. This may be important to assure complete sample capture, as the automatic units will not continue to collect samples when the sample bottles are full. If the programmed sampling volume is altered during the event, the sample bottles would be changed and the laboratory would recomposite the bottles proportionate to the sampling volume setting for each bottle.

During wet-weather monitoring, the criteria for when to stop sampling at a given station would depend on the amount of flow occurring at that station, rather than the amount of rainfall. The automatic samplers are triggered by flow, so if the flow monitoring equipment detects no flow, the sampler would not try to collect a sample. For the stations which have base flow, the criterion for halting sampling can be based on the return of flow to about 120 percent above the pre-storm base flow. This criterion is a compromise between the time needed to capture the falling limb of the stream hydrograph and the deadlines imposed by constituents with short holding times. As the overall monitoring program progresses, more specific criteria for halting the samplers at each station can be developed as more hydrographs are obtained.

If another storm front arrives unexpectedly within a six-hour period from when rainfall and sampling was halted, the two fronts could be considered one storm event, sampling could resume, and the sample bottles from both fronts could be composited in the lab. Weather forecasting should be utilized to minimize the likelihood of halting sampling prematurely.

For the dry-weather sampling, a procedure similar to that described above should be used to collect the composite samples. The primary difference between the dry-weather and wet-weather procedures is that in dry-weather sampling, initiation and completion of sampling would be set to correspond to convenient working hours rather than flow conditions.

Once sampling is terminated, the sample bottles will be removed and transferred directly to the laboratory under strict chain-of-custody procedures. If an excess amount of water is collected, these samples will be manually composited in the laboratory. In this case, the sample water must be thoroughly mixed by using a pump to transfer the water back and forth between a bottle from each set. Mixing will be considered adequate when the turbidity (as determined by EPA Method 180.1) of the samples in the bottles is the same.

## 5.4 GRAB SAMPLES

Grab samples would be collected for bacteria (due to the short 24-hour holding time required), volatile organic compounds, TPH, oil and grease, total phenols, cyanide, acrolein, acrylonitrite, and field measurements including pH, temperature, conductivity and turbidity. For manhole stations that are deeper than 10 feet below ground surface elevation, grab samples could be collected using the automatic samplers. The program on the automatic sampler could be halted temporarily. The pump tube would then be disconnected from the sampler in order to fill the grab sample bottles using the manual pump actuating feature of the automatic sampler. Grab samples from depths of less than 10 feet can usually be taken using manual grab sampling equipment. Alternatively, other types of pumps can be provided for deep locations.

# TABLE 5-1
# PRIORITIZED COMPOSITE ANALYSIS LIST AND VOLUME REQUIREMENTS WATER QUALITY SAMPLES

| Composite Sample<br>Priority Level | Priority Analyte | Volume Required | Volume Required | Volume Required | Volume Required | Volume Required |
|---|---|---|---|---|---|---|
| 1 | TOTAL METALS<br>Antimony, Arsenic, Beryllium, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Silver, Thallium, Zinc | 250 mL | 250 mL | 250 mL | 250 mL | 250 mL |
| 2 | DISSOLVED METALS<br>Antimony, Arsenic, Beryllium, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Silver, Thallium, Zinc | 250 mL | 250 mL | 250 mL | 250 mL | 250 mL |
| 3 | TSS/TDS/ HARDNESS/BOD5/ COD | 1L | 1L | 1L | 1L | 1L |
| 4 | NH3/TKN/TOTAL P/ NO3/ORTHO-P | 1L | 1L | 1L | 1L | 1L |
| 5 | SEMI-VOLATILE ORGANICS | 1L | 1L | 1L | 1L | |
| 6 | POLYNUCLEAR AROMATIC HYDROCARBONS (PAH) | 2L | 2L | 2L | | |
| 7 | ORGANOPHOSPHORUS PESTICIDES/ ORGANOCHLORINE PESTICIDES | 2L | 2L | | | |
| 8 | CHLORINATED HERBICIDES | 1L | | | | |
| | **TOTAL VOLUME REQUIRED** | 8.5 L | 7.5 L | 5.5 L | 3.5 L | 2.5 L |

**Grab Samples:**

1. Bacteria - a) Fecal Coliform (1 - 125 ml container)
   b) Fecal Streptococci (1 - 125 ml container)
   c) Enterococci (1 - 125 ml container)
2. Total Oil and Grease/TPH (1 - 1L Glass Bottle)
3. Volatile Organics (2 - 40 ml VOA vials)
4. Acrylonitrile and Acrolein (2 - 40 ml VOA vials)
5. Total Phenols (1 - 1L Glass Bottle)
6. Cyanide (1 - 1L Glass Bottle)

For wet-weather monitoring, grab samples should be collected during the beginning of the storm on the rising limb of the hydrograph. This may provide concentrations reflecting the higher levels of pollutants which are sometimes observed in the first part of an event, as compared with those observed during the remainder of the event. If the total mass emissons are to be estimated, a representative number of samples must be collected from both legs of the hydrograph.

## 5.5 SAMPLE TRANSFER AND CHAIN-OF-CUSTODY

The transfer of samples from the field to the laboratory should proceed through the proper chain of custody. Once grab samples are collected in the field, they should be taken to a centralized location for transfer to the laboratory. The centralized location should be accessible to all field personnel and laboratory couriers. Samples should be iced, labeled, and readied for pick-up or delivered to the laboratory. Chain-of-custody forms similar to the example shown in Figure 5-2 will be completed. The field sampling team leader would coordinate sample transferrals and courier pick-ups, as appropriate. A similar procedure should be used when composite samples have been collected.

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# Chain of Custody Record

PROJECT NO.

SAMPLERS (Signature)

| DATE | TIME | SAMPLE NUMBER | ANALYSES | | | | | | | | | | | NUMBER OF CONTAINERS | REMARKS (Sample preservation, handling procedures, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | General Mineral | Priority Pollutant Metals | EPA Method 624 | EPA Method 625 | EPA Method 608 | | | | | | | | |
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TOTAL NUMBER OF CONTAINERS

| | | | | | |
|---|---|---|---|---|---|
| RELINQUISHED BY: (Signature) | DATE/TIME | RECEIVED BY : (Signature) | RELINQUISHED BY: (Signature) | DATE/TIME | RECEIVED BY : (Signature) |
| METHOD OF SHIPMENT | | SHIPPED BY: (Signature) | COURIER: (Signature) | RECEIVED FOR LAB BY : (Signature) | DATE/TIME |

Figure 5-2 CHAIN-OF-CUSTODY RECORD FORM

# 6.0
# CHEMICAL ANALYSIS METHODS

This section of the monitoring plan describes the selection of sample analysis methods and the analysis suites.

## 6.1 BACKGROUND

The main purpose of the monitoring plan is to improve the quantification of pollutant loadings to Santa Monica Bay from separate storm sewer systems and to facilitate efforts to identify "problem" land use areas for prioritizing the implementation of a storm water management program. The sample analysis methods are EPA-approved methods which have low detection limits in order to generate reliable data at the typically low analyte concentrations present in storm water samples. The general strategy for selection of constituents for analysis is to begin with a broad analysis list (i.e., full analytical suite) (Table 6-1) and, based on the results from the first three storm events, focus the program on those constituents which are present in storm drains to Santa Monica Bay at concentrations which may be of concern (i.e., the proposed reduced analytical suite). The analysis suite required for the Federal NPDES Permit Part 2 discharge characterization application for separate storm sewer systems is shown for the readers' information.

## 6.2 CONSTITUENTS AND ANALYSIS METHODS

For the Santa Monica Bay Storm Water Monitoring Program, the suggested list of chemical constituents that should be analyzed in storm water runoff contains all of the parameters required for the Part 2 NPDES permit application plus several additional constituents which are of local interest. The analyses should be performed by a certified laboratory.

### 6.2.1 Federal Permit Requirement Sampling Suite

The Federal requirements do not include analyses for some chemical parameters which may be important components of storm water discharge (e.g., pesticides, herbicides, total petroleum hydrocarbons). Therefore, storm water analysis for Santa Monica Bay should include these parameters during the first three storm events (Table 6-1). Selection of these additional constituents was based on two major considerations: 1) analytes expected to be present in separate storm sewer systems based on results of the Nationwide Urban Runoff Program (NURP); and 2) parameters which are necessary to interpret data for other pollutant chemicals. For example, total hardness is necessary to determine the aquatic toxicity of some metals and, total petroleum hydrocarbons have been shown to be present at significant concentrations in other urban storm water studies. The reduced analysis list may be used for subsequent sampling events, based on results from the first three events.

### 6.2.2 Reduced Analysis Suite

The reduced analysis suite should be finalized after the results from several full analysis storms are available. Due to the anticipated turn-around-time for laboratory analysis, an additional storm event may be sampled before all of the data have been obtained from the previous storm. An anticipated reduced suite that is based on the results of NURP and storm water monitoring in other municipalities has been developed for interim storm water analysis (Table 6-1).

## TABLE 6-1
## ANALYSIS SUITES

| PARAMETER | EPA METHOD | FULL SUITE | REDUCED SUITE | REQUIRED SUITE* |
|---|---|---|---|---|
| CONVENTIONAL | | | | |
| TSS | 160.2 | X | X | X |
| TDS | 160.1 | X | X | X |
| BOD5 | 405.1 | X | X | X |
| COD | 410.1 | X | X | X |
| Hardness | 130.2 | X | X | |
| NUTRIENTS | | | | |
| Total Phosphorous | 365.2 | X | X | X |
| Ortho-Phosphate | 365.2 | X | X | X |
| TKN | 351.2 | X | X | X |
| Nitrate | 352.1 or 300.0 | X | X | X |
| Ammonia | 350.2 | X | X | X |
| BACTERIA | | | | |
| Fecal Coliform | SM 9222D | X | X | X |
| Fecal Streptococci | SM 9230C | X | X | X |
| Enterococcus | SM 923OC | X | | |
| METALS- TOTAL AND DISSOLVED | | | | |
| Antimony | 204.2 | X | | X |
| Arsenic | 206.2 | X | X | X |
| Beryllium | 210.2 | X | | X |
| Cadmium | 213.2 | X | X | X |
| Chromium (total) | 218.2 | X | X | X |
| Copper | 220.2 | X | X | X |
| Lead | 239.2 | X | X | X |
| Mercury | 245.1 | X | X | X |
| Nickel | 249.2 | X | X | X |
| Selenium | 270.3 | X | X | X |
| Silver | 272.2 | X | X | X |
| Thallium | 279.2 | X | | X |
| Zinc | 289.2 | X | X | X |
| Cyanide | 335.2 | X | | X |
| ORGANICS | | | | |
| PAH | Modified 625 | X | X | X |
| Total Oil and Grease | 413.2 | X | X | X |
| Volatile Organics | 624 | X | | X |
| Semi-Volatile Organics | 625 | X | X | X |
| Total Phenols | 420.1 | X | | X |
| Acrolein and Acrylonitrile | 624 (modified) | X | | X |
| Total Petroleum Hydrocarbons | 418.1/SuO$_2$ | X | X | |
| PESTICIDES/HERBICIDES | | | | |
| Organochlorine Pesticides | 608 | X | X | X |
| Organophosphate Pesticides | 614 | X | X | |
| Chlorinated Herbicides | 615 | X | X | |

* Required for Part 2 of the Federal NPDES storm water permit application.

# 7.0
# QUALITY ASSURANCE AND CONTROL PLAN

This section presents the Quality Assurance and Quality Control Plan for the monitoring program.

## 7.1 BACKGROUND

The measurement of chemical constituents at the trace level is often difficult due to inherent properties of environmental samples, field sampling techniques, and analysis techniques. In order to assess and maximize data quality, a strict Quality Assurance and Quality Control (QA/QC) Plan should be implemented as an integral part of the monitoring program.

The objective of a QA/QC Plan is to provide a mechanism for on-going control and evaluation of the sampling and analysis procedures throughout the course of the project, and to quantify data precision and accuracy for use in future data interpretation processes.

A strict system of quality assurance and quality control should be followed in all phases of the monitoring program, including sampling, laboratory analysis, and data reporting/validation. This plan includes elements to address both sampling and analysis concerns, including sample contamination, variability, and analytical accuracy and precision.

## 7.2 STANDARD OPERATING PROCEDURES

A field manual of Standard Operating Procedures (SOPs) should be prepared for crews. This section contains information that should be incorporated into the SOPs.

### 7.2.1 General Field Procedures

Field crews would be responsible for setting up the stations, collecting grab samples, ensuring that composite sampling is occurring properly, replacing bottles, recording information from the samplers, and documenting activities taking place, transferring and labeling bottles properly. The following Standard Operating Procedures should be followed by field crews to ensure acquisition of reliable and accurate data.

### 7.2.2 Pre-Sampling Mobilization

Station Assignments

Field personnel should be divided into a number of two-person crews (Field Teams) depending on the duration of the sampling event, and local safety rules. One member of each Field Team would be designated as the Team Leader. Multiple Field Teams would be used to ensure the timely collection of grab samples during the beginning of a sampling event, especially in short storms, which require very rapid collection of grab samples. The Field Manager should assign each Field Team to a set of monitoring stations, based on the geographical location of the monitoring stations. A single Field Team should assist during the later stages of a sampling event.

Sample Bottle Check

Pre-Storm Bottle Delivery - The Field Manager would make arrangements for clean bottles, ice chests, and blue-ice packs with laboratory personnel for all deliveries and pickups.

Bottle Inventory - Each Field Team would perform a bottle inventory check before leaving for the field. Individual inventories would depend on the number of sampling stations a Field Team has been assigned. Tables 7-1 and 7-2 contains the number, size, and types of bottles required for a single station.

Equipment Check

Each Team Leader should perform an equipment check-out on all field equipment. The check should confirm that all equipment is available and in proper working order. Check lists for vehicles, water quality, safety, personnel, and miscellaneous equipment would be provided.

Water Quality Sampler Preparation

All automatic water quality samplers should be inspected and made operational before each sampling event. This process would consist of the following procedures:

- Inspection of the sampler, hoses, and electrical connections
- Checking of the sampler program
- Installation of charged batteries (if applicable)
- Inspection of pump tube and replacement as needed
- Loading of cleaned sample bottles
- Icing of cleaned sample bottles (if temperatures are above 40°F)
- Setting of sampler to “run” mode

### 7.2.3 Sample Collection

Sampler Access Procedures

Sampler Access (Manhole Sites) - Water quality samplers at manhole sites could besuspended below the manhole covers using three suspension cables and clips, or located at the surface in a structure, as indicated previously. Removal of the manhole cover would be preceded by setting up the traffic control system and checking the manhole with a four-gas meter (used to test for indications of oxygen, methane, carbon monoxide, and hydrogen sulfide). If the meter indicates a problem, the manhole cover would not be opened, and the station would not be sampled until the meter indicates there is no problem.

Sampler Access (Stream Stations) - Stream stations would have samplers contained in locked enclosures. Access would be gained by unlocking a padlock and lifting the top of the enclosure. The lid would be supported by a brace located inside the enclosure. The

## TABLE 7-1

## SAMPLE BOTTLE INVENTORY

| Sampling Device | Type of Sample | Is Sample Preserved? | Type of Bottle | No. of Bottles | Size of Bottles |
|---|---|---|---|---|---|
| Automatic Sampler | Composite | No | Glass | 4 | 3.78 L |
| Grab | Volatile Organics | No | Glass | 2 | 40 ml |
| | Acrolein & Acrylonitrile | Yes | Glass | 2 | 40 ml |
| | Bacteria | No | Plastic | 3 | 125 ml |
| | Oil & Grease | Yes | Glass | 1 | 1000 ml |
| | Total Phenols | Yes | Glass | 1 | 1000 ml |
| | Cyanide | Yes | Plastic | 1 | 1000 ml |
| Beaker(s) | Field Analysis | N/A | Glass | 2 | 500 ml |

## TABLE 7-2

## GRAB SAMPLING REQUIREMENTS

| Constituent | Is Sample Preserved? | Type of Bottle | No. of Bottles | Bottle Size | Special Instructions |
|---|---|---|---|---|---|
| VOC | No | Glass | 1 | 40 ml | Fill to top/no trapped air |
| Acrolein & Acrylonitrile | Yes | Glass | 1 | 40 ml | Fill to top/no trapped air |
| Bacteria | No | Plastic | 3 | 125 ml | |
| Oil & Grease | Yes | Glass | 1 | 1000 ml | |
| Total Phenols | Yes | Glass | 1 | 1000 ml | |
| Cyanide | Yes | Plastic | 1 | 1000 ml | |

sampler should not need to be removed from the enclosure for any of the sampling activities.

## Grab Sampling Procedures

Type of samples to be collected at each station - Grab samples would be collected for six analyses. Each analysis has specific volume and bottle material requirements which must be met. In addition, some constituents require preservatives or other special attention. Table 7-2 summarizes specific grab sampling requirements. Note that grab sample QA/QC would require the collection of additional volumes for each of the parameters at a location designated by the Field Manager. The sample bottles for the volatile organic compounds and acrolein and acrylonitrile must be completely filled with no trapped air.

Getting sample into bottles - At stations deeper than 10 feet, grab samples should be obtained by pumping samples with the water quality sampler. The flow composite program would be interrupted, and the sample would be pumped using the sampler's manual mode. In order to avoid interfering with the normal flow compositing process, Field Teams would need to consult with the Sampling Event Coordinator before interrupting and restarting any sampler program. At stations less than 10 feet deep, manual sampling equipment would be utilized.

## Field QA/QC Procedures

Water Sampling QA/QC - Several tests would be conducted to help identify potential sources of introduced error in the water sampling process. These tests include: travel, grab sample, and equipment blanks; grab and composite duplicates; and matrix spike and matrix spike duplicates. Potential laboratory and/or field contamination would be assessed through analysis of blind equipment blanks and sample duplicates at a frequency of one duplicate and one equipment blank per sampling event. The degree to which collected samples reflect actual field samples would be assessed through the analysis of duplicate field samples at a frequency of one field duplicate per sampling event. The Field Manager would assign QA/QC responsibilities during sampling mobilization. The specific field procedures for conducting these tests are presented below.

Travel Blanks - The travel blanks should be supplied by the contract laboratory. Travel blanks would be placed in one of the fields outgoing ice chests and transported through the entire sampling event. These blanks would then be returned to the lab for analysis. Travel blanks would not be opened by any person(s) other than laboratory personnel.

Grab Sample Blanks - Grab sample blanks would be obtained by completing the normal grab sampling process, but instead of pumping sample water, clean deionized water should be used. One set of blanks will be collected for each sampling event.

Equipment Blanks - Equipment blanks would be obtained by letting the sampler fill a complete set of bottles with clean deionized water. One set of blanks would be collected from a single station for each sampling event. Equipment blanks should be collected at the end of a sampling event to minimize program interruptions.

Flow Composite Matrix Spike and Matrix Spike Duplicates - One automatic water quality sampler should be set to collect twice the normal sample volume per sampling event in order to provide for the matrix spike and matrix spike duplicate analysis. Water quality samplers would be instructed to take twice the normal sample volume by doubling the number of triggers generated by the flow monitor. The process would be controlled by the

Sampling Event Coordinator. This would require collection of two sets of sample bottles and compositing in the laboratory.

<u>Sample Labeling and Chain of Custody Procedures</u>

Team Leaders would bear responsibility for the care and proper transfer of samples. Care of the samples would be the responsibility of the Team Leaders until official transfer (using proper chain-of-custody records) of the samples to the assigned Sample Custodian. As part of this responsibility, the Team Leader must be sure samples are labeled correctly and meet critical holding times. Samples with short holding times must be transferred in a timely manner.

Sample Labeling - Sample labels must be filled out completely. At a minimum, the following information should be entered on every label:

1. Date and time (24-hour clock). Storm composites should include the time when sampling was initiated.
2. Site code (station identification)
3. Type of analysis required
4. Total number of containers for each analysis and the number of each contained (e.g., 1 of 3, 2 of 3, and 3 of 3)
5. Signature or initials of Team Leader

Chain-of-Custody - The following organizational scheme has been developed to minimize confusion during the sample chain-of-custody process:

1. Each Team Leader should check bottle labeling, assemble all samples in an orderly manner, and fill out chain-of-custody forms.
2. Each Team Leader should surrender samples to the Sample Custodian (designated by the Sampling Event Coordinator) using chain-of-custody forms.
3. The Sample Custodian should then transfer the samples to laboratory personnel. The Sample Custodian would be fully responsible for the care of the sample and meeting critical holding time limitations until the samples are officially transferred to the contract laboratory.

### 7.2.4 Post-Sampling Procedures

When the Sampling Event Coordinator makes the final determination that the sampling is complete, crew(s) will:

1. Remove and label the remaining sample bottles.
2. Record the number and timing of samples taken by the sampler. This will be accomplished by halting the Water Quality Sampler Program and reviewing the sampler history log.
3. Turn off the samplers.

4. Remove the batteries.

After sampling is complete and the sampling event is officially over (as determined by the Sampling Event Coordinator), field crews would unload equipment. Crews should check in with the Sampling Event Coordinator to make sure all staff are safely accounted for.

## 7.3 LABORATORY PROCEDURE QA/QC

A list of laboratory analysis methods are described in Section 7.0. A certified contract laboratory would be contracted to perform all chemical analyses (unless a certified public agency laboratory is utilized). The suite of chemical analysis for all water samples is shown in Table 6-1. In addition to performing the analysis, the laboratory must make every effort to meet target detection limits for each analytical method. Other QA/QC objectives that the laboratories must meet include holding times and sample preservation techniques, as shown in Table 7-3.

### 7.3.1 Precision

Laboratory precision should be assessed through the analysis of laboratory duplicates and matrix spike duplicates at the frequency of 10 percent of the total samples for the lab duplicates and five percent for the matrix spike duplicates. Combined field and laboratory precision should be evaluated through the analysis of field duplicate samples at the frequency of one duplicate sample per sampling event, as described above. Specific field duplicate precision objectives are presented in Table 7-3. Due to the inherent variation in environmental samples, these objectives may be viewed as goals and not requirements.

### 7.3.2 Accuracy

Laboratory accuracy should be assessed through the analysis of "blind" standard reference samples and through the analysis of laboratory-prepared matrix spike samples. A goal of five percent of the samples would be analyzed as matrix spikes by spiking the sample with standard and measuring the analytical recovery. Blind reference samples would be analyzed once every quarter in which samples are analyzed.

### 7.3.3 Laboratory Blank

Sample contamination resulting from laboratory analysis procedures or sample storage methods should be assessed through the analysis of laboratory blanks and equipment blanks. Laboratory blanks (reagent and/or method) should be reported for each day samples are analyzed.

### 7.3.4 Completeness

All reported analyses should be evaluated against the requested analyses to evaluate the completeness of the analytical characterization of the water samples. Any missing data will be accounted for by the laboratory or field programs with an overall goal of 95 percent completeness.

# TABLE 7-3
# QUALITY CONTROL LIMITS FOR WATER QUALITY SAMPLES

| Parameter | Units | Methodology | EPA Method (a), (b) | Maximum Holding Time | Target Detection Limit | MS/MSD Precision %RPD | Sample Dup Precision % RPD |
|---|---|---|---|---|---|---|---|
| **CONVENTIONAL** | | | | | | | |
| Hardness | mg/L | Semi-automated | 130.2 | 6 months | 1 | NA | <15 |
| TSS | mg/L | Gravimetric | 160.2 | 7 days | 4 | NA | <15 |
| TDS | mg/L | Gravimetric | 160.1 | 7 days | 10 | NA | <15 |
| BOD5 | mg/L | Bio-assay | 405.1 | 48 hours | 1 | NA | <15 |
| COD | mg/L | Spectrophotometric | 410.1 | 28 days | 1 | NA | <15 |
| **NUTRIENTS** | | | | | | | |
| Total Phosphorous | mg/L | Spectrometric | 365.2 | 28 days | 0.05 | <20 | <30 |
| Ortho-Phosphate | mg/L | Spectrometric | 365.2 | 48 hours | 0.05 | <20 | <30 |
| TKN | mg/L | Titrimetric | 351.2 | 28 days | 0.1 | <20 | <30 |
| Nitrate | mg/L | IC | 300 | 48 hours | 0.05 | <20 | <30 |
| Ammonia | mg/L | Titrimetric | 350.2 | 28 days | 0.1 | <20 | <30 |
| **BACTERIA** | | | | | | | |
| Fecal Coliform | MPN/100ml | Assay | SM9222D | 6 hours | 2 | NA | <25 |
| Fecal Streptococci | MPN/100ml | Assay | SM9230C | 6 hours | 2 | NA | <25 |
| Enterococcus | MPN/100ml | Assay | SM9230C | 6 hours | 2 | NA | <25 |
| **METALS - TOTAL AND DISSOLVED** | | | | | | | |
| Antimony | ug/L | HGA-Furnace | 204.2 | 6 months | 1 | <25 | <35 |
| Arsenic | ug/L | HGA-Furnace | 206.2 | 6 months | 5 | <25 | <35 |
| Beryllium | ug/L | HGA-Furnace | 210.2 | 6 months | 1 | <25 | <35 |
| Cadmium | ug/L | HGA-Furnace | 213.2 | 6 months | 0.2 | <25 | <35 |
| Chromium (Total) | ug/L | HGA-Furnace | 218.2 | 6 months | 1 | <25 | <35 |
| Copper | ug/L | HGA-Furnace | 220.2 | 6 months | 5 | <25 | <35 |
| Lead | ug/L | HGA-Furnace | 239.2 | 6 months | 1 | <25 | <35 |
| Mercury | ug/L | Cold Vapor | 245.1 | 28 days | 0.5 | <25 | <35 |

# TABLE 7-3
# QUALITY CONTROL LIMITS FOR WATER QUALITY SAMPLES (concluded)

| Parameter | Units | Methodology | EPA Method (a), (b) | Maximum Holding Time | Target Detection Limit | MS/MSD Precision %RPD | Sample Dup Precision % RPD |
|---|---|---|---|---|---|---|---|
| Nickel | ug/L | Cold Vapor | 249.2 | 6 months | 5 | <25 | <35 |
| Selenium | ug/L | HGA-Furnace | 270.3 | 6 months | 0.5 | <25 | <35 |
| Silver | ug/L | HGA-Furnace | 272.2 | 6 months | 0.2 | <25 | <35 |
| Thallium | ug/L | HGA-Furnace | 279.2 | 6 months | 1 | <25 | <35 |
| Zinc | ug/L | HGA-Furnace | 289.2 | 6 months | 5 | <25 | <35 |
| Cyanide | ug/L | Spectrophotometric | 335.2 | 14 days | 20 | <25 | <35 |
| ORGANICS | | | | | | | |
| PAH | ug/L | HPLC | mod 625 | 7 days | 5 | <50 | <50 |
| Total Petroleum Hydrocarbons | mg/L | IR | 418.1 | 7 days | 0.5 | <30 | <50 |
| Total Oil and Grease | mg/L | IR | 413.1 | 28 days | 0.5 | <30 | <50 |
| Volatile Organics | µg/L | GC/MS | 8240 | 14 days | 5 - 20 | <30 | <40 |
| Semi-Volatile Organics | µg/L | GC/MS | 8270 | 7 days | 10 - 50 | <50 | NA |
| Total Phenols | mg/L | Spectrometric | 420.1 | 7 days | 5 | <30 | <30 |
| PESTICIDES/HERBICIDES | | | | | | | |
| Organochlorine Pest. | µg/L | GC/ECD | 608 | 7 days | .005-0 | <30 | <30 |
| Organophosphate Pest. | µg/L | GC/NPD | 614 | 7 days | 1 - 20 | <30 | <30 |
| Chlorinated Herbicides | µg/L | GC/ECD | 615 | 7 days | 0.5 - 5 | <30 | <30 |

(a) Methods for Chemical Analysis of Water and Wastes (1983) EPA-600/ 4-79-020
(b) Standard Methods for the Examination of Water and Wastewater, 16th Ed., APHA-WPCF, 1985

## 7.4 LABORATORY COMPOSITING

Compositing of the samples would be performed at contract laboratory. Unless the trigger volumes have been changed with the second set, the mixing is done directly. A 19 liter glass bottle should be cleaned using non-phosphate liquid detergent and triple-rinsed with deionized water. The bottle should be placed on a stir plate with a magnetic stir bar. The minimum volume in the bottles should be determined, and this quantity should be taken from each sample bottle and added to the 19 liter glass bottle. The final mixed sample should be distributed into the appropriate glass, amber, or plastic bottles prior to the analytical testing. If the volume for triggering a particular sample was changed during the course of a sampling event, the Sample Custodian would work with the contract laboratory to composite properly the sample.

## 7.5 DATA REDUCTION, VALIDATION, AND REPORTING

Overall data quality would be assessed based on sampling and analytical conditions, adherence to internal QC procedures, and results of accuracy and precision checks.

Actual detection limits would be reported in the final report summary along with the results of the external QA samples, field replicates, laboratory duplicates, matrix spike, matrix spike duplicates, and equipment and reagent blanks.

## 7.6 CORRECTIVE ACTION

In the event the data quality objectives are not met, the contract laboratory should notify the Quality Assurance Task Leader who would evaluate the severity of the problem and recommend a solution to the monitoring task leader.

## 7.7 QA/QC REPORT

Summary results of the QA/QC program would be provided as brief memorandums detailing any analysis or sampling problems and the potential effects on the analysis results for each event.

# 8.0
# DATA REPORTING

Data collected as part of this monitoring program should be stored in electronic format to enable easy retrieval, data interpretation, and graphing.

Data collected would fall under the following categories:

- Rainfall
- Runoff
- Field Chemical Data
- Laboratory Chemical Data
- Quality Assurance/Quality Control Data

Hydrological data (rainfall and runoff) collected at the monitoring stations should be transferred to a centralized file. These data should be checked for errors and arranged to show rainfall and runoff volumes and hydrographs during each sampled storm event. Following each event, a storm report should be prepared which summarizes the results of sampling, except laboratory results.

Chemical data generated by the contract laboratory would be input into a database by the laboratory. In addition to the laboratory electronic data, raw laboratory data reports would also be received from the laboratory. Once the data are received by the Project Manager, errors in transcription and reporting and compliance to QA/QC contract objectives would be checked and resolved. The final chemical data would be reported in a manner that is easy to read and understand. After laboratory results are received from the laboratory, a brief memorandum would be prepared which summarizes the chemistry results for each event.

At the end of the program, a monitoring data report would be prepared which summarizes results of the program. The report would be based upon the storm reports and a laboratory results memorandum.

# 9.0
# MONITORING PLAN MANAGEMENT, ADMINISTRATION AND COORDINATION

An example organizational chart for the Monitoring Program is provided in Figure 9-1. Implementation and overall coordination of the Monitoring Program is the responsibility of the Program Manager. The Program Manager would be assisted by the Sampling Event Coordinator and the Quality Assurance Task Leader.

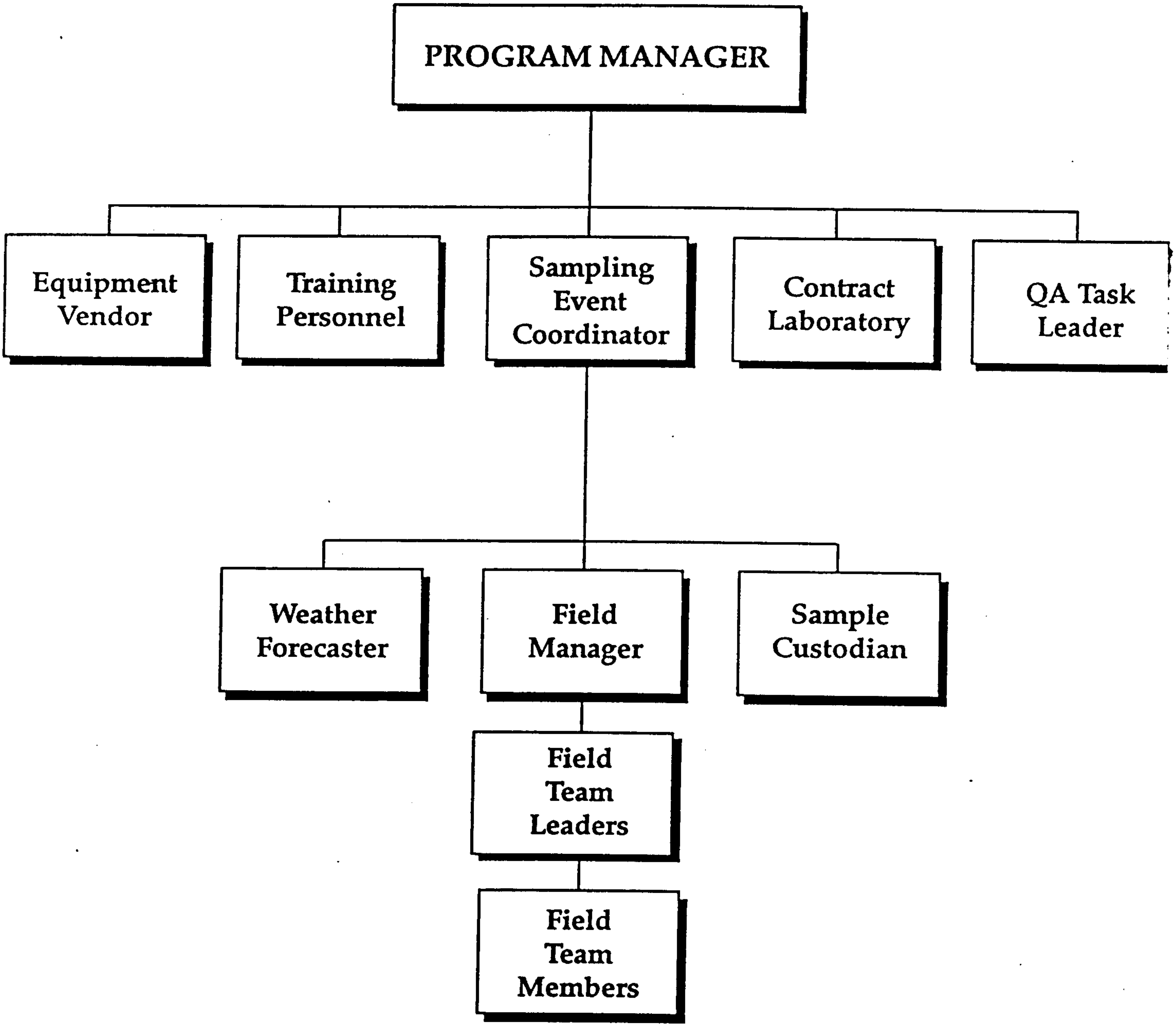
The Sampling Event Coordinator would be responsible for evaluating the weather forecasts as provided by the storm forecasting service and, in consultation with the Program Manager, deciding on which storms warrant mobilization for the sampling efforts. The Sampling Event Coordinator would also be responsible for the Field Manager.

The Field Manager would be in charge of the field sampling program, which includes; 1) assignment and supervision of Field Teams and Team Leaders, 2) field equipment maintenance and operation, 3) proper sampling collection and handling, and 4) field QA/QC and laboratory analysis.

The Quality Assurance Task Leader would be responsible for on-going review, auditing, and evaluation of the overall QA program related to sampling and laboratory procedures.

The Project Manager would also be responsible for the contract laboratory. Prior to selection, the contract laboratory should be audited to 1) evaluate the laboratory's ability to perform the work, 2) ensure proper QA/QC programs are in place, and 3) initiate education of specific personnel at the laboratory on protocols involved in the analysis of water samples.

FIGURE 9 - 1 MONITORING PROGRAM ORGANIZATION AND COORDINATION



# 10.0
# MONITORING PLAN SCHEDULE

The schedule for implementation of a plan like this should be developed based upon the implementing agencies time and budgetary constraints and desired timing of data needs for water quality management planning.

Sufficient time must be allowed for:

1. Final station selection, 1-2 months
2. Equipment selection, ordering, and receiving, 1-2 months
3. Equipment installation, 1 month
4. Equipment testing, weather dependent

## 11.0
## FIELD CREW TRAINING

Personnel to be involved with the field operations of the Monitoring Program would be trained in the water sampling and flow monitoring protocols set forth in this plan. The training sessions would include instruction in the set-up and operation of monitoring equipment and software used to operate the sampling equipment. Operating procedures and sampling criteria would be developed for field personnel as part of the training task. Descriptions of the training sessions are presented in this section.

### 11.1 MONITORING EQUIPMENT OPERATION AND MAINTENANCE

Two training sessions would be conducted on monitoring equipment operation and maintenance. The first training session would be a "dry" session to teach personnel the standard procedures necessary for successful monitoring. The second session would be a "wet" session conducted in the field during a "practice" sampling event. Field crews would be trained as they assist training personnel in all of the field procedures during an actual sampling event.

During the two training sessions, the training personnel would provide standard operating procedure summaries (SOPs) and familiarize field crews in the operation and maintenance of sampling equipment and software. The equipment for each station would consist of an automatic type composite sampler, a compatible data logger and modem, a control module, depth monitoring equipment, and possibly velocity-flow monitoring equipment.

### 11.2 SAMPLE COLLECTION TRAINING

Field personnel should be trained for in-field water quality sampling and measurements and data recording procedures. This training would include procedures for grab sampling to obtain certain field measurements such as temperature, pH, and dissolved oxygen content. Also, field personnel would learn techniques for field sampling consisting of composite sampler operation and grab sampling for constituents which cannot be reliably measured in composite samples. Personnel would learn the procedures for getting samples from the monitoring site to the laboratory. This would include proper sample handling, storage, and chain-of-custody procedures for both grab samples and samples taken with the automatic composite sampling equipment.

### 11.3 HEALTH AND SAFETY

A health and safety manual should be developed for the sampling program. All personnel should review the manual and should receive a health and safety briefing during training.

# 12.0
# METHODS FOR ESTIMATING POLLUTANT LOADS

As noted in the introductory section, one objective of the monitoring program is to assess pollutant mass emissions to Santa Monica Bay. This section presents methods for estimating pollutant mass loads using the data to be collected in the monitoring program.

## 12.1 OVERVIEW OF STORM WATER POLLUTANT LOADING MODELS

The median land use concentrations by land use computed by Nationwide Urban Runoff Program (NURP) have been used in subsequent studies to estimate pollutant load from urban areas. This is commonly used for preliminary planning studies where little or no local sampling was conducted. Eugene, Oregon, for example, used NURP's mean estimate total pollutant load (WCC, 1991) as did the Piper's Creek Nonpoint Source Action Plan Study in Seattle, Washington. For both studies, runoff volumes were computed from the long-term average rainfall times the area times the runoff coefficient of each land use. Runoff coefficients were computed based on the percent impervious area typical of each land use, using a relationship developed by the Federal Highway Administration (FHWA 1990; Driscoll, et al., 1990). The relationship is expressed as follows:

$$R_V = 0.007*\mathrm{IMP}+0.10$$

Where:

$R_V$ = runoff coefficient
IMP = impervious fraction of the drainage area (as a percentage)

This method of computing pollutant load is the simplest of all those reviewed. It is probably sufficient for a preliminary planning study and has the advantage of minimal data requirements. However, this method assumes that the water quality of the area being modeled can be sufficiently represented by the NURP data.

Several other studies have used land-use-specific EMCs, using either NURP data or locally collected data, to compute pollutant load from a region. Woodward-Clyde Consultants estimated pollutant loads from Santa Clara Valley, California, using data from local sampling stations (WCC, 1991). Sampling stations were selected to represent uniform land use. A representative concentration for each respective land use category was computed by averaging the site mean concentrations from stations with similar land use. Runoff volumes were computed using the runoff block of the EPA's Storm Water Management Model (SWMM). Volumes of runoff from each land use type were multiplied by the representative concentration to compute loads. Mixed land use stations were used to verify the load estimates. A bias correction factor was calculated as the ratio of the predicted loads and the measured loads for the mixed land use stations. This factor was used to correct the estimate of loads from each land use. The main difference between this method and the NURP method is that SWMM is used to estimate runoff and the water quality data was collected exclusively in the study area. The advantage of this method is that by using the SWMM model the benefits of large control structures or other storm water retention best management practices can be investigated. However, a disadvantage of this method is that large amounts of data are required by SWMM for simulation. Another disadvantage is the error associated with using data from a small set of homogeneous land use stations to represent all the land use areas in the study area.

The Aquatic Habitat Institute (AHI) used data from WCC's Santa Clara Valley study and several other studies to compute pollutant loads to the entire San Francisco Bay (Gunther, 1991). AHI used runoff coefficients to compute runoff volume, in a manner similar to the Eugene study. Constituent concentrations were computed similarly to the Santa Clara study, but with a data set which included stations throughout the Bay area. This method is similar to the NURP method but uses water quality data from a specific region instead of the whole country.

Silverman, et al. (1988) developed an approach to concentration and load computation using regression analysis. They computed the load of oil and grease to San Francisco Bay using data collected at 15 stations within the region. They used runoff coefficients to compute flow volumes, which were computed from the measured flow volume at five of the sampling stations. Land uses extracted from census tract data were used to determine the percent of land tributary to each station identified as residential, commercial/industrial or developed. A total of 34 samples were taken at these stations. Using land use as the independent variables and the oil and grease concentration as the dependent variable, a regression model relating land use to oil and grease loading was derived using 34 equations and three variables or unknowns. Using the coefficients from the regression model, the pollutant concentrations in storm water were calculated from all watersheds tributary to San Francisco Bay from the known areas of each land use.

Woodward-Clyde Consultants developed a regression model for computing pollutant loads in Alameda County, California, using the proportion of runoff from each land use tributary to sampling stations (WCC, 1991). This method used the assumption that the measured concentration at a sampling station is the flow weighted average of the concentration in runoff from each tributary land use. Samples were taken at 15 stations during a total of 11 storms. The land uses were divided into four categories (open, residential, commercial, and industrial). Runoff volumes, by land use, were computed using the runoff block of SWMM. Using runoff volume by land use as the independent variables and concentration at each station as the dependent variables, a multiple linear regression was performed to determine the best estimate of the concentration by land use. These concentrations by land use were then multiplied by the runoff volume by land use for the entire study area to determine the total load. The advantage of using this method is that it allows data from nonhomogeneous land use stations to be included when computing the water quality associated with each land use.

The USGS published a report (Driver and Tasker, 1990) which describes methods developed for estimating storm runoff loads and concentrations. These methods were developed by applying step-wise linear regression to the data collected from the National Urban Runoff Program (EPA, 1983). The nation was divided into three general climatic regions. For each region, a regression model was developed relating storm-runoff volumes and storm-runoff loads for 11 constituents to physical, land-use, and climatic characteristics.

The USGS selected a group of response variables according to the frequency of the variable in the database and according to the importance of the variable in urban planning. Specific response variables for each regression model were then selected using the step-wise regression procedure. This procedure sequentially selects response variables for inclusion to the model by testing the contribution the variable makes to improving the model. The variables most often selected were:

Total contributing drainage area

Total storm rainfall
Percent impervious area
Percent industrial land use

The variables included in each regression model varied by region and constituent. However, there is some question of the validity of using rainfall as a variable in the regression analysis since it is directly related to runoff quantity.

These regression models provide a convenient, planning-level tool for estimating storm runoff loads. Mean annual loads can be estimated by multiplying the estimated storm load by the average number of storms per year. The chief advantage of the USGS's methodology is that it can be performed using data commonly available to planners, before any sampling is conducted. The primary disadvantage is that it does not provide any means of identifying any unusual conditions within the region of interest.

The methods previously used to model pollutant loads from storm water runoff represent a range of approaches, from fairly simple to rather complex. All of the methods, with the exception of the USGS regression analysis provide a methodology for computing the runoff and a methodology for estimating water quality; each exclusive of the other. As with any modeling effort, the method chosen for a particular study depends on the resources available, the availability of data, and the purpose of the study.

## 12.2 RECOMMENDATIONS

The NURP method was used as an initial estimate of storm water pollutant loads to Santa Monica Bay (Stenstrom and Strecker, 1993). However, the NURP 90th percentile values of the EMCs were used in place of the median (50th percentile) values of the EMCs because existing water quality data indicated that pollutant concentrations in the watershed are higher than the NURP median values.

Water quality data collected during the monitoring program should be used to calibrate and validate the NURP model for Santa Monica Bay. Regression techniques used in other studies could be applied to the data to determine the best estimate of pollutant concentrations for each land use type. The results of the model will provide a quick estimate of mass emissions to the Bay by subbasins and land use for use in water quality management and planning.

More detailed assessment of pollutant loadings could be developed using more complex physically-based computer models such as SWMM. Physical models have several advantages over the lump parameter models such as those using the NURP data. Storm water variations that occur between and during storms and in wet and dry seasons could be captured by physical models. Also, the effectiveness of storm water management controls could be better evaluated with physical models. The drawbacks to physical models are that more data are required and greater analytical resources including modeling expertise, computing power, and time are needed.

The data to be collected in the monitoring program will provide the data required for physical modeling. Rainfall and runoff quantities will be measured throughout the two-year monitoring period. Water quality data collected during both wet weather and dry weather will also be available. The extent to which these data can be used in a physical model will depend on the amount of data collected and the quality of the data. In addition to the data, the success of the modeling effort will depend on the expertise of the modeler and the resources allocated to the task.

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# ASSESSMENT OF STORM DRAIN SOURCES OF CONTAMINANTS TO SANTA MONICA BAY, Volume III, Surface Drainage Water Quality Monitoring Program Plan

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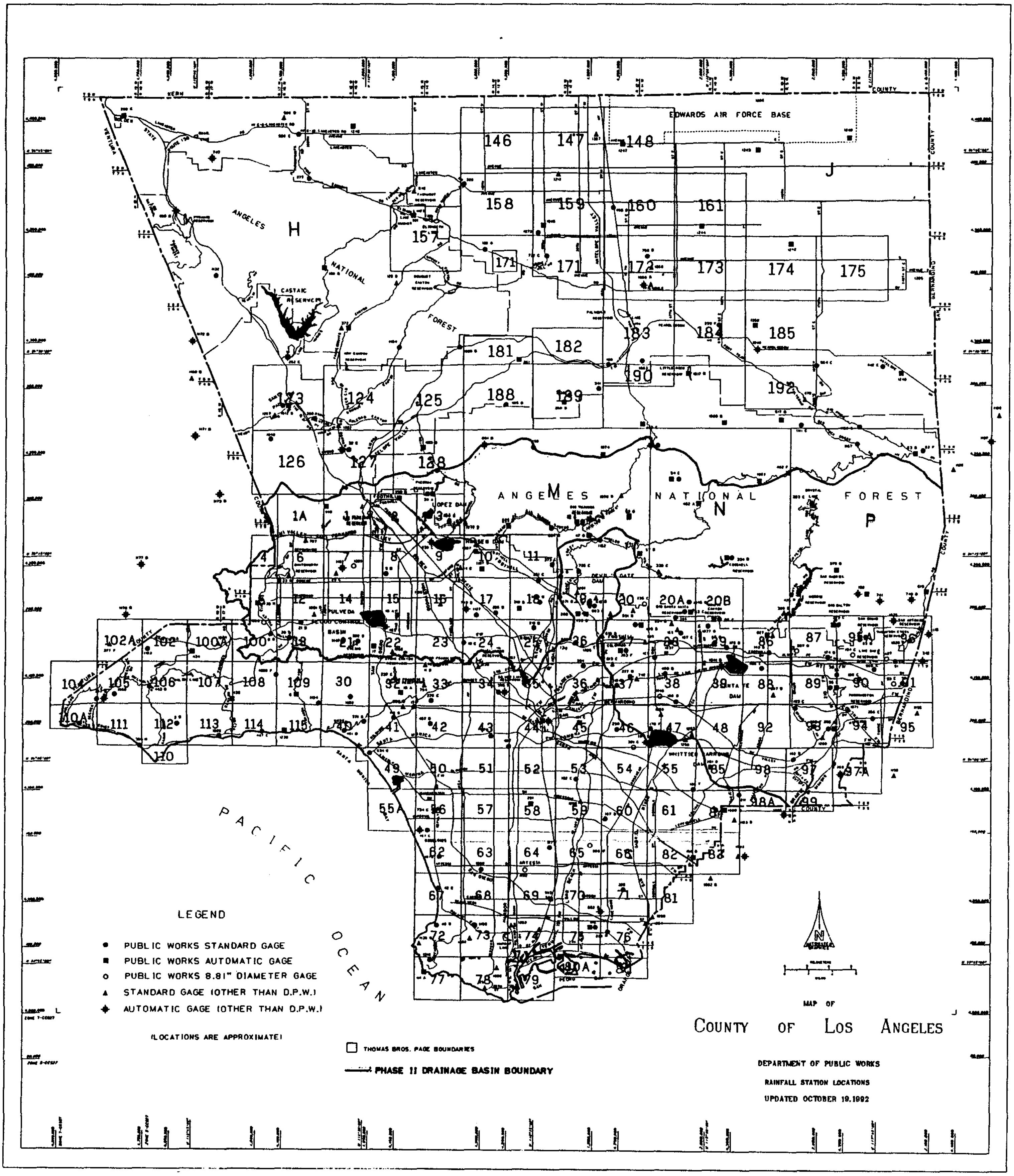

Figure 3-1. Rainfall Stations Location Map 1988-89.