SECTION 2
DEVELOP PURPOSE AND OBJECTIVES

In general, Caltrans stormwater monitoring projects are meant to provide data to support the Caltrans stormwater management program, and to comply with various regulatory and legal requirements. The data produced by these monitoring programs must satisfy the immediate goals and objectives of the projects as defined in the Caltrans Stormwater Management Plan (Caltrans, 1999a) and the Caltrans Monitoring and Research Strategy (Caltrans, 2000), and must also be scientifically defensible in a range of other potential applications. Possible applications beyond the specific purposes of the monitoring program (e.g. characterization of discharges or evaluation of BMP performance) include various modeling applications, comparisons to other studies, and assessments of contributions to receiving water loadings.

The planning steps of Caltrans stormwater monitoring programs, as presented in this guidance document, are part of a "systematic planning process" designed to develop appropriate acceptance/performance criteria for data collection and evaluation. [Note: The systematic planning process will be described by USEPA in a soon-to-be drafted manual (expected July 2000), "Guidance on Performance and Acceptance Criteria" (John Warren, USEPA, personal communication).]

The systematic planning process used as the basis for this section is distinct from EPA's "Data Quality Objectives (DQO) Process" (USEPA, 1994). As described by EPA, the "DQO Process" is a specific application of the more general systematic planning process, focused on studies involving a decision-making process in which "environmental data are used to select between two opposing conditions". For Caltrans monitoring projects, the data collection effort is generally not directed at choosing between two alternatives. The planning process described in this section includes relevant ideas from EPA guidance as they apply to the planning and implementation of Caltrans monitoring projects.

For the purposes of this Guidance Manual, "data quality objectives" (DQOs) refer to the set of specific performance and acceptance criteria applied to field and laboratory activities. The DQOs developed for each project establish measures of acceptable performance and data quality for the collected data, and this guidance manual describes procedures by which the data should be generated and evaluated.

This section of the manual outlines the systematic decision-making process necessary to plan a Caltrans monitoring project that will achieve project-specific goals and objectives, including the development of appropriate DQOs. The process includes the following seven steps that summarize the systematic planning process:

KEY TOPICS

- **Determine Project Goals and Objectives**
- **Identify Resources and Constraints**
- **Identify Data Characteristics and Tools**
- **Determine Key Study Parameters**
- **Specify Methods for Obtaining Data**
- **Develop Performance/Acceptance Criteria**
- **Optimize the Design for Obtaining the Data**

A flow chart of the systematic planning process as applied to Caltrans projects is included as Figure 1 below.

In many cases, the initial steps in the process discussed here will already be determined by the Caltrans Stormwater Management Plan and the Monitoring and Research Strategy. These steps are reviewed below for planning related to Caltrans stormwater monitoring projects.

➤ DETERMINE PROJECT GOALS AND OBJECTIVES

The initial step in the development of a monitoring program[1] is to determine the goal of the project based on the task order or problem statement presented by Caltrans. The overall goal of the study will in most cases have been defined previously in the Caltrans Stormwater Management Plan (SWMP) and other planning documents. The purpose of the monitoring project is then to provide data in fulfillment of the study goals. Once the program goals and purpose are established, a set of specific study questions and objectives should be compiled.

Determine Project Goal

As listed in the SWMP, goals for a planning-support monitoring program should involve one or more of the following key activities:

[1] Any stormwater monitoring conducted by Caltrans is likely to be part of a broader, statewide, Caltrans stormwater monitoring program. In this document, the terms "project" and "program" are used interchangeably to refer to any monitoring effort conducted under the statewide program.

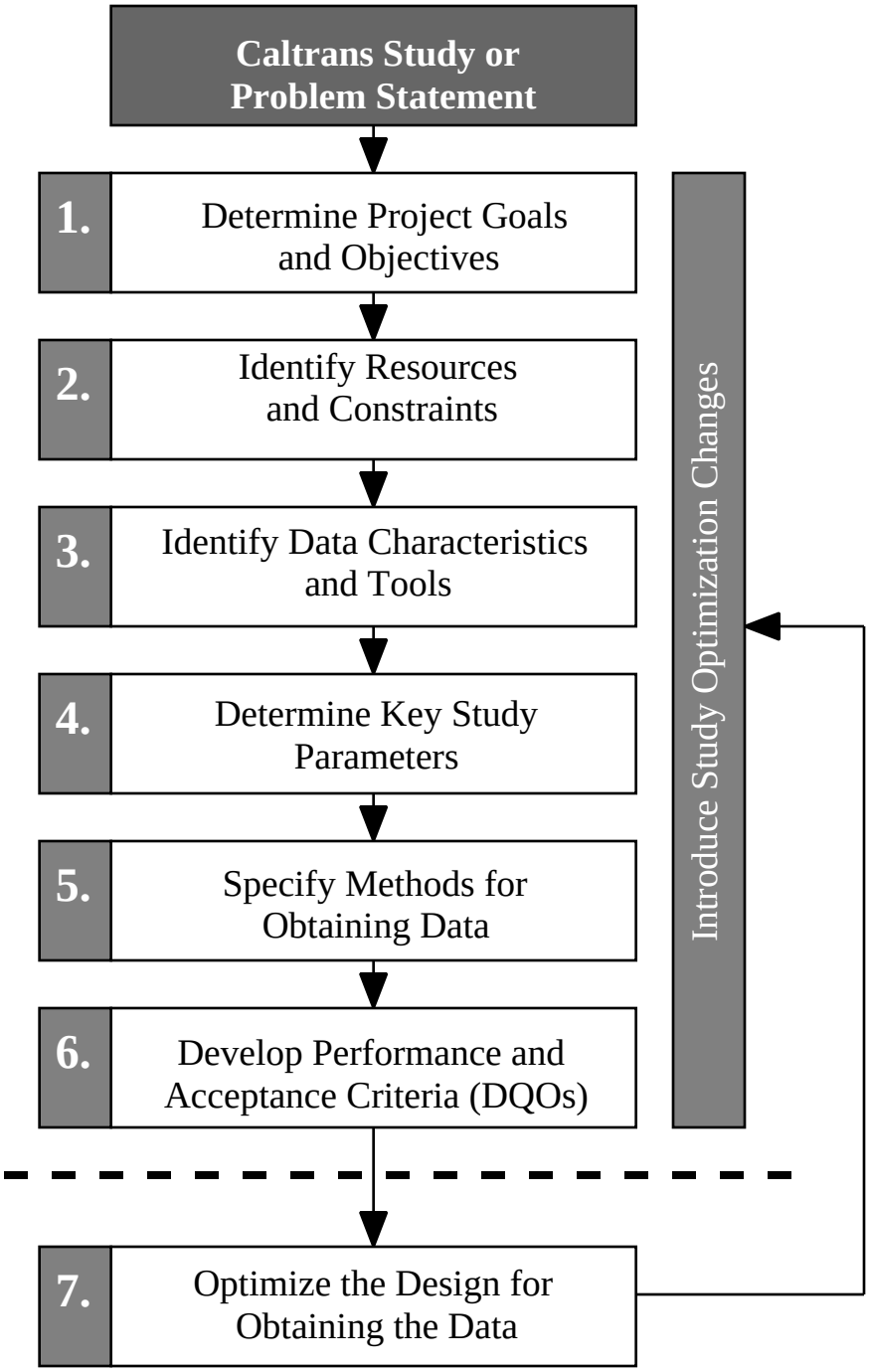

Figure 2-1. Systematic Planning Process Flow Chart

- Identification of factors that affect the concentrations and loads of problem constituents in transportation runoff,
- Identification of the physical and chemical mechanisms that affect the mobilization, transport, and transformation of problem constituents, and/or
- Evaluation of costs, effectiveness, and benefits of stormwater management practices (BMPs).

While the project goal is most often determined by Caltrans in previous planning documents or in the applicable task order, the project goal may need to be refined or restated once additional data are collected or additional resources and constraints are identified.

Once the goal of the study is well defined, the project purpose can be stated so as to direct the project to provide data to fulfill the study goal. The goal and purpose of the study are strongly linked.

Determine Specific Study Questions/Objectives

The statement of purpose and program goals should be used to develop specific questions that the monitoring program will be designed to answer. These study questions are also in may cases previously defined in the Caltrans Stormwater Management Plan (SWMP) and other Caltrans planning documents. Specific monitoring project objectives are then developed to provide answers to the specific study questions.

Any applicable regulatory or legal program requirements must be considered in formulating the key question(s) to be used in defining project objectives. The study questions and project objectives must be specific enough to provide the basis for a detailed study design.

Once study questions and objectives are known, specific project information needs are identified. The information needs must address the identified legal or regulatory requirements of the program, and focus the monitoring planning effort on providing answers to the key question(s) addressed by the project.

➤ IDENTIFY RESOURCES AND CONSTRAINTS

The specific resources available and constraints pertaining to implementing the monitoring project objectives should then be identified. Planned studies are often supported by a body of data resources from previous studies, as well as other existing resources such as personnel, equipment, and services. Studies are typically constrained

by time, available budget, physical limitations of the study area, and practical weather constraints (e.g., number of storms in a year). These resources and constraints must be well established during the planning process. At the start, the systematic planning process assumes that the fiscal constraints on a project are not primary. Practically speaking, budget constraints are known from the beginning and generally affect the scope and detail of the study. The project may also be constrained by applicable regulatory or legal requirements.

➤ IDENTIFY DATA CHARACTERISTICS AND TOOLS

The study design should specify the expected characteristics of the monitoring data and the planned data analysis tools, so as to optimize collection of data within the limitations of the proposed study and ensure that useful results will be provided to fulfill study objectives.

Essential data characteristics include the type of data to be collected (e.g., constituent concentrations), the variables affecting the data (e.g., antecedent conditions, rainfall intensity, site type and location), and the expected variability of the data (derived from previous studies when available). Statistical techniques such as power analysis can then be used to determine key study parameters, such as the number of monitoring locations and storm events to be monitored (see discussion below).

Prior to the initiation of environmental sampling, a strategy should be developed for analysis of the data, directed to answering the specific study questions. The selected data analysis technique(s) may influence the type and quantities of data required to satisfy study objectives. The analysis methods applied to data collected for BMP evaluations or characterization studies typically involve straight-forward statistical operations; however, Caltrans data may be applied to multiple applications in the future (e.g., modeling applications, comparisons to other studies, and assessments of contributions to receiving water loadings), and data should be collected and presented in a manner that will allow the most versatile use of the data.

➤ DETERMINE KEY STUDY PARAMETERS

Key parameters of the monitoring project are determined using the information gathered in the previous steps of the systematic planning process. Key study parameters include site selection (see ***Section 3***), number of monitored storm events and their temporal distribution, characteristics of target storm events, types of samples (composite, grab, etc.) and analytical constituents (see ***Section 4***). The better these characteristics are understood, the more efficiently the monitoring data can be collected.

The monitoring locations can be selected to optimize the physical monitoring of the environmental sample stream(s); this is discussed in more detail in ***Section 3***.

To the extent possible, the numbers of monitoring sites and events should be determined by the numbers and types of data points required to provide statistically significant answers to the key study questions, based on the known controlling variables and the expected variability of the data. Power analysis is a common statistical tool used for such purposes. It is also often helpful to consult with a statistician to identify key issues and variables at this stage of the planning process.

The planned numbers of sites and monitoring events are often constrained by fiscal factors; this involves not only the costs of sample collection, but also the costs of sample analysis. For this reason, the list of analytical constituents is often considered in the early stages of project planning (see ***Section 4***), so the costs of the appropriate sample collection and analysis can be factored into the expected cost per monitoring event. The analytical constituents are often prescribed by regulatory or legal mandate.

The types of storms to be monitored and optimal temporal distribution of monitoring events also should be considered during project planning. For example, if the project objectives include characterizing seasonal variation in stormwater quality, the monitoring events must be adequately distributed throughout the period(s) of interest. Besides seasonal distribution, a number of variables can be considered when selecting types of storms to monitor. These variables could include storm size (rainfall amount), duration, and antecedent conditions (such as number of days since the previous rainfall). Storm selection criteria should be developed to guide project managers in the appropriate selection of monitoring events during the monitoring season.

When developing storm selection criteria prior to a monitoring season (see ***Section 9***), special consideration should be given to allowing for characterization of a full range of the key variables such as antecedent conditions. Simple statistical techniques can be used to determine data collection gaps in previously collected data. These techniques include development of probability plots for key variables and identification of key variable ranges. If data variability has been determined, a power analysis can be used to help determine storm selection criteria and sampling frequency. Statistical expertise should be sought when these technically simpler analyses do not provide sufficient specific guidance.

➤ SPECIFY METHODS FOR OBTAINING DATA

Once the key study parameters are known, appropriate data collection methods are specified (see ***Sections 5, 10 and 12***). This includes the types of samples collected and sample collection techniques (flow-based composite, automated sampling, grab, etc.), the equipment used to collect the samples, the analytical methods, QA/QC procedures, and the specific procedures to be followed in accordance with the physical layout of the study site (e.g., which discharge flows best characterize the highway runoff and the practical considerations for collecting samples at that site). The sample collection methods must

consider the analytical method specifications for containers, sample type, and preservation (see ***Sections 5*** and ***12***).

➤ DEVELOP PERFORMANCE/ACCEPTANCE CRITERIA

The central goal of any monitoring program is to provide scientifically defensible data in fulfillment of program objectives. This goal is best achieved through scientific design of the program and sound technical planning. Statistical methods may be used in the design of the program to determine the optimum number of sampling sites and sampling events (monitoring frequency) that will be needed to fulfill specific project objectives. Performance acceptance criteria, also known as DQOs, should be specified for the project, to help ensure that the data produced by the monitoring program will be useful in addressing program objectives, and to establish meaningful confidence levels for the monitoring data.

DQOs, as defined for this guidance document, specify the quality of data required to support the specified objectives of the monitoring program. DQOs generally are used to determine the level of error considered to be acceptable in the data produced by the monitoring program; in large measure they are used to specify acceptable ranges of field sampling and laboratory performance.

Numerical DQOs should be established for constituent reporting limits, analytical precision, accuracy, completeness, and representativeness. These parameters are discussed in detail in ***Section 13***. The DQOs should be specified in the project Data Quality Evaluation Plan (see ***Section 13***) and referenced in the SAP.

Constituent reporting limits should be set low enough to reliably quantify constituents at meaningful levels. The primary goal of setting acceptable reporting limit concentrations should be to accurately quantify constituent concentrations. All efforts should be made to report constituent concentrations at levels greater than the reporting limit. Program-specific reporting limits may be modified if site-specific data demonstrate that any change would improve the overall quality of collected data and still meet the DQOs. For toxic constituents, reporting limits are set low enough to quantify the presence of the constituent at levels lower than the lowest Recommended Water Quality Criterion published by USEPA, whenever feasible.

Analytical precision and accuracy are often determined by historical laboratory performance; in some cases interlaboratory studies conducted by USEPA or others are used to set these limits. Each project should include a thorough QA/QC data review and evaluation to assess project success in meeting accuracy and precision acceptance criteria (see ***Section 13***).

Completeness refers to the percentage of samples that are sampled and analyzed as planned, for which results are found to be valid following QA/QC data validation (see ***Section 13***). A typical completeness level that can be expected of environmental analysis is 95%. Constituents that occur as common laboratory contaminants, such as phthalates, typically require a less restrictive DQO for completeness.

Representativeness criteria are discussed in detail in ***Section 10*** and are based on storm size, percent storm capture, and total number of composite sample aliquots.

➤ OPTIMIZE THE DESIGN FOR OBTAINING THE DATA

Ideally, the systematic planning process can be iterative for each project, as needed. It is possible to modify study parameters, with approval from the Caltrans task order manager, to optimize data collection to meet study objectives, based on newly collected data and field observations. This can sometimes be done during natural break points of the study (e.g., at the end of the wet season), when data are analyzed and achievement of study objectives is assessed. In some cases, the collected information may indicate modification of the study goals, the collection methods, the analytical constituent list, or the types and frequency of storms sampled.

The systematic planning process, as applied to the Caltrans Statewide Stormwater Monitoring Program, is a synthesis of currently evolving EPA guidance and the practical considerations of overall Caltrans goals (Caltrans, 2000). The seven-step process described in this section is the starting point for structuring specific Caltrans monitoring studies. The remaining sections of this manual carry out and build on these steps, from site selection to QA/QC data evaluation. The seven step process is iterative with the final step providing for feedback to any of the previous six steps.