Advanced Stormwater Monitoring

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Stormwater Monitoring – a Unique Set of Challenges

"Doing it right"

loosely defined as:

conducting the monitoring so as to produce meaningful, representative, and useful data of verifiable quality

requires extensive knowledge and preparation, and an even greater commitment.

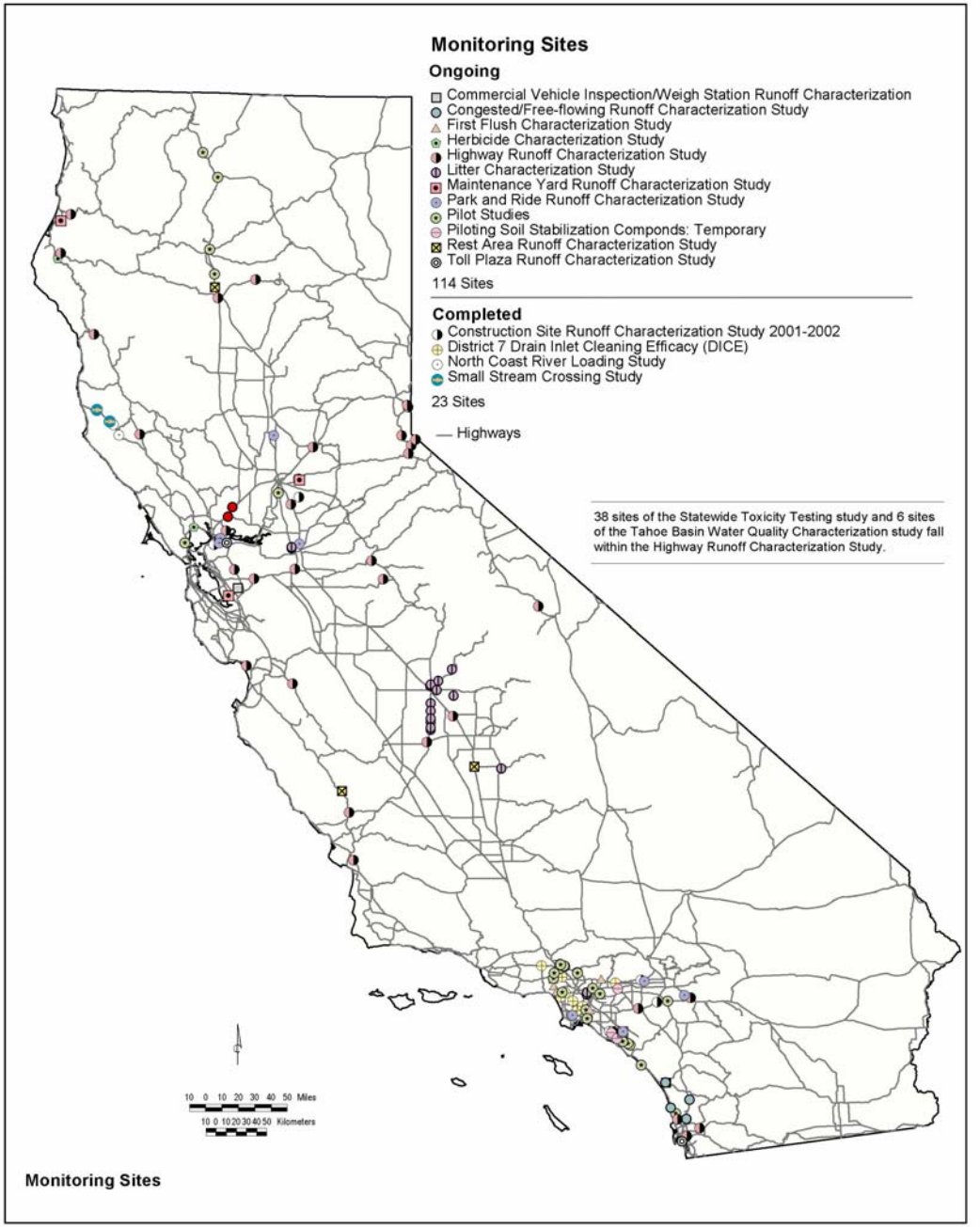
The California Department of Transportation (Caltrans)

Advanced System for Stormwater Monitoring Goals:

- Cost-effective programs,
- Produce data that have scientific credibility, and
- Produce information that is *useful in managing runoff from transportation facilities in California*

Caltrans Facilities

- Highways
- Construction sites
- Park and ride lots
- Maintenance yards



Locations of Caltrans storm water monitoring sites.

Covering the Bases

- Runoff Water Quality
- Sediment/Particle Quality
- Litter
- Toxicity

Table 4-1. Minimum Constituent List for Characterization[1]

	Units	*RL*
Constituent/Parameter name		
Conventional		
Conductivity	µmhos/cm	±1[2]
Hardness as $CaCO_3$	mg/L	2
pH	pH Units	±0.1[2]
Temperature	°C	±0.1[2]
Total Dissolved Solids (TDS)	mg/L	1
Total Suspended Solids (TSS)	mg/L	1
Dissolved Organic Carbon (DOC)	mg/L	1
Total Organic Carbon (TOC)	mg/L	1
Nutrients		
Nitrate as Nitrogen (NO_3-N)	mg/L	0.1
Total Kjeldahl Nitrogen (TKN)	mg/L	0.1
Total Phosphorous	mg/L	0.03
Dissolved Ortho-Phosphate	mg/L	0.03

Table 4-1. Minimum Constituent List for Characterization(1) continued

Metals (total recoverable and dissolved)		
Arsenic (As)	µg/L	1
Cadmium (Cd)	µg/L	0.2
Chromium (Cr)	µg/L	1
Copper (Cu)	µg/L	1
Lead (Pb)	µg/L	1
Nickel (Ni)	µg/L	2
Zinc (Zn)	µg/L	5
Organic Compounds(3)		
Diuron	µg/L	1
Glyphosate	µg/L	5
Oryzalin	µg/L	1
Oxadiazon	µg/L	0.05
Triclopyr	µg/L	0.1

(1) For analytical methods and other specifications, see ***Table 12-1*** in ***Section 12***.

(2) Refers to instrument resolution.

(3) Analysis for the listed herbicides applies to Caltrans statewide characterization monitoring only; this analysis may not be appropriate or necessary for other types of projects.

[Excerpted from: *Guidance Manual: Stormwater Monitoring Protocols*, Caltrans, 2000.]

Success Requires

- Careful and thorough advance planning,
- 24/7 commitment during the wet season, and
- Detailed follow-up/rigorous data validation

Comprehensive set of protocols and tools for stormwater monitoring –

An Advanced System

Monitoring Planning and Implementation

- Planning documents

  describe overview/scope of projects and their objectives
- Monitoring protocols guidance manuals

  covering all aspects of monitoring
- Data reporting protocols

  to ensure consistency in data formatting
- Comprehensive quality assurance/quality control system

Data Processing

Laboratory data validation and error checker software

- Hydrologic software utility
  - converts flow data into useful information
  - allows assessment re: sampling representativeness
- Relational database
  - user-friendly, geo-referenced interface
  - menu-driven querying
- Data analysis software tool
  - rapid production of summary statistics for selected data sets;
  - includes statistically-based handling of non-detect data

Planning Documents

- Three Year Action Plan
- Characterization Monitoring Plan
- Project-specific Sampling and Analysis Plan

Scientific Defensibility

- Standardized procedures
- Flow-proportioned composite sampling to improve sample representativeness
- Use of “clean” sampling techniques to reduce sample contamination
- A comprehensive QA/QC program to provide documentable data quality
- A hydrologic software utility to assess sample representativeness

Standardized Procedures

- Monitoring Protocols
- Data Reporting Protocols
- Data Management/Quality Control Oversight

Comprehensive Monitoring Protocols Guidance Manual

- Stormwater Runoff Water Quality Monitoring
- Particle/Sediment Quality Monitoring
- Litter Monitoring
- Toxicity Studies

Principal aims of the Guidance Manuals are to:

- Ensure consistency in monitoring methods throughout state
- Specify scientifically-sound sampling and analytical techniques
- Minimize contamination of environmental samples
- Produce data of verified quality

Guidance Manual: Stormwater Monitoring Protocols (Caltrans, 2000)
http://www.dot.ca.gov/hq/env/stormwater/special/index.htm

Data Reporting Protocols

- Detailed specifications for data fields and instructions for content
  - for all four data types

- Ensure data reported in consistent format – and data records include sufficient information

Automated Composite Sampling

- Flow-proportioned composite samples
  - most representative sampling regimen
  - accounts for variation in flow and/or runoff quality

- Standard Caltrans automated set-up:
  - automated composite sampler
  - flow meter
  - rain gauge
  - programmable data logger/controller

Quality Assurance/Quality Control

- Schedule listing the events and locations for:
  - field blanks
  - field duplicates
  - laboratory duplicates
  - matrix spike samples
- Data quality evaluation
  - results compared to the data quality objectives
  - suspect data are qualified (flagged) as necessary
  - follow up with the labs!
- Automated Data Validation (ADV) software
  - provides extensive error-checking
  - results in electronic data deliverable (EDD)
- Final data validation
  - EDD conforms to the Caltrans Data Reporting Protocols

Clean Sample Handling

Collect and handle water samples in a way that results in neither contamination, loss, or change in the chemical form of the analytes of interest.

Samples are collected only into rigorously pre-cleaned sample bottles.

- Pre-cleaned sample bottles and related equipment (sample tubing, strainers, etc.) are placed into double zip-lock bags by the laboratory performing the cleaning.
- At least two persons, wearing clean, powder-free nitrile gloves at all times, are required on a sampling crew.
- One person (“dirty hands”) touches and opens only the outer bag of all double bagged items (such as sample bottles, tubing, strainers and lids), avoiding touching the inside of the bag.
- The other person (“clean hands”) reaches into the outer bag, opens the inner bag, and removes the clean item (sample bottle, tubing, lid, strainer, etc.).
- After a grab sample is collected, or when a clean item must be re-bagged, it is done in the opposite order from which it was removed.
- Clean, powder-free nitrile gloves are changed whenever something not known to be clean has been touched.
- Clean techniques must be employed whenever handling containers or equipment used for collection of samples for trace metals or organics analysis.

Clean Sample Handling continued

To reduce potential sample contamination, sample collection personnel must adhere to the following rules at all times while collecting or handling samples:

- No smoking!
- Always wear clean, powder-free, nitrile or similar surgical-quality gloves when handling sample containers.
- Never sample near a running vehicle. Do not park vehicles in immediate sample collection area (even non-running vehicles).
- Minimize the amount of time any sample container is left open.
- Do not set lids down where they may accumulate contaminants.
- Prevent foreign material (blowing dust, leaves, etc.) from entering any open sample container.
- Never touch the inside surfaces of sample bottles, lids, or composite carboys, even with gloved hands.
- Never touch the exposed end of a sampling tube.
- Avoid allowing rainwater to drip from rain gear into sample bottles.
- Do not eat or drink during sample collection.
- Do not breathe, sneeze or cough in the direction of an open sample bottle.

Sample Representativeness

Minimum number of sample aliquots

Minimum “percent capture”

(=percentage of total event runoff flow during which composite sample collection occurred)

Table 10-1. Monitoring Event Representativeness Requirements

Total Event Precipitation	*Minimum Acceptable Number of Aliquots*	*Percent Capture Requirement*
•0-0.25”	•6	•85
•0.25-0.5”	•8	•80
•0.5-1”	•10	•80
•>1”	•12	•75

[Excerpted from: *Guidance Manual: Stormwater Monitoring Protocols*, Caltrans, 2000.]

Hydrologic Software Utility

Assess composite sample representativenss

Calculates:

- total flow volume
- total event rain
- estimated percent capture

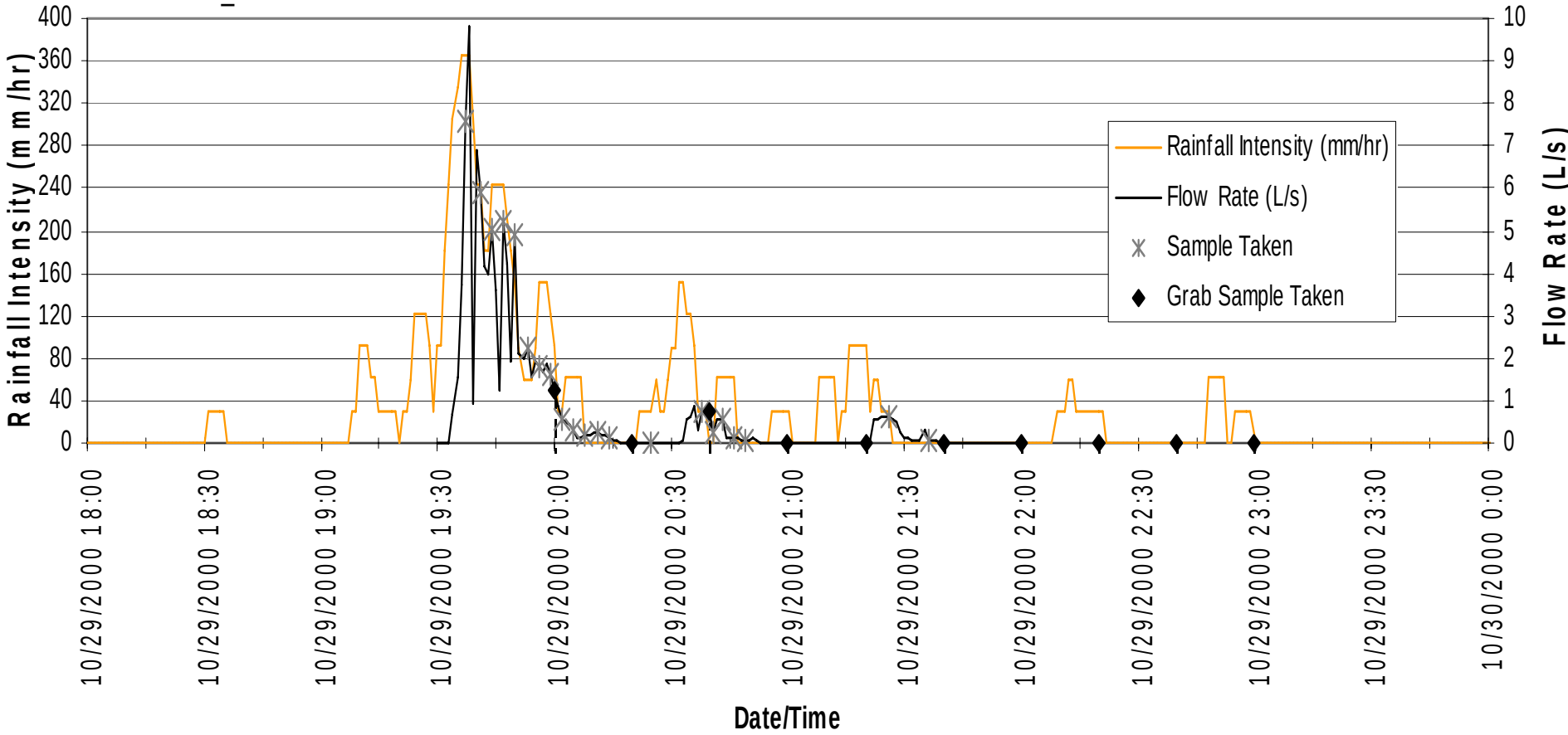
generates a hydrograph and a hyetograph

installed as an “Add In” in Microsoft Excel

Event Summary

Site: HWY (HWY-01)
Event: LAW_CT-01

Catchment Area (ha): 0.001
Assumed Fraction Runoff/Rain Volume: 1



Rain Data

Start Date/Time:	10/29/00 18:31
Stop Date/Time:	10/30/00 00:03
Event Rain (mm):	197.20
Max Intensity (mm/hr):	366.00

Runoff Data

Start Date/Time:	10/29/00 19:30
Stop Date/Time:	10/29/00 22:00
Total Flow Volume (L):	6378
Peak Flow (L/s):	9.84
Obs. Fraction Runoff/Rain Volume:	3.234

Sample Data

Start Date/Time:	10/29/00 19:30
Stop Date/Time:	10/29/00 21:38
Estimated Percent Capture:	95%
Successful Aliquots:	21

Notes: Sample 2 data.

Data Management

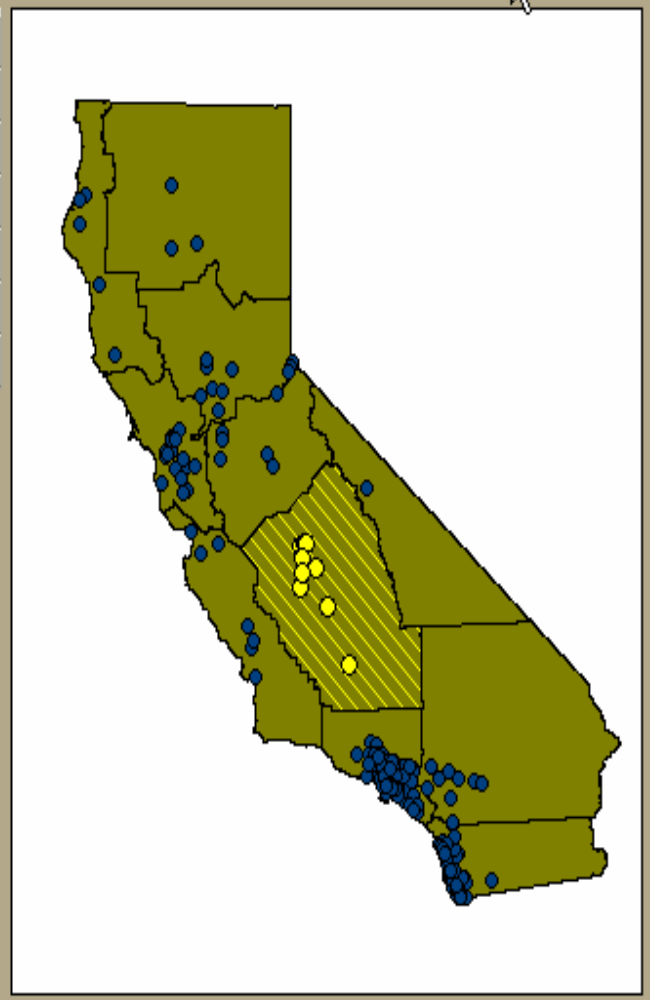
User-Friendly Interface

GIS-based map feature
menu-driven query screen
quick and easy retrieval of data

Data Analysis Software Tool

efficiently generate descriptive statistics
including handling of non-detect data

CALTRANS Storm Water Management Program



Select For Query | District | Clear Map Selections

Site ID: All Sites Selected

View By Site ID | View By CT District | View By RWQCB

Caltrans

Caltrans Monitoring and Water Quality Research Program

Data Management Tool

Select Data Type: Water Chem

Select Primary Query Parameters

- Regional Board: 1, 2, 3, 4
- Caltrans District: 1, 2, 3, 4 → 6
- Caltrans Site IDs: 6-01, 6-02, 6-03, 6-04, 6-05, 6-06, 6-07
- All Sites
- Confirm Primary Query Selection

Select Secondary Query Parameters

- Runoff Character: Construction, Hwy, Maintenance → Construction
- Surface Type: Pavement, Right-of-Way
- Event Representation: Peak, Whole → Peak
- Sample Matrix: Water → Water
- Confirm Secondary Query Selection

Select Remaining Query Parameters

- Date Range: Start 11/10/1997 End 1/23/1999
- Constituent Type: CON, HC, ION → CON, HC
- Constituent: BOD, COD, EC → BOD, COD, EC
- All Constits
- Fraction
- Confirm Remaining Query Selection

Get Data For Preview

Show Data Table

Clear All Selections and Requery